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Ecology & Evolution: New perspectives  
and societal challenges

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00007

## Smallholder agricultural landscapes in the African tropics maintain functional insect biodiversity despite seasonal variation

Oral

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### Abstract

Insects play a central role in agricultural ecosystems. Some are detrimental to crops and yields, but others provide crucial ecosystem services to farmers around the world. Consequently, recent reports of insect declines have raised major concerns. Most of the supporting evidence, however, was collected in temperate regions, whereas insects in Sub-Saharan Africa, especially in agricultural landscapes, are largely understudied. To date, a systematic quantitative assessment of flying insects across multiple taxa in tropical smallholder farming systems of Sub-Saharan Africa is missing. Here, we investigated if and to what extent habitat, season and the surrounding landscape play a role in shaping flying insect communities in this region. We assessed differences in arthropod biomass, taxon richness and community composition of five functional groups of flying insects (herbivores, omnivores, parasitoids, pollinators and predators) using Malaise traps. We compared collections from traps in farmland vs. shrubland at 24 study sites along a landscape complexity gradient in a smallholder agricultural region in northern Malawi at four different times throughout the year. Bulk arthropod samples were identified through DNA metabarcoding, yielding a total of 6970 taxa from 15 different insect orders. We found that, on average, dry arthropod biomass was 33 % higher in farmland than in shrubland, with its peak in the late rainy season. Taxa richness of all functional groups was not different between habitats within each individual survey, but was significantly higher in shrubland for herbivores and pollinators when surveys were pooled across the year. Additionally, we found that farm- and shrubland supported different taxa assemblages that varied significantly across the year, for both the overall insect community and for each of the functional groups. There were scale-dependent landscape effects on taxa richness of some functional groups, but no landscape effects on dry biomass. Our results indicate that, while biomass, insect richness and taxa assemblages strongly vary with season, each habitat supports a unique insect community assemblage and functional biodiversity is maintained throughout the year. We recommend preserving the remaining shrubland in the agricultural landscape as source habitat to ensure the conservation of diverse flying insect communities in tropical smallholder farming landscapes.

00013

## **Aphid conservation biological control in arable crops via flower strips: the predominant role of plant resources over diversity effects**

Oral

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Abstract

The implementation of habitats to improve functional biodiversity is known to increase natural enemies of pests, but it does not necessarily lead to a significant reduction in pest populations. The performance of flower strips and natural enemies in terms of biological control depends on many factors and we need to understand why some mixtures of plant species perform better than others.

In a field experiment, we compared the effect of contrasting floral mixtures comprising native and perennial plant species. In these mixtures, we have varied the proportion, the species and functional diversity of plant species providing resources towards natural enemies. Each flower mixture was sown on a 6 × 45 m strip and replicated on three blocks. In the adjacent oilseed rape crop, at 5 and 20 m from the strip, we recorded aphids, their predators and parasitized aphids in all the crops at rotation scale (wheat, maize, barley, pea-barley intercrop, faba bean and oilseed rape). We investigated the effects of the plant mixtures on aphid infestation, predator-prey ratios and parasitism rates. The observed plant composition of the different mixtures was characterized by the species richness and the functional diversity of the plant traits involved in plant–insect interactions.

In general, the percentage of plant cover providing trophic resources to natural enemies (nectar resources and alternative prey hosted by legumes) increased predator-prey ratios as well as aphid parasitism, and it decreased aphid population growth rates. Species richness and the functional dispersion of traits involved in plant-arthropod interactions had a lower importance and the direction of their effect was crop specific.

These results provide useful insights into the design of perennial plant mixtures for creating or restoring habitats supporting a range natural enemies. Plant communities providing large amounts of nectar and alternative-prey resources are the best able to enhance the biological control of aphids over a crop rotation.

00056

## Effects of crop management at the landscape scale on biodiversity : a review and research perspectives

Oral

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### Abstract

Agricultural activity, through farming practices and landscape changes, is an important driver of biodiversity and ecosystem service provision. While the relationship between land-use and biodiversity is widely studied, few studies consider the "hidden" heterogeneity of agricultural landscapes represented by crop management. Indeed, most species living in agroecosystems are affected by the intensity and spatial distribution of farming practices, which can be as—or even more—influential as the diversity of crops and non-crop habitats. The objective of our review is to assess 1) how crop management was described at the landscape scale and 2) the estimated effects on biodiversity and potential of ecosystem service provision. According to a Web of Science request, we retrieved 133 original studies dealing with the broad notion of crop management at the landscape scale and rejected studies only considering land-cover and land-use metrics. Three components of crop management are studied in analyzed papers: effect of agricultural system (i.e., organic vs. conventional farming), effect of crop rotation, and effect of individual farming practices (e.g., soil tillage, pesticide or nitrogen use). Natural enemies, insect pests, pollinators, birds, and weeds are the primary organisms for which the effect of crop management at the landscape scale has been studied. Overall, preliminary results show that many studies examine the effect of a single component of crop management (in most cases, the effect of organic farming) and do not compare the effects of crop management at the local and landscape scales. Extensiveness of crop management in the landscape seems to benefit biodiversity and the provision of ecosystem services. While expansion of organic farming in the landscape benefits to pollinators and weeds, diversification of rotation has positive effect on bird. Individual farming practices have shown species and practices-dependent effects, suggesting that the direction of effect is not obvious and deserves to be studied. Our findings suggest that the interest for crop management in the landscape needs to be reinforced in ecological studies. A better knowledge of their impact on biodiversity would allow intensifying the joint landscape-scale management of both heterogeneities of land use and crop management.

00097

# Contrasting effects of landscape composition and configuration on farmland bird and bat communities

Oral

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## Abstract

Agricultural expansion and intensification are major threats to European biodiversity. In particular, the homogenization of agricultural landscapes, with ever larger fields and reduced crop diversity, may threaten farmland biodiversity, such as birds and bats. However, how agricultural landscape composition (e.g., crop diversity) and configuration (e.g., field size) affect birds and bats is still little understood.

In summer 2021, we surveyed 32 study landscapes in southern Germany around Stuttgart, covering independent gradients in landscape composition and configuration. These study areas were monitored for at least 7 days with acoustic recorders (Audiomoths) to determine bat and bird communities. We collected a total of 386.25 hours of audio recordings, distributed over 282 recording. We automatically filtered the audio recordings for bat calls, which were then manually analysed and identified. We counted a total of 4211 bat passes and assigned them to 5 sonotypes, with the common pipistrelle being the most frequently recorded species (77%). Recordings containing bird calls were analysed using BirdNET-Analyzer, resulting in a total of 17942 detections of 78 species. The most frequently recorded bird species were skylark (44 %), followed by yellowhammer (18 %).

We found that the effects of landscape composition and configuration strongly differed between bat and bird communities. While structural elements such as hedges or tree rows were important predictors of bat diversity and activity, field size had no influence. For birds, however, field size was a strong predictor, with small fields hosting the lowest bird diversity, but at the same time the highest bird activity. The effect of crop diversity was consistent for bats and birds, with fields with medium crop diversity having the highest bat and bird diversity and activity. In addition, species traits (e.g., body size or foraging guild) affected bird responses.

Our study emphasises the great importance of composition and configuration of the agricultural landscape matrix, with differing effects between bat and bird communities. While bats primarily depend on structural elements for foraging and dispersal, promoting farmland birds may require the conservation of a small-scale agricultural matrix that is at odds with current developments towards increasing field sizes and homogenized landscapes.

**00107**

# **Agroforestry and biodiversity in temperate silvoarable systems**

Oral

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Abstract

Silvoarable systems (SAS) are agroforestry systems where trees are closely linked to arable cropping, often in alleys (alley cropping systems). They have the potential to provide many agricultural and environmental benefits, are innovative and expanding. As diversified farming systems, they have the potential to influence biodiversity and related ecosystem services (ES). This presentation reviews the scientific knowledge on the link between temperate SAS and biodiversity at all taxonomical levels (plants, microorganisms, invertebrates and vertebrates). This concerns both the potential interest of these systems for biodiversity conservation, as well as their impact on ES or disservices provided by the diversity of organisms present. This work is a summary of a systematic review where 45 articles corresponding to the issue were identified among 3458 references from the Web of Sciences database. SAS have a positive impact on biodiversity conservation for the different taxonomic groups. Regarding ES, the few papers that studied the effect on pollinators or pollination also showed a positive effect. The majority of studies on natural predators and biocontrol, as well as those on soil organisms and related supporting services, showed a positive effect of SAS. However, some studies failed to show this or showed the opposite effect depending on specific conditions. For weeds, pests and damages, data are limited and results are contrasted according to studies. Different parameters that can influence this biodiversity and the resulting services have been listed: influence of the location, crop and agroforestry management. The influence of the experimental design was also reported, for example control and comparison used or sampling methods. Moreover, the link with other ES (mainly provisioning but also cultural services) is discussed. Finally, a prospect for future research is made and advices are proposed in line with the issues discussed in this work.

00108

## What are the global effects of agricultural management on biodiversity? Research we know, research we need.

Oral

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Abstract

Agriculture, as the largest managed biome, represents both a land-use with great impacts on ecosystems and great potentialities to a better sustainability of climate mitigation, food security and biodiversity. Yet, its effects on biodiversity importantly vary among agricultural managements. Currently, no global synthesis analysing the available evidence of multiple individual or combined agricultural intervention on biodiversity exists.

Here, we systematically synthesise evidence of the published meta-analyses on the effects of: individual practices (fertilization, crop diversification, tillage, pest and disease management, residues management, water management), agro-ecological systems (agroforestry, conservation agriculture, organic agriculture) and landscape scale management (landscape complexity, land-use change), on various biodiversity groups in croplands. We searched through four online search engines on July 2021. We thereby identified more than 150 meta-analyses to create a database representing ca. 1500 effect-sizes. From this, we produce: (i) an evidence map highlighting the data availability and knowledge gaps, and (ii) a vote-counting analysis representing the positive/neutral/negative effects of agricultural interventions on biodiversity.

First, our results show that most of the meta-analyses focus on the effects of one individual agricultural practice: mainly fertilization (mineral or organic) and crop diversification. In contrast we gathered less meta-analyses on agricultural systems or landscape scale effects. All agricultural interventions highlighted micro-organisms as the most studied biodiversity group, followed by invertebrates (predominantly arthropods) and weeds. We notice that notably megafauna and avifauna are scarcely represented. For all biodiversity groups, the most studied metrics are biomass, abundance and taxonomic richness, while activity metrics are highly represented only in micro-organisms. Trait-based functional responses are very few represented.

Second, our results highlight that when several meta-analyses focused on the same intervention-biodiversity combination, they mainly yielded contradictory results (e.g. organic agriculture) suggesting a lack of statistical power or very variable effect according to environmental factors. Conversely, few intervention-biodiversity combinations lead to homogenous results (e.g. crop diversification benefits microorganisms).

We finally discuss the need for further research on (i) specific intervention-biodiversity combinations, and (ii) for balanced effects of agricultural management on biodiversity, thus opening perspectives in moderation effects from various factors such as biogeography, climate, soil characteristics, etc.



00113

## Floral resource diversification promotes solitary bee reproduction and may offset insecticide effects

Oral

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### Abstract

Pollinator declines in agricultural landscapes are driven by multiple stressors, but potential interactions of these remain poorly studied. Using a highly replicated semi-field study with 56 mesocosms of varying wild plant diversity (2–16 species) and oilseed rape treated with a neonicotinoid, we tested the interacting effects of resource diversity and insecticides on reproduction of a solitary wild bee. Compared to mesocosms with oilseed rape monocultures, availability of resources from wild plants complementing oilseed rape doubled brood cell production. In addition, bee reproduction increased due to plant diversity and identity effects. Exposure to neonicotinoid-treated oilseed rape reduced bee larval to adult development by 69%, but only in mesocosms with oilseed rape monocultures. Availability of complementary flower resources can thus offset negative effects of neonicotinoid-treated oilseed rape on wild bee reproduction. Policy should encourage the implementation of diverse floral resources mitigating negative effects of crop monocultures and insecticides, thereby sustaining solitary bee populations in agricultural landscapes.

**00163**

**Unearthing the effect of cropping systems on soil biodiversity: indicators to describe disturbances caused by agricultural practices**

Oral

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Abstract

Soil organisms are key actors of agroecosystem functioning, especially as they drive soil physical and chemical fertility (Brussaard et al., 2007). In intensively cropped soils, their density and diversity are particularly low due to a wide range of physical and chemical disturbances caused by management practices (Christel et al., 2021). Thus, it is crucial to understand the consequences of various practices on soil organisms in order to develop alternative cropping systems that will rely on soil biodiversity. However, we still lack understanding on the agronomic levers that could promote soil organisms. Indeed, most studies on agricultural soils assess biodiversity by distinguishing between the main cropping systems, usually conventional, organic and no-till systems. Under real conditions, even within these broad categories of systems, there is a wide diversity of practices. This actual gradient of practices may be responsible for a large part of the observed variability and can lead to a misinterpretation of their effects on soil biodiversity.

Indicators have been developed by agronomists in order to better characterize cropping systems and to overcome the usual system classification. In this study, we use those indicators, not only to describe cropping systems more finely, but also to assess the effect of physical and chemical disturbances on the soil community. We rely on a recent methodology to select indicators belonging to three categories: soil disturbance and protection, organic matter inputs and nitrogen fertilization, and crop protection.

Soil macrofauna, mesofauna and microorganisms were sampled in 21 fields during autumn 2020 and 2021. We sorted organisms by groups, and identified earthworms, collembola, fungi and bacteria at the species level. Management practices on all fields were collected by conducting exhaustive farmer surveys. Resulting indicators revealed gradients of disturbance intensity among fields. The relationship between these indicators and the density and diversity of the sampled soil organisms enable us to evaluate the intensity of soil community disturbance. Overall, the variability of soil biodiversity among fields remains high. Therefore, future studies are necessary to fully assess the potential of those indicators to describe the effect of various cropping systems on soil biodiversity.

00176

# Environmentally friendly landscape management improves oilseed rape yields by increasing pollinators and reducing pests

Oral

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Abstract

Pollination and pest control are two major ecological functions sustaining crop yield. In insect-pollinated crops, previous studies have revealed that an increase of resources and habitats in landscapes can increase pest control by natural enemies as well as insect pollination by pollinators. However, data have been lacking that simultaneously considers the effects of landscape on both pollinators and pests, and the direct and indirect effects on yields of farming practices interacting with landscape, bees and pests. This study aimed to fill this gap by focusing on oilseed rape (OSR), an insect-pollinated crop of high economic value. We first quantified the effects of landscape and farming practices on both bee and pest abundance caught in OSR blooming season in 124 farmed fields over a six-year study, and then used structural equation modelling to assess the direct and indirect links between bees, pests, farming practices and landscape on yield. The results showed that landscape had a stronger effect on bee and pest abundance than agrochemical farming practices. Bees and pests decreased with the amount of OSR in the landscape surrounding the focal field, and showed contrasted effects with the amount of meadow and organic farming i.e. positive for bees and negative for pests. Bee abundance also increased with the amount of sunflower in the landscape the preceding year, and decreased with increasing field size. While agrochemicals surprisingly had barely any effect on bees and pests, their use improved OSR yield, though at a similar magnitude as bee and pest abundances. This study, conducted in commercial crop fields, underlines the important contribution of sustainable landscape management for enhancing OSR yield. Despite agrochemicals' ability to improve or maintain OSR yields, their unconditional use is unsustainable due to negative externalities. Therefore, alternative options such as those highlighted in our study – such as reducing field size, increasing the amount of organic farming in the landscape, or sowing OSR in landscapes rich in sunflowers the preceding year – appear to be relevant tools to promote ecosystem services, maintain yield and conserve biodiversity. These findings support the potential of nature-based solutions to foster more sustainable agriculture.

00177

# Effects of configurational and compositional crop heterogeneity on farmland birds revealed with national-scale bird monitoring data

Oral

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Abstract

Agricultural management and landscape structure have been changing strongly across Europe over the past decades. Crop rotations and crop portfolios became less diverse and field sizes increased leading to an ongoing homogenization of the landscape. The configuration of landscapes (size, shape and spatial arrangement of land-use patches), in addition to their composition (proportion and heterogeneity of land-use types), has been proposed to be a key determinant of biodiversity patterns and associated ecosystem services in agricultural landscapes. Recent results suggest that enhancing landscape heterogeneity by increasing crop heterogeneity itself can be an effective way to increase farmland biodiversity without taking land out of production. However, studies investigating the effects of crop heterogeneity on farmland biodiversity are still scarce and it remains largely unexplored how these effects are modulated by woody semi-natural features and how they vary with species traits.

We combined a large dataset on common farmland birds from the German Common Breeding Bird Monitoring with a novel crop type map derived from dense time series of remote sensing data. From these, we derived the diversity of functional crop types, mean field size and estimated the cover of small woody features. Across countrywide gradients, we derived the effects of crop diversity and field size on farmland bird diversity and abundance. As we expected similar responses of species based on the degree of their association with small woody features, we grouped them accordingly and explored whether responses differed between groups. We further tested whether the effects of compositional and configurational crop heterogeneity on farmland bird diversity and on the abundance of species groups were modulated by the cover of woody features in a landscape. Based on our results, we discuss the impact of recent changes in agricultural landscapes on bird populations in Germany and develop recommendations for agricultural policies that aim at preserving farmland birds while considering target species groups, landscape compositional and configurational crop heterogeneity.

00181

## Livestock density affects species richness and ecological traits of butterflies at the national scale

Oral

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Abstract

Over the past century European agricultural landscapes have changed dramatically. Land-use change and deterioration in habitat quality through agricultural intensification have led to a loss of grassland habitats. Numerous groups of insects dependent on permanent, extensively managed grasslands are suffering from ongoing land-use intensification caused by an increase of herbivores livestock density, higher mowing frequency, and increased nitrogen fertilization. So far, studies on the effects of land-use intensity mainly have analysed processes operating at local scales and evidence on the effects across broad geographic extents remain scarce. It further remains largely unexplored how these effects are modulated by species traits, i.e. habitat specialisation and mobility.

Using nation-wide butterfly data from the German Butterfly Monitoring Scheme, we investigated the effects of three indicators related to land cover and agricultural land-use intensity within a 2-km buffer surrounding each butterfly transect. Based on agricultural census data with a spatial resolution at municipality level, we analysed the relationship between the share of permanent grasslands and the total livestock density (as a proxy for organic fertilization) as well as the herbivores livestock density (as a proxy for management intensity) on species richness and trait composition of butterfly communities. We found a negative relationship of butterfly species richness to the indicator related to the herbivores livestock density. Further, habitat specialisation decreased and the size of butterflies increased with increasing herbivores livestock density, indicating a shift in communities towards mobile habitat generalists with increasing herbivores stocking rate. Our findings corroborate studies on the effects of grassland management intensity on insect diversity carried out at local scale and highlight the importance of low herbivores livestock densities to halting the loss of pollinating insects and safeguard biodiversity as well as associated ecosystem services. We here demonstrate that indicators related to grassland management intensity based on livestock distribution data at the municipality level can provide inside into processes and spatial diversity patterns of butterflies at the national scale. Further, we highlight potentials and limitations of using agricultural census data to quantify and assess effects of land cover and land-use intensity on butterflies, and make recommendations for further research needs.

00183

## Direct and indirect effects of birds and landscape structure on leaf damage in organic apple orchards

Oral

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### Abstract

Bird predation on arthropods can influence plant damage, which can affect pest control in agroecosystems. Yet, the effects of birds on pest control are often context-dependent and such that it varies between landscapes. A more detailed examination of direct and indirect interactions between birds, predatory and herbivorous arthropods may contribute to a better understanding of variable effects of birds on plant damage.

We surveyed bird abundance and activity, predatory arthropods, pest infestations and leaf damage on 44 apple trees in 11 organic apple orchards in Sweden. From bud burst until fruit maturity, we excluded birds from the canopy of 22 trees. We hypothesized that bird effects on plant damage would be mediated via their effects on predatory and herbivorous arthropods. We assessed the influence of landscape factors on each trophic level and analysed direct and indirect links between birds, predators, herbivores and plant damage using a piecewise structural equation modelling framework.

We observed either positive, negative or neutral effects of bird exclusion, depending on the landscape context. We found both direct and indirect effects of birds on apple leaf damage; however, our expectation that bird effects would be mediated via predatory arthropods was not supported. Leaf damage was positively linked to pest infestation rate, as expected. Damage by larvae was reduced on trees with high bird activity and in landscapes with high orchard cover. Damage by aphids was lower in orchards with high bird abundance and high cover of large trees. Orchard landscape cover was an important driver of pest infestation rate, but had opposite effects on larvae and aphids. Abundance of predatory arthropods and bird activity were mainly influenced by cover of large trees and local vegetation management.

Our results show that several local and landscape drivers influence herbivorous pests in apple orchards and the damage they cause. The findings also indicate that during years with low pest infestation rate and low arthropod abundance, the links between birds, predatory arthropods and pests are relatively weak. The results suggest that landscape context and local pest population size are potentially important determinants of the overall effects of birds on herbivore-predator interactions.

00214

# Biodiversity of arthropods in viticulture – Influence of management and landscape

Oral

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Abstract

Arthropod biodiversity has strongly declined in many agricultural landscapes in the past decades, which is, among other reasons, attributed to intensified agriculture. However, it is not known whether such negative trends are also occurring in viticulture, where the conditions for species may have recently improved in the context of integrated plant protection with no further use of insecticides and the establishment of greening in the inter-rows of vineyards. The occurrence of species in viticulture can be influenced both by management practices within the vineyard and by the surrounding landscape. Besides the use of either conventional or organic pesticides, the frequency of spraying can have an impact on arthropods. The cultivation of fungus-resistant grapevine varieties (PIWI), for example, allows major reductions of pesticides compared to classical varieties and can thus be beneficial for biodiversity. Greening of inter-rows as well as semi-natural habitat structures in the surrounding area can also promote biodiversity by providing feeding and nesting resources for various species.

In this project, we are investigating how local management, the cultivation of PIWI grapevine varieties, and the surrounding landscape affect the biodiversity of arthropods in vineyards. Using e.g. Malaise traps, we assess biodiversity in eight landscapes in the wine-growing region Palatinate in southwest Germany, which form a gradient in the proportion of semi-natural habitats within a radius of 1,000 meters of the vineyards. In each landscape, we sampled two conventionally and two organically managed plots, planted with either a classical or a PIWI grapevine variety. Species are determined using morphological and molecular methods (metabarcoding). Preliminary results indicate dominant effects of landscape structure on flying insects. Locally, the benefits of fungus-resistant varieties appear stronger than of organic farming. The study is part of the “National Monitoring of Biodiversity in Agricultural Landscapes” (MonViA) and is intended to form the basis for a long-term monitoring of arthropods in viticulture.

00270

# Does permaculture enable an ecologically sustainable agriculture?

Oral

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## Abstract

Industrial agriculture is a strong driver of today's main environmental problems, such as biodiversity loss, climate change and soil degradation. Permaculture is a promising design system for sustainable, agroecological farming. However, there is a lack of scientific evidence on the effectiveness of permaculture.

In this study we investigated nine farms with permaculture in Germany and Luxembourg and direct control fields of locally predominant agriculture. We determined different indicators for species biodiversity, carbon storage and soil quality. For permaculture, area weighted means were calculated among different land use types for comparison with control fields.

Compared to control fields, on permaculture plots we found on average 4.7 times more vascular plant species and 2.6 times more earthworm species. Soil organic carbon storage within 30 cm was 36 % higher and depth of humic topsoil layer was 56% higher on permaculture plots. On permaculture plots we found 21 % lower soil bulk density, 2.9 times higher earthworm abundance and a tendency to 42% higher phospholipid fatty acid concentration as indicator for microbial biomass.

We conclude that permaculture can meet its claims on biodiversity and soil conservation. We suggest to further investigate those innovative agricultural systems to facilitate a transition to sustainable agroecosystems.



00291

## Reviewing the evidence base for synergies and trade-offs between agricultural yield and biodiversity

Oral

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### Abstract

As farmland biodiversity declines worldwide at an accelerated speed in the last decades, several agri-environment schemes (AES) have been developed to combat this challenge. AES are implemented in the agricultural landscape to increase biodiversity and maintain ecosystem services, such as pollination or pest control. However, the effectiveness of AES in increasing biodiversity and agricultural yield via ecological intensification, and especially their trade-offs, are still poorly understood. We performed a systematic review including meta-analyses to investigate synergies and trade-offs between the effectiveness of AES for arthropods and agricultural yield on cropland. Altogether, we found 24 studies with 107 data points, which fulfilled our study inclusion criteria for a meta-analysis. From each study we extracted biodiversity (arthropods species richness and/or abundance) and yield data for AES management and conventional control groups. We used the log response ratio as a measure of effect size for both arthropod biodiversity and yield. Additionally, we calculated the compatibility index from conventional to AES as an additive effect of biodiversity effect size (generally a gain) and yield effect size (often a loss). Our results showed that the majority of the studies reported that arthropods had higher species richness and abundance, but lower yield on AES than on conventional farms. Still, we found evidence that it is possible to produce crops in environmentally-friendly ways supporting biodiversity, while concurrently farmers can get an even higher yield than in current conventional agricultural practice. Additionally, our results showed that AES can be very effective for pollinators species richness and abundance and also for yield. On the contrary, the compatibility index was significantly lower for natural enemies, indicating that the trade-off between biodiversity (natural enemies) vs. yield is inclined to conventional farming. Thus, there is evidence that there are winners and losers also among arthropod functional groups. We found that in-production vs. out of production AES, organic farming vs. other AES types and complex vs. simple landscape conditions moderated also the compatibility index. Still, future research is needed to invest more effort to clarify what is the optimal trade-off between biodiversity and yield.

**00296**

## **Interacting effects of agri-environmental measures and landscape structure on bee biodiversity in agricultural landscapes**

Oral

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### Abstract

In recent years a dramatic decline in the biomass, abundance and biodiversity of insects has been reported, which also affects wild bees. Almost half of all bee species are red listed in Germany and are therefore threatened with extinction. One of the most important causes of their decline is agricultural intensification, which leads to a reduction in floral resources and loss of habitats. Organic farming and flower fields are two popular agri-environment schemes (AES) which have been shown to enhance bee diversity and abundance in farmland by providing floral resources. However, it remains unknown how these two AES interact at the landscape scale and how their effectiveness changes with the availability of semi-natural habitats (SNH), which might provide important nesting and foraging sites. We expected to find highest wild bee abundance and diversity in landscapes with high amounts of all three habitat types, both forms of AES and SNH.

To examine these potentially interactive effects, we selected 32 landscapes with three independent landscape gradients (percentage area of organic crops, annual flower fields and SNH) and conducted transect walks over three sampling rounds to record flower visiting bees. Transect walks were conducted in seven locations per landscape that were spread across the study landscapes.

Initial results show that a higher amount of annual flower fields in the landscape positively affects the abundance of wild bees, but their benefits for wild bees are only seen if the cover of organic crops is low. This effect could be due to the high amount of floral resources which, when already provided by organic farming, make an additional surplus of flowers ineffective without providing more nesting sites. Surprisingly, SNHs had no effect on wild bees, maybe because the quality of an SNH is more important than its spatial extent.

Our preliminary results indicate that high amounts of AES are necessary at the landscape scale to promote wild bees. However, flower fields mainly benefit wild bees if implemented in landscapes with more intensive farming, i.e. low amounts of organic crops, if no additional nesting sites are provided.

**00332**

## **Towards sustainable pollen beetle management in winter oilseed rape: the role of flowering time and dynamics in oilseed rape cover**

Oral

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### Abstract

Despite the associated environmental damage, synthetic pesticides are frequently used to reduce pollen beetle abundances in winter oilseed rape (OSR). However, mobile pest species like the pollen beetle are also influenced by resources at the landscape scale, and may even respond at larger spatial scales than commonly investigated (e.g. > 2 km). At the same time, crop damage is modulated by the timing of pollen beetle infestation relative to the vulnerable bud stage, with both infestation time and crop phenology being temperature-dependent. Thus, crop yield may differ along a temperature gradient, depending on relative temperature effects on the crop and the pest. Here, we assessed the influence of landscape parameters and temperature on pollen beetle abundance, parasitism, crop damage and yield to advance sustainable OSR pest management.

In a large-scale field experiment, 29 OSR fields were investigated along a multi-annual mean temperature gradient (7–10°C) in Bavaria, Germany. Flowering date was estimated, which marks the transition from the vulnerable bud stage to flowering. OSR plants were sampled at full flowering and close to crop ripeness to assess pest abundance, parasitism, bud damage and seed yield, respectively. Landscape parameters (area of OSR, non-crop area and change in OSR area relative to the previous year) were calculated based on detailed land-cover maps at multiple scales (0.2–5.0 km).

First results show earlier flowering, higher pollen beetle abundance and increased bud damage of OSR plants in warmer compared with cooler climates, whereas pollen beetle parasitism and crop yields were similar along the temperature gradient. Yet, earlier flowering went along with higher crop yield, which suggests that the choice of early flowering cultivars may benefit high yields. Besides, roughly constant or increased OSR area relative to the previous year at large spatial scales (e.g. 5-km scale) favoured low pollen beetle numbers per plant, presumably by preventing concentration effects and additional factors regulating pest population size.

Farmland management and cultivar choice promoting earlier flowering may contribute to more sustainable OSR production, but possible trade-offs with increased risk of late frost damage due to climate change need to be taken into account.

00347

## How semi-natural habitats affect the lifespan and foraging behavior of individual honey bees in farmlands?

Oral

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Abstract

Agricultural intensification, promoted by the Common Agricultural Policy over the past decades, led to important declines of biodiversity in European farmlands. In particular, the simplification of agricultural landscapes is known to affect insect pollinators, although paradoxically the yield of numerous crops depends on their survival. The Western honey bee (*Apis mellifera*) is one of the most important pollinators in farmlands. However, honey bee populations suffer high mortality rates, partly related to the loss of semi-natural habitats leading to a decrease in flower diversity and to periods of food shortage. While some studies assessed the link between semi-natural habitats and honey bee mortality at the colony level, it remains poorly investigated at the individual level. Individual worker bees play a critical role in the colony given that they can adjust their life history and foraging behavior to ensure sufficient intake of food according to colony needs. Therefore, assessing whether the loss of semi-natural habitats disturbs the lifespan and foraging behavior of individual honey bees could help to understand the mechanisms underlying colony mortality. To do so, we selected 14 sites along a landscape gradient of semi-natural habitats in a farmland system, in Western France. We monitored the life history of 1427 newly emerged worker honey bees in the study sites over periods of mass-flowering (April and July) or food shortage (May and June). We used the automatic RFID device (Radio Frequency Identification) to track their lifespan, their flight activity and their allocation to foraging in the different landscapes. We found noticeable effects of semi-natural habitats on the lifespan and foraging behavior of individual honey bees that would help to understand how individual workers adapt their own life history traits to sustain food intake in landscapes with reduced flower availability. These results will be discussed with the general objective to provide recommendations of landscape management to safeguard insect pollinators in farmlands.

00349

## Biodiversity and multifunctionality: insights from rice varietal mixtures in the highlands of Madagascar

Oral

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Abstract

The role of biodiversity on ecosystem functioning is increasingly discussed in a multifunctionality context. However, assessing multiple performances *in natura* is complex and applied perspectives remain scarce. Interestingly, the growing interest for varietal mixtures in agronomy represents a unique opportunity to challenge the role of intraspecific diversity for the regulation of multiple outcomes at the same time. This is the case for rice production in Madagascar. Especially, as the highlands region is increasingly impacted by climate change and by the socio-economic burden resulting from these environmental changes. Pests and pathogens are placing undue pressure on rice crops while disease resistance is also being affected by climate change.

The effect of varietal diversity on upland-rice multifunctionality, as well as yield components and resistance to *Pyricularia* were assessed and quantified during a two-year trial in the highlands of Madagascar. In the first year of the trial, binary mixtures of ten phenotypically contrasted varieties were established. Based on these first-year results, the four most contrasting varieties were selected to repeat the field trial the following season, this time with the inclusion of two levels of fertilization (high and low). First-year results showed that the crop susceptibility to blast disease was reduced by 6.5% in the mixed plots compared to plots with pure stand. Furthermore, varietal mixture generated a yield gain of 13% compared to pure crops in the first year and a yield gain of 17% in the second year under low fertilization. In the highly fertilized treatment, however, the gain was reduced to 4%. In order to identify the multifunctional variety combinations, a functional classification using a combinatorial model was used. Our results suggest that varietal association composed of different functional groups promotes the multifunctionality of cropping systems, when cultivated in suboptimal conditions for plant growth. Our findings represent a robust test of ecological theory, and the biodiversity-multifunctionality framework in particular, and pave the way of its applications in a crop diversification context. The identification of assembly rules for crop mixtures will be a critical next step.

**00354**

## **Landscape and crop competition are both ways towards more sustainable management and conservation of weeds in oilseed rape fields**

Oral

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Abstract

Within agroecosystems weeds have a crucial but ambivalent role. By their own presence and providing resources, weeds support farmland biodiversity but they also compete with crops for resources, then reducing yields. Consequently, they have been intensively managed by farmers, causing important declines. Meeting the challenge of maintaining weed diversity without compromising crop production requires determining the processes that shape weed assemblages, and how agricultural practices and landscape arrangement affect them. In a study in 115 oilseed rape fields, we assessed the effects of crop competition, management practices and landscape on both weed diversity and abundance. We showed two main patterns. Field margin weed assemblages are mainly shaped by the number of meadows in the landscape, revealing spatial dispersal processes. Field centre weed assemblages are mainly limited by the crop height, a proxy of crop competition, a stronger effect than the herbicide one. Using structural equation modelling, we further showed that in field core, weed assemblages are also indirectly shaped by landscape through spatial dispersal from the field margin. In a second study, we included the measures of crop biomass in two experimental zones defined according to the intensity of pesticides and fertilizers : a control zone, where management is at the farmer's usual intensity, and a reduced zone (of about 50% of the usual management intensity). While we showed significant higher crop biomass in control zones, this effect is not significantly due to lower weed abundance, richness nor biomass. Moreover, the latter are not significantly affected by weed control, confirming that crop competition is more efficient than herbicides to control weeds. Overall, our studies give empirical support for crop competition as a way to reduce the intensity of chemical weeding, without compromising yields and for meadows as a way to enhance biodiversity in the landscape.

00378

## Biodiversity conservation and organic wine production: a glass half-full

Oral

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Abstract

Organic farming is a promising but still debated option to ensure sustainable agriculture. However, whether organic farming fosters synergies or mitigates tradeoffs between biodiversity, ecosystem services and crop production has rarely been quantified. Here, we investigate relationships between multitrophic diversity (14 taxa), yield, biological pest control and soil quality (14 proxies of ecosystem services) in organic and conventional vineyards along a landscape gradient. Organic farming enhanced biodiversity and pest control, but decreased wine production. Regardless of management type, we found a strong tradeoff between wine production and pest control, but not between wine production and biodiversity.

The landscape context was not a strong moderator of organic farming effects across taxa groups and ecosystem services, but affected specific taxa and ecosystem services, especially biological pest control. Our study reveals a safe operating space where wine production and biodiversity conservation are compatible. We conclude that organic farming is a first step to improve the sustainability of viticulture, that needs to be complemented by management options at the local and landscape scales in order to fully balance biodiversity conservation with the simultaneous provision of multiple ecosystem services.

**00395**

## **Effect of different fertilizer types on edaphic diversity in agro-ecosystems**

Oral

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Abstract

For centuries, farmers around the globe have used different types of fertilizers to enhance soil quality and fertility. However, an increase in intensive agricultural practices has caused a worldwide decline in various invertebrate taxa, many of which are important ecosystems providers. This highlights the need to specifically address the effects of different management practices on soil biodiversity in more detail. In the DüNaMed project, we use field trials to assess the influence of different organic and mineral fertilizers on edaphic diversity (cattle manure and slurry, straw, biogas digestate, and compost). We monitor biodiversity using four different methods: pitfall traps, emergence traps, Berlese funnels and soil eDNA, targeting a wide range of invertebrate taxa (Diptera, Coleoptera, Hymenoptera, Araneae, Collembola and Acari). Preliminary results show a significant higher abundance of Nematocera (Diptera) in cattle slurry and manure compared to other treatments. Moreover, we find differences in Carabidae (Coleoptera) species composition between different treatments. The results from the wide range of different treatments used here are expected to enable a more comprehensive assessment of the importance of fertilizer management for the conservation of edaphic diversity.



00314

# Rows make the field: Winter wheat fields with manipulated crop architecture show potential for ecological intensification based on higher natural pest and weed seed control

Oral

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## Abstract

Ecological intensification aims to reduce environmental costs of agricultural production by increasing biodiversity and using associated ecosystem services instead of, or in combination with, external inputs, so that yields are maintained at high levels or increased. However, to date there are few effective measures, which are easy to apply, and for which such ecological intensification-benefits have been demonstrated in the field.

We manipulated seeding patterns in winter wheat fields to create diversified crop architectures consisting of 'open-rows' and 'dense-rows', and we tested potential of this for ecological intensification. Specifically, we tested whether (i) structural and microclimatic conditions are more heterogeneous in fields with manipulated crop architecture compared to fields with conventional crop architecture, (ii) this is related to higher species richness, activity density and/or altered body size distribution of carabid communities, (iii) this in turn increases ecosystem service provisioning (natural pest and weed seed control), (iv) manipulation of crop architecture doesn't lead to yield loss. Natural pest and weed seed control were examined experimentally with sentinels. Furthermore, we assessed effects on cereal leaf beetles, an important pest species in wheat, and associated impacts on crop damage under natural field conditions.

Temperature and crop density in 'open-rows' differed significantly from conditions in fields without manipulated crop architecture. Predatory carabids exhibited higher species richness (trend only) and larger body sizes in 'open-rows', which was related to stronger suppression of pest sentinels in 'dense-rows'. Cereal leaf beetle density and crop damage was strongly reduced in 'dense-rows' (crop damage by 56%). Activity density of carabid seed predators was higher in 'open-rows', which was related to higher predation of weed seed sentinels in 'dense-rows'. Wheat yields weren't significantly different in fields with or without manipulated crop architecture. We demonstrated effectiveness of manipulating crop architecture in promoting natural pest and weed seed control without lowering the yield. Thus, the simple measure could help reduce insecticide and herbicide applications, thereby reducing environmental costs of wheat production. This is one of the rare examples of an ecological intensification-measure demonstrating ecological benefits not associated with agronomic and economic disadvantages such as land opportunity costs, yield loss or increased workload.

**00427**

## **Arthropod diversity in semi-natural habitats relative to habitat age**

Oral

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### Abstract

#### Arthropod diversity in semi-natural habitats relative to habitat age

It is well known that farming intensification is a major player for the rapid species loss in agroecosystems, which thus contributes to the ongoing species crisis worldwide. Consequently, agri-environment schemes have been initiated in many European countries to promote semi-natural habitats in agroecosystems. Initially, we aim to give an overview on the impact of the age of semi-natural habitats on arthropod richness, abundance, biomass, species composition, nutritional condition and reproductive potential. Many but not all of these characteristics, which were investigated in the research group of TF over the last twenty years in Switzerland and Austria, responded positively to habitat age. Specifically, some results from the current project "REGRASS: Re-establishing grasslands to promote biodiversity and ecosystem services on farmland" are presented. This project was started in 2016, where 10 m wide species-rich grasslands were newly established (NG) within the arable land to promote both overall arthropod diversity and numbers of beneficial predators in winter cereals adjacent to NG. The project compares i) the insect diversity in NG with that one in permanent old grasslands (OG) and in species-poor subsidized grasslands (SG) designated as "biodiversity areas" in the Austrian agri-environment program (ÖPUL), and ii) arthropod diversity in OG, NG and in cereal field areas near (CN) and far (CF) from NG. In 2017-19, pollinators (solitary bees, bumblebees, syrphids) benefited quickly from NG as their abundance and richness were significantly higher in NG compared to SG. Butterfly abundance and species were highest in OG. There were more heteropteran bugs in NG and SG compared to OG, whereas grasshoppers revealed similar numbers of individuals and species in all three grassland types. Richness and activity density of carabids did not increase in NG from 2017-19, indicating slower adaptation to new semi-natural habitats. Spider activity density increased in NG and in adjacent cereals, with significantly more spiders in CN than in CF. This indicates a promising effect of predator promotion in cereals caused by NG. Overall, pollinators responded faster to newly established grasslands than epigeic predators.

**00438**

# **Effects of biodiversity measures and landscape heterogeneity on the abundance and diversity of bees in different agricultural landscapes in Germany**

Oral

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## Abstract

Agricultural intensification has led to increased field sizes, a decline of semi-natural habitats and simplified crop rotations in agricultural regions. It has been assumed that an increase in landscape heterogeneity and implementation of biodiversity measures would support wild bee communities. While there is strong evidence for the importance of landscape heterogeneity, a positive effect of biodiversity measures on wild bees has rarely been shown at the landscape level.

We selected nine intensively used agricultural regions with different landscape composition and configuration across Germany to investigate whether (1) area of biodiversity measures, (2) measures quality index, higher heterogeneity in terms of (3) area of mass flowering crops, (4) crop richness, (5) crop evenness (6) edge density and (7) area of semi-natural habitats promotes six different wild bee groups. For this, we established nine matched pairs of landscapes (1 km x 1 km), with one landscape containing novel biodiversity measures and the other representing the usual land use. Within the landscapes, we use standardized transect walks to record wild bees. Transects had a defined length of 1000 m which was subdivided into segments that were proportionally distributed among the major habitat types in the landscape sections.

We found that the area covered by biodiversity measures enhanced 'all wild bees' and 'solitary bees', as well as 'common' and 'rare' bees. Compared to recent studies our results confirm that crop richness and especially evenness is an important predictor for wild bee abundance and richness. Crop richness increases the abundance of 'all wild bees' and, except for 'solitary bees', all bee groups react on higher evenness of crops. Mass flowering crops lead to a decreased abundance of 'frequent' bees. Also, we surprisingly found that 'bumblebees' decreased with a higher amount of semi-natural habitats. Higher edge densities showed no effect for any group. Our results highlight that not only biodiversity measures but also crop diversity can be an important tool to promote wild bees in intensive managed agricultural land as both together enhance the availability of more diverse and continuous food and nesting resources.

00529

## Spiders and their prey in integrated pest management and organic apple orchards in Eastern Germany

Oral

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### Abstract

Habitat management to promote the diversity and abundance of spiders as natural enemies of pests is a promising practice to increase levels of biological control services. Apple orchards in Germany are facing frequent pest infestations which may cause significant economic damage. Traditionally, pests are controlled through applications of synthetic pesticides which have side effects on beneficial arthropods. More sustainable pest management options are needed, but to recommend practices it is important to know how they affect the prey composition of spiders. In our study, we aim to understand how decisions about the management of apple orchards affects web-building spiders and their prey. In total, 16 apple orchards under different integrated pest management (IPM, N=8) or 8 organic farming (N=8) were sampled in eastern Germany. Web-building spiders and prey remains from their webs were collected from the tree canopies and the work rows between trees. We collected 3535 web-building spiders and 2976 prey items. Interaction networks between web-building spiders and prey were characterized by 50% (canopy) and 114% (work row) more spider species in the IPM compared to the organic orchards. Predation by web-building spiders was lower in the work rows compared to the canopy, but aphids, mosquitos and wasps were always the most dominant prey taxa across both management systems and habitats. Web-building spider species on average had more links to prey taxa in the canopy than in the work rows, but prey taxa on average had more links to predator species in the IPM compared to the organic orchards. Orchards under organic management are more disturbed by mechanical treatments for weed control in the work rows, which impacts web-building spiders and their prey. The observed higher predation in the canopy may result from the fact that the surrounding landscape acts as a sink for highly mobile prey taxa. An improved understanding of the interactions between predators and prey can help to develop more efficient biological control strategies with a focus on conservation biological control and spiders as major natural enemy group.

00537

## Plant diversity increases multifunctionality in intensively managed grassland leys

Oral

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### Abstract

Over the last decades, agricultural yields have increased continuously. However, management that is solely focused on production causes negative environmental side effects like diversity declines and pollution. Diversifying agriculture has been suggested as a mitigation strategy. Large grassland biodiversity experiments show positive effects of plant species richness on ecosystems and their functions, among others productivity. However, the transferability of results has been questioned because of the plant species chosen and extensive management. To determine whether diversity can provide benefits in agricultural grasslands, diversity experiments under realistic agricultural management are needed. Such research is being realized in the international, distributed research network LegacyNet (<https://legacynet.scss.tcd.ie/>). Using intensively managed multi-species grassland leys comprised from 6 plant diversity levels (1, 2, 3, 4, 6, 10 species) and 3 functional groups (legumes, herbs, and grasses), we studied diversity effects on 16 ecosystem processes ranging from plant biomass and quality, via insect diversity and small mammal activity, to soil water content and nutrient content. Besides moderate effects of diversity on individual ecosystem functions, we showed that functional group richness increased multifunctionality, i.e. the integrated index of all ecosystem processes, significantly, whereas species richness itself played a minor role. Additionally, the species *Cichorium intybus* and *Trifolium repens* were key plant species, as their presence enhanced multifunctionality. These results confirm conclusions from classic biodiversity-ecosystem functioning experiments in semi-natural grasslands about the benefits of species mixtures. In our experiment, species- and functional group richness increased ecosystem processes related to production more than processes considered important for conservation. Consequently, including diverse grassland leys in crop rotations can be beneficial from an agro-economic perspective in addition to the benefits for sustainability.

**00550**

## **Systematic review of the effects of landscape structures on pollinators in agricultural plains**

Oral

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### Abstract

Since the Second World War, changes in agricultural practices have been characterized by intensification of input use, reduction in habitat diversity (landscape composition) and complexity of landscape patterns. These changes have led to a decline in wild pollinating insects. Therefore, over the last two decades, many studies have focused on the development of policy levers to conserve or promote the presence of insect pollinators in arable areas. In order to summarize the nature and results of this work, we present here the results of our systemic review of the literature. This project is complementary to the work conducted by Ratsimba et al. (2022) on conservation-based biological control. The knowledge review methodology will be similar to that carried out in Ratsimba's thesis with the use of the PRISMA methodology and her expertise. We show that the studies focus on a small number of taxa and regions: honeybees and bumblebees, domestic and wild, in America and Europe. In addition, after developing an ontology of the concepts used in these studies to allow a homogeneous analysis, we finely analyzed the nature and meaning of the relationships between landscape determinants and the abundance and diversity of the taxa studied. On the basis of these analyses, our objective is to produce a "fuzzy cognitive map" that could be used to simulate landscape management scenarios potentially favorable to the conservation or development of wild pollinators.

00552

## Where have all the flowers and insects gone? Drivers for abundance and diversity loss in farmland – the Austrian monitoring programme BINATS

Oral

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Abstract

Biodiversity loss - mainly driven by habitat destruction, fragmentation, land-use change including intensification, abandonment of traditional farming, sealing, invasive species, and climate change - is currently the key challenge for nature conservation worldwide. The dramatic decline of insects which fulfil key ecosystem functions such as pollination, pest control, and food supply, is not only affecting protected areas, but also farmland. In order to assess the extent of species decline and the change in species composition in the Austrian farmland and identify their main drivers, the biodiversity monitoring programme **BINATS** (Biodiversity-NATure-Safety) was carried out in 2007/08 (**BINATS I**) and for a second time in 2017/18 (**BINATS II**). For this purpose, **habitat structures, vascular plants, butterflies, grasshoppers** and **wild bees** (since BINATS II) were investigated, with a focus on maize and oilseed rape cropping areas. Surveys were performed in 100 randomly selected test squares with a side length of 625 m. Habitat structures were mapped area-wide, while plants and animals were recorded in ten randomly selected test circles with a radius of 20 m within each test area.

Consistent with the results of BINATS I, the extent of arable land in the test areas showed a strong negative relationship with species numbers of all BINATS II plant and insect indicators, whereas species diversity was positively correlated with the presence of fallow grassland and the Shannon Landscape Diversity Index. Additional factors such as weather conditions, flower supply, and slope inclination also affected the insect groups. The combination of several ÖPUL (Austrian agri-environmental programme) measures applied to about 10% of the total BINATS survey area (6,250 ha), showed a medium to low significant positive correlation with species richness of all four indicators. However, with increasing area of conventionally managed fields, species number and abundance declined. In farmland, most plant and insect species were found in **semi-natural habitats**, which comprise only a small area. Field and path margins, roadsides, ruderal areas, hedgerows, and trees, therefore, enhance plant and animal diversity and should be promoted as biodiversity hotspots in the farmland.

**00672**

## **Drought resilience of temperate forage grasslands is determined by soil nutrient rather than plant physiological processes**

Oral

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Abstract

Reoccurring drought events severely restrict forage production and increase the urge for understanding the resilience of agricultural (forage) systems. Intensively managed temperate forage grasslands are known to be highly resilient after drought and rewetting (DRW) (Hahn et al, 2021). The underlying mechanisms determining this resilience are, however, still unknown. This study examined the effect of a 2-month experimental summer drought with subsequent rewetting on yield performance, plant physiological properties and soil nutrient processes of one intensively and two extensively managed temperate forage grasslands between 2019 and 2021. To disentangle plant physiological and soil nutrient cycling effects on yield recovery, a post-drought transplantation experiment of control and DRW soil and plants withdrawn from the field was performed concurrently in 2020. Our results show, that yield of formerly drought-stressed swards of both, intensively and extensively managed grasslands, surpassed the respective control swards by on average 40% and 30%, respectively. Despite transplanted DRW plants show higher leaf elongation rates and higher specific leaf area during the first weeks after rewetting, they showed lower dry matter yield after DRW compared to control plants. In contrast, DRW soils induced post-drought yield outperformance by on average 25% compared to control soil irrespective of the plants DRW treatment. Looking into soil nutrient processes, we observed substantially higher plant N, P and K availabilities in formerly drought-stressed soil compared to control soil. However, this effect seems not to originate from altered microbial nutrient turnover since mineralization rates and microbial enzyme activity were not or only marginally affected by DRW. In summary, our data show that despite impaired plant growth after DRW, formerly drought stressed swards surpassed control yields by profiting of higher nutrient availability.

References:

Hahn C, Lüscher A, Ernst-Hasler S, Suter M, Kahmen A (2021) Timing of drought in the growing season and strong legacy effects determine the annual productivity of temperate grasses in a changing climate. Biogeosciences.

**00654**

## **No clear evidence of local effect of organic agriculture on raptor nestlings' health**



Oral

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Abstract

Agricultural intensification is one of the main threats to biodiversity. Farmland bird specialists, such as the **Montagu's harrier** (*Circus pygargus*), are particularly at risk and declining. **Conventional farming** (CF) practices comprise mechanization, landscape homogenization and use of synthetic pesticides that may have direct and indirect effects on these species. On the other side, **organic farming** (OF) practices that promote agro-ecosystem health are presumably beneficial for biodiversity and birds' reproductive success. No study to our knowledge has investigated the potential effects of agricultural systems on Montagu's harrier chicks' **life history traits** (LHT). Still, altered LHT could impair chicks' survival and future reproductive success, which in turn, can impact populations dynamics. We investigated the relative effects of CF vs. OF on a set of LHT covering the **behaviour, immune function and morphology, in 380 chicks monitored between 2016 and 2021, depending on the OF percentage around the nests at different buffer sizes** (every 100m-radius from 100m up to 2000m). We found that above 500m around the nest, a higher proportion of OF increased the number of **fault bars** on rectrices (breaks in feathers indicative of punctual stressors) suggesting that OF practices may represent a higher stress for chicks due to potential higher agricultural work in crop plots. The **coloration of chicks' cere**, a secondary sexual trait, increased with increasing OF around the nest at 1400-1800m. This suggests that CF would lead to a trade-off, reallocating carotenoids to detoxification of the organism at the expense of the development of sexual characters. Behaviour and **acetylcholinesterase** activity, an enzyme implied in neural functions which could be altered by several pesticides, did not seem to be affected by the main type of agricultural system around the nest as well as other LHT. These findings suggest that farming practices at a local scale surrounding the location of the nest may have **subtle effects on chicks' development** but also on **trade-offs** between important physiological functions.

00418

# Towards Predictions of Interaction Dynamics between Cereal Aphids and Their Natural Enemies: A Review

Oral

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## Abstract

The development of conservation biological control strategies for regulating crop pests is a promising approach to reducing the use of pesticides. Although most past studies are based on static analyses of the pest regulation drivers, evidence shows that a greater focus on the temporal dynamics of these interactions is urgently required to develop efficient strategies. Focusing on aphids, one of the major direct and indirect crop pests in temperate climates, we systematically reviewed (i) empirical knowledge on the drivers influencing the dynamics of aphid–natural enemy interactions and (ii) models developed to simulate aphid dynamics.

Reviewed studies mainly focus on the abundance dynamics of aphids and their natural enemies, and on aphid population growth rates. While empirical studies demonstrate that natural enemies have negative impacts on aphid population dynamics, the dynamics of natural enemies' direct impact (parasitism and predation) is rarely measured, although it is often represented in models. Among climatic drivers, temperature is most often studied and is always positively correlated with aphid population growth rates. Plant phenology is poorly represented in models while it is a strong driver of aphid arrival and population increasing and decreasing. Landscape effects on aphid-natural enemies interaction dynamics vary between empirical studies and are absent in the models.

Based on the outcomes of our review, we propose a research agenda to progress towards models and empirical knowledge usable to design effective CBC strategies. As only 9% of authors have made both empirical and modeling contributions, we claim that crossover works will help designing new empirical settings based on simulations results, and building more accurate and robust models integrating more key drivers of the aphid dynamics. Such models, turned into decision support systems, are urgently needed by farmers and advisors in order to design effective integrated pest management.

**00028**

**Asynchronous recovery of predators and prey mitigates deleterious effects of droughts on litter decomposition in freshwater ecosystems**

Oral

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Abstract

The predicted increase in the intensity and frequency of drought events associated with global climate change will impose severe hydrological stress to freshwater ecosystems, potentially altering their structure and function. Unlike freshwater communities' direct response to drought, their post-drought recovery capacities remain understudied despite being an essential component driving ecosystem resilience. I will present how we used tank bromeliad as model ecosystem to emulate droughts of different duration and then assess the recovery capacities of ecosystem structure and function. By following macroinvertebrate predator and prey biomass we characterize the recovery dynamics of trophic structure (i.e. predator–prey biomass ratio) during the post-drought rewetting phase. It appears that drought significantly affects the trophic structure of macroinvertebrates by reducing the predator to prey biomass ratio. The asynchronous recovery of predator and prey biomass appeared as a critical driver of the post-drought recovery trajectory of trophic structure. Surprisingly, the alteration of ecosystem trophic structure mitigated the effects of drought on an essential ecosystem function: litter decomposition rate. We showed that litter decomposition remained stable after drought events because of compensatory effects between detritivores biomass and feeding activity. We conclude that, in a context of global change, the asynchrony in post-drought recovery of different trophic levels may impact the overall drought resilience of small freshwater ecosystems in a more complex way than expected.

00184

## Does hydrology influence fish communities in canals of reclaimed marshes?

Oral

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### Abstract

Alterations of natural hydrology in aquatic ecosystems have been found to significantly affect the community structure for different taxa. It has yet been mainly studied in lotic ecosystems, focusing on fish and invertebrates. In reclaimed marshes, water use such as agricultural irrigation often exerts a significant control over the natural dynamics of water depths. This can affect the availability of aquatic habitats, for instance flooding grounds adjacent to canals, and the extent of connectivity between aquatic habitat patches. Despite the potential influence of hydrology on the structure of fish communities, the literature on this issue is still very scarce in reclaimed marshes, where canals represent widespread lentic habitats. This study aims at contributing to fill this gap using a quasi-experimental design (i.e. independent hydrological units) over a six-year period. We expected water depths, variation of water depths in canals between winter and spring, and spring flooding duration of meadows adjacent to canals, to be important drivers of the structure of fish communities according to fish life-history strategies (opportunistic, equilibrium or periodic). The strategists the most represented in this study were periodic and opportunistic species. The strong management of water levels led to low interannual variations of hydrology parameters, except during exceptional climatic events leading to prolonged flooding. Despite differences in hydrology between canals, we found that the hydrology explained a very low proportion of variation in the structure of the fish community. The extent of flooded areas did not influence fish community composition, not even periodic species that are expected to rely on such temporary ecosystems. Instead, fish communities were influenced by local habitat variables such as the aquatic vegetation cover in the canals, the turbidity or the availability in tree roots and underbank refuges. It is possible that the hydrology in the large reclaimed marsh under study is so strongly managed, with water depth rapidly decreasing in spring and being low in summer, that only tolerant fish species inhabit these canals, therefore not responding to the remaining hydrological contrasts observed between sites. Our results call for further research in similar wetlands with a larger range of hydrological conditions.

00222

## Understanding genetic and species diversity patterns across multiple trophic levels in river landscapes

Oral

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Abstract

Testing whether biodiversity co-vary spatially across trophic levels and diversity facets (intra- and interspecific diversity) is of utmost importance for conservationists and for generalizing the processes driving biodiversity patterns in natural landscapes. Conceptual and theoretical works suggest that similar processes can act similarly both across trophic levels and diversity facets, which should lead to a global spatial co-variation of biodiversity. Nonetheless, this prediction has rarely been tested empirically because databases integrating multiple diversity facets and multiple trophic levels in a common landscape are rare. To meet this challenge, we focused on a riverine freshwater ecosystem (37 sites) in which we sampled intra- (genomic diversity) and interspecific (species diversity) data across three trophic levels: riparian trees, benthic macroinvertebrates and fish. For each trophic level, we quantified species diversity and dissimilarity based on abundance data, and we selected a dominant and functionally relevant species (*Alnus glutinosa*, *Gammarus* sp. and *Phoxinus phoxinus*) to quantify genomic (SNPs) diversity and dissimilarity within species. We first used a meta-analytic approach to test for a global co-variation over space among alpha and beta diversity patterns for each trophic level and diversity facet. We then tested whether five environmental predictors similarly affect each biodiversity estimate to infer common processes acting across trophic levels and diversity facets. We found that spatial co-variation among diversity estimates were generally weak and not significant, which was true for both alpha and beta diversity components. Moreover, we identified two environmental descriptors (area and isolation) that affected alpha and beta diversity components similarly across trophic levels and diversity facets. This suggests that these two descriptors may have “universal” influence on biodiversity in river ecosystems. Nevertheless, all others environmental descriptors acted differently on trophic level and diversity facet, which likely explained why spatial co-variation among biodiversity estimates were weak overall. Our study demonstrates that biodiversity patterns are difficult to generalize (even in highly structured ecosystems such as rivers), and are actually idiosyncratic. However, some eco-evolutionary processes related to the diversity-area and dissimilarity-isolation relationships seems to affect biodiversity similarly for all trophic levels and diversity facets.

**00266**

## **Drivers of fish size spectrum and bioindicators in lentic ecosystems across France.**

Oral

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### Abstract

Freshwater biodiversity has strongly decreased during the last decades and reliable bioindicators have been developed to assess biodiversity status and ecosystem health by providing quantitative tools for conservation planning. To date, most bioindicators are primarily based on the taxonomic features of plant and animal communities and do not account for the structural organization among organisms that shape the fluxes of energy across trophic levels. Body size is one of the most important ecological traits in aquatic ecosystems because it determines how organisms interact with their environment but, surprisingly, body-size approaches are rarely used in bioindicator assessment frameworks. The community size spectrum is defined as the linear relationship between the abundance and the body size of organisms and reflects several important ecological features such as ecosystem carrying capacity, predation-prey interactions, and recruitment dynamics. In this study, we explored the potential of using the size spectrum parameters (slope, elevation and linearity) of fish communities as complementary bioindicators in 54 natural lakes and 101 reservoirs distributed across France. Using Structural Equation Models (SEMs), we tested how the size spectrum parameters and common taxonomic bioindicators based on fish, macrophyte and phytoplankton communities responded to eutrophication, physical habitat alterations in the littoral zone and biological invasions within a holistic framework between natural and anthropogenic drivers. We found that (i) the drivers of size spectrum parameters differed between lakes and reservoirs; (ii) size spectrum parameters responded to different anthropogenic activities than common taxonomic bioindicators; and (iii) the size spectrum slope was the most integrative parameter, responding to habitat alterations and eutrophication regardless of potential changes in fish community composition. This study highlights that the use of community size spectrum in biomonitoring protocols could provide additional insights into our understanding of the responses of freshwater ecosystems to global changes.

00387

## Multiple lines and levels of evidence for bird-mediated colonization of isolated lakes by freshwater fish

Oral

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### Abstract

Understanding how aquatic organisms colonize isolated freshwater ecosystems and identifying natural vectors is crucial. Rare examples of bird-mediated introductions of aquatic organisms such as plants, zooplankton and macroinvertebrates exist but, for fish, robust evidence remains scant and no direct demonstration has been reported yet. Direct demonstration of avian ectozoochory (propagules moved externally) and endozoochory (propagules moved internally) *in natura* is almost impossible. Hence, we applied an indirect approach (i.e. multiple lines and levels of evidence) to demonstrate that conditions for bird-mediated colonization of isolated lakes by the European perch (*Perca fluviatilis*) are met and that other potential pathways can reasonably be excluded. We studied a set of artificial lakes (n = 37) with some lakes having a prohibited-access (i.e. owned by gravel extraction companies; public access forbidden) and other having a public-access (mainly for angling activities). Importantly, more than 80% of prohibited-access lakes were colonized by perch, and in higher abundance than in public-access lakes. A survey of lake managers and anglers revealed that legal or illegal stocking of perch is unlikely in prohibited-access lakes. This was also confirmed by a similar genetic diversity and genetic structure between the two types of lakes, unlike the effects that would have been induced by multiple stocking events. Five supplementary lines of evidence supported introduction by avian zoochory. First, perch spawning period is synchronized with waterfowl wintering period in the study area. Second, there is a spatial overlap between eggs laying location and waterfowl foraging area for both 'dabbling' and 'diving' waterfowl. Third, fish eggs can be consumed by waterfowls as they are nutritionally attractive for birds, and can be also hooked on their plumage or feet. Fourth, recent studies showed that fish eggs can mechanically survive to waterfowls' gut passage and air exposure on their body. Fifth, the flight distances of foraging waterfowls are comparable with perch migration distance calculated using genetic analyses. All together, these findings strongly support indirect evidence of avian zoochory for fish in isolated freshwater ecosystems, with important implications for species conservation and the management of biological invasions.

**00437**

## **Source and pathways of carbon in lake food webs under anthropogenic perturbations.**

Oral

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### Abstract

Lakes are crucial ecosystems for the transport, emission and storage of considerable amounts of carbon. They play a key role in the global carbon cycle as sink with organic carbon sequestration, and as sources with greenhouse gas emissions. The recent intensification of anthropogenic pressures has led to a disruption of the biogeochemical carbon cycle for many lakes, resulting in an intensification of organic matter mineralization processes through accelerated waters eutrophication. These dynamics can then lead to an imbalance between the processes of emission, storage and transport of carbon in food webs. Understanding the carbon cycle response to environmental changes is then becoming a crucial challenge in the context of the preponderance of human pressures. However, the control factors and mechanisms of carbon transfer in food webs remain poorly understood, especially for pelagic food webs. This work aims to study these mechanisms of carbon transfer to pelagic consumers at variable temporal scales, as well as its response to metabolic perturbations, by implementing combined synchronous and diachronous approaches on eastern French lakes based on the analysis of stable carbon isotopes of *Daphnia* and their subfossil remains. The studied lakes showed strong seasonal variations of carbon source availability and transfers to pelagic food webs, characterized by intensification of methanogenic carbon transfers to pelagic consumer populations in winter. The magnitude of these winter transfers seems to largely depend on the amount of methane stored in the hypolimnion during the stratification period, and thus on the amount of methane released with autumnal turnover. Both synchronous and diachronous approaches shows that this intensity of methane production and transfer partly depend on watershed land use and trophic level. These studies provide new insights into the impacts of human induced changes on the sources and pathways of carbon in lake food webs through their influence on lake metabolism.



00443

## Combined effect of agricultural run-off and warming on agricultural streams: a mesocosm experiment

Oral

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### Abstract

Lowland streams are inherently exposed to multiple stressors such as nitrate and pesticides from neighbouring agricultural areas and warming due to ongoing climate change. Determining how multiple different stressors may interact in affecting complex ecosystems remains a challenge. Our study aimed to investigate the effect of multiple stressors, combining warming and exposure to agricultural run-off (ARO), on small streams and to determine how biotic interactions will mediate the response of these aquatic ecosystems. Our hypothesis was that warming will amplify the negative effect of ARO.

We used 16 outdoor flume mesocosms to simulate lowland streams. At the beginning of the experiment, each mesocosm was prepared with macrophytes planted in sandy sediments, a natural inoculum of periphyton and phytoplankton, the grazer *Lymnaea stagnalis*, the shredder *Gammarus roeseli*, the filter feeder *Dreissena polymorpha* and leaf litter. We tested in a factorial design the effect of heating (3 °C above ambient temperature) and a cocktail of pesticides and nitrate to simulate ARO during 8 weeks between April and June 2021.

Phytoplankton density remained low during the first six weeks of the experiments in all treatments before increasing strongly in ARO-containing mesocosms. All the mesocosms got rapidly covered by mats of filamentous algae, with a significantly higher coverage in the ARO treatment. Filamentous algae coverage decreased more rapidly in the heated treatments. The macrophyte community was dominated by *Potamogeton perfoliatus* in all the mesocosms; its growth was negatively affected by ARO but positively by warming. Periphyton achieved a higher biomass in ARO-treated mesocosms but the differences between the treatments diminished strongly during the three last weeks of the experiment. The invertebrates (*L. stagnalis*, *G. roeseli*, *D. polymorpha*) were all negatively affected by ARO. Warming favoured *L. stagnalis* reproduction and the breakdown of leaf litter.

Exposure to the different stressors led to complex responses of the ecosystem. The direct effects of ARO and warming on grazers, periphyton and filamentous algae were likely at the origin of an indirect effect on the macrophytes through shading and nutrient competition. Overall, our results did not indicate an enhanced effect of ARO on the ecosystems when streams get warmer.

00523

## How can the hydric stress modify the potential of phototrophic biofilms to sustain secondary production?

Oral

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### Abstract

Phototrophic biofilms are important primary producers in streams and many consumers rely on this resource. Their ability to sustain secondary production is likely to be impaired or modified by any disturbance that impacts their biochemical and specific composition and/or their biomass. With climate change, an increasing number of streams are exposed to hydric stresses which may threaten this resource. Our study aims at understanding how a dry period would affect the nutritional quality of biofilms and in what extent this would depend on biofilm initial quality. We hypothesized that (1) the longer the dry period lasts, the higher the resource quality decreases and (2) that the disturbance will reduce the initial differences between biofilm qualities. To test these hypotheses, we conducted a laboratory experiment where four biofilms of contrasted specific composition (mixing diatom, green algae or cyanobacteria in different proportions) and nutritional qualities were grown in 16 channels. After the colonization step, we applied either a short (3 days) or a long (14 days) dry period. Biofilms were sampled just before the application of the dry period and 3 and 18 days after water flow resumed, to assess their pigment composition, fatty acids content and elementary composition. Moreover, 240 *Gammarus fossarum* individuals were fed for 29 days with pellets prepared with each resource and several parameters related to their growth and behaviour were measured. As expected, desiccation had a strong significant impact on biofilm structure, but contrary to our hypothesis this effect was mainly independent from dry period duration. The recovery trajectory of biofilms depended on both their initial structure and dry period duration. The nutritional quality increased after 18 days of rewetting for the cyanobacteria-dominated biofilm, while other biofilms returned to their pre-disturbance quality. This is consistent with results of the consumer feeding experiment. As hypothesized, while individuals fed with the pre-disturbance cyanobacteria-dominated biofilm had a lower condition index, no more significant differences were observed on gammarids fed with biofilms sampled after the recovery period. This experiment demonstrates that the effect of the hydric stress on the nutritional quality of phototrophic biofilms is mainly driven by their initial composition.

00040

## Don't worry be wormy: no anxiety-like behavior in amphipods infected by a manipulative parasite

Oral

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### Abstract

Parasites of diverse clades alter their host behaviour in ways that seemingly benefit their own life cycle. However, the cognitive processing and proximate mechanisms underlying parasitic manipulation are mostly unknown. One of the most striking alterations is the reversal of antipredator behaviour induced by some trophically-transmitted heteroxenous parasites in their intermediate host, thereby increasing their chances of reaching their final host. One hypothesis is the alteration of infected hosts cognitive ability in such way that fear- or more generally stress-related emotions are impaired. We tested this hypothesis in a key model system in the study of parasitic manipulation, the fish acanthocephalan parasite *Pomphorhynchus tereticollis* and its intermediate crustacean host *Gammarus fossarum*, using the threat of shock paradigm. We exposed uninfected and *P. tereticollis*-infected *G. fossarum* to chronic and/or acute stress and quantified their sheltering behaviour as a proxy for anxiety-like emotional state. The chronic treatment consisted of daily ten-minute sessions of electric shocks (9 or 15V) during the six days preceding a refuge use test and the acute treatment was a last session imposed ten minutes before the refuge use test. Uninfected gammarids that received the acute or both the acute and chronic treatments of both voltages, as well as those that received the chronic 15V treatment, hid more than their unshocked counterparts. On the other hand, treatments did not influence parasitized gammarids' refuge use. Our results support the hypothesis that acanthocephalan parasites hijack general anxiety-like circuitry of their intermediate host. Further studies are needed to investigate whether it involves inappropriate processing of information, impaired integration, or altered activation of downstream pathways initiating behavioural action.

00072

## Worker presence and number favour the success of colony foundation in ants

Oral

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### Abstract

Dispersal strategy, such as being in a group or alone, or the size of the group, is highly variable across animals. Different costs and benefits are associated with each strategy, and understanding which factors favour or disfavour each strategy is a key issue in ecology and evolution. Ants exhibit a strong polymorphism of dispersal and foundation of new colonies across species. Some species have winged queens that disperse far and wide by flying alone, while other species have apterous queens that disperse with a group of workers by walking short distances. Few species are known to have both strategies which makes it difficult to study the benefits of each strategy. For instance, there are many studies on the effect of the number of queens during the foundation, but very few on the role of workers so that the effects of their presence are still unclear. We carried out laboratory experiments with the ant *Myrmecina graminicola*, which can use both strategies, to study the impact of group versus solitary dispersal on foundation success. Using young gynes emerged and mated in the laboratory, we set up foundations with one gyne with or without workers, and varied the number of workers. We monitored the survival and growth of foundations over one year. We found that the presence of even a few workers increases the survival and growth of colony foundations. In addition, we observed an increase in the amount of brood as the number of workers accompanying the queen increased. These results show the benefit of dispersing in groups, and exhibit a competition/colonization trade-off within the same species, with a queen morph that disperses a lot and is less competitive during the foundation of a new colony compared to a queen morph that disperses less but is more competitive. This is, to our knowledge, the first study that highlights the crucial role of workers during colony foundation, which is a crucial stage in the life of colonies.

00202

## Incubation behaviour and importance of extended recesses in an Arctic shorebird: The Sanderling (*Calidris alba*).

Oral

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Abstract

Sanderlings (*Calidris alba*) undertake a spectacular long migration to reach the Arctic where they breed during the short summer. In this harsh and unpredictable environment, incubation is challenging due to high energetic demands and variable resource availability. Incubating birds hence face a time allocation compromise between two fundamental and exclusive behaviours: incubation and foraging. In-bout and off-bout periods are known to be highly variable between individuals, leading sometimes to exceptionally long recess periods. Until recently, extended incubation recesses were considered to occur infrequently and their quantification and determinants remain poorly documented. We used thermoprobes placed in the nest cups to monitor the incubation behaviour of uniparental Sanderling at Hochstetter and Karupelv, NE Greenland, during eleven breeding seasons (2011-2021). This allowed us to determine the occurrence of extended recesses, quantify the inter-individual variation in the incubation patterns, and define the causes and consequences of this variation for these income breeders (i.e., where individuals rely on available resources during breeding, with only very short-term energy reserves). We defined a recess as extended when longer than 120 min. We observed 337 extended recesses, representing 1.6% of the total number of recesses. They occurred in all years and in 59 of the 102 monitored nests (58%). Although rare in frequency, they seem to be widespread in the population and represent for some individuals a high proportion of the total off-bout time. Extended recesses could allow parents to meet their own energy requirements and shift their behaviour towards self-maintenance under stressful conditions. They suggest a flexibility in the incubation behaviour, as well as high resistance of eggs to chilling. They could represent a powerful mechanism allowing incubating birds to cope with energy deficit under challenging conditions.

00208

# Resource-Dependent Disruption of Spatial Foraging Dynamics in a Seed-Caching Bird

Oral

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## Abstract

Resource availability plays an important role in explaining the foraging behavior of animals. Theory predicts that animals have to move more when resources are limited, whereas they move less when resources are abundant. Investigating how resource availability influences the movements of seed-dispersing animals is, however, challenging. Here we studied the foraging behavior of spotted nutcrackers, which harvest and accumulate seeds of Swiss stone pine, and rely on them as a year-round food source. Over a period of three years, we investigated the movement patterns of 23 GPS-tagged nutcrackers during the time of seed-harvesting in fall. We found that during two years of plentiful pine seed crop, birds showed intense long-distance seed dispersal behavior with regular back-and-forth flights across several kilometers. Contrastingly, during one year of exceptionally low pine seed crop, the nutcrackers showed no signs of seed dispersal behavior and reduced both total area covered and hourly distance travelled by more than 90%. The reduction of movement depicts a remarkable exception to the textbook theory under which poor resource availability forces animals to increase their radius of movement in order to gather sufficient resources. Our results may be explained by the birds switching to an omnivore diet, pilfering seed caches from previous years, and generally showing energy conserving behavior. Overall, the lack of hoarded pine seeds likely entails detrimental effects on winter survival and reproduction of spotted nutcrackers. Considering seed crop data of plants improves our understanding of the foraging movements of seed dispersers.

00244

## Water deprivation interacts with chemoreception and anti-predator behaviors in a Lacertid lizard

Oral

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### Abstract

Although many lizards use visual cues to orient themselves and explore their environment, they also have a highly developed chemo-olfactory sense. Their vomeronasal organ allows them to perceive volatile chemicals in their environment and identify the presence of conspecifics or predators via their forked tongue. The scent of a predator can trigger different anti-predator tactics among which immediate flight, increased tongue-flicking or tail vibration, which are survival strategies thought to be adaptive behaviors.

Heretofore, very few studies have addressed how external factors may influence the ability of lizards to discriminate scents and react to predator signals. In particular, the effect of environmental moisture and the water balance on these behaviors has not yet been studied. A proximate tradeoff may exist between chemoreception and water balance since opening the mouth and extending the tongue likely increase evaporative water loss (EWL). Therefore, the hydration status should interact with chemoreception, with altered response performance to predator scents in water deprived individuals.

In our study, we tested the impact of a moderate water restriction (similar to what a few days long drought would create) on the investment in the detection of predator scents, the ability to distinguish a dangerous snake from an inoffensive one, and the anti-predator behaviors adopted. We considered the common lizard (*Zootoca vivipara*), a widely distributed Lacertid lizard that lives in peat bogs and thus is very sensitive to water constraints of the environment.

We found that water restriction increased reaction time to a scent. In addition, water restricted lizards decreased their tongue flick rate, which altered their ability to distinguish dangerous snakes from inoffensive ones, and prevent them from displaying the appropriate anti-predator behavior. These results suggest a relevant impact of water stress on chemoreception abilities in this species, and thus on its survival probabilities in a drier world.

00251

## Ecology and Evolution of a highly invasive spider (*Mermessus trilobatus*)

Oral

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### Abstract

Only a few decades after its introduction from America, *Mermessus trilobatus* has become one of the most abundant spiders in Central European grasslands. The expansion of its invaded range has accelerated from about 150 km in the 1980s to some 400 km in the last decade. We sampled live *M. trilobatus* individuals from several European countries to investigate if their mobility and other traits have evolved in the course of their invasion history. Furthermore, we performed breeding and behavioural experiments to study interactions with native species. The propensity of aerial dispersal proved strongly heritable. As expected, dispersal propensity was higher in newly invaded areas compared to longer established populations. This indicates the accumulation of dispersive genotypes at the invasion front, which can explain the increased speed of range expansion over time. However, the successful establishment of *M. trilobatus* in native communities remains unexplained since they appear neither more tolerant to disturbance, more competitive, nor more successful in avoiding predators compared to native Linyphiid species.



00275

## State-space models show that functional replacements of extinct megafauna have distinct habitat preference in a European rewilding area

Poster

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Abstract

Trophic rewilding aims to restore lost ecological functions and processes, e.g., by replacing extinct species with functional analogues. In many European rewilding areas, feral horses and cattle have been reintroduced to replace the ecological role of extinct megafauna species. However, our understanding on how horses and cattle use the rewilding area is still limited, potentially hindering the desired outcomes of such projects.

Here, we assessed habitat preference of two feral populations of Exmoor ponies and Galloway cattle in the Rewilding Mols project in the Mols Bjerge National Park in Denmark. We used GPS collar data from two individuals of each species from December 2017 to March 2021 to fit a state-space model (SSM) to decompose animal movement into distinct behavioural states. From the SSM, we sampled locations which were not selected by the animals even though they were able to move there according to their behavioural state. Such absences were then used, together with GPS locations, to fit a logistic step-selection function to investigate animal preferences with respect to: vegetation density, type, and productivity, proximity to water and artificial structures (shelter, mineral lick) and the species-specific “energy landscape”, i.e. the energetic cost of locomotion.

We identified two movement states for horses and three for cattle. We found that horses preferred areas with browsable vegetation over areas with only grazable vegetation, whereas cattle had opposite preferences. Moreover, vegetation productivity did not affect horse habitat usage, while cattle preferred areas with high productivity values. Both populations preferred areas that were closer to water and artificial structures and that had high vegetation density and minimised locomotory energy expenditure. We also identified seasonal variability in habitat preference, notably that proximity to water and artificial structures was more important during summer than in winter.

Overall, our study shows that horses and cattle have quite distinct habitat preferences, highlighting the complementarity of these two species in replacing part of the lost megafauna and their ecological functions. Moreover, our findings stress the importance of site design, particularly of where to place artificial structures, often required by law, which strongly influences how animals use the rewilding area.

00280

**Dietary diversity and variability of food resources: bonobos (*Pan paniscus*) ecological strategies adapted to a forest-savannah mosaïc habitat.**

Oral

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Abstract

Food availability is assumed to have a key influence on the socio-ecology of primates and other mammals. Studying species ecological flexibility (e.g. feeding and foraging strategies adopted by individuals of a given species in different habitats) is therefore of critical importance for drawing evolution scenarios and promoting biodiversity conservation plans. Such studies are particularly needed in bonobos (*Pan paniscus*) as the majority of study sites are located in continuous forest while their home range contains more fragmented environments that are poorly studied. Furthermore, one hypothesis explaining the socio-ecological differences (social tolerance, tool-use, etc.) between chimpanzees (*Pan troglodytes*) and bonobos relies on the assumption that a more stable environment in bonobos leads to a low intragroup competition. Here, we specified the variability/constancy of food resources and the nature and contribution of each feeding species in the diet of bonobos ranging in a forest-savannah mosaïc in DR Congo. We gathered longitudinal data (four years) from ecological and behavioral methodologies on the bonobo community of the Manzano forest to explore food availability, habitat use and diet variability. Based on 167 hours of behavioral observations (i.e., individual focal sampling), our feeding time data showed that twenty food items composed more than 85% of the diet, out of a set of seventy different items. Bonobos were able to use food plants from both the forest, savannah and edge areas. Despite a low variability of global food availability in the environment (i.e., including every food items consumed by bonobos), diet diversity varied across months, suggesting that seasonal variations in ressources availability challenge bonobos ability to adapt their diet. Nevertheless, regardless of the plant species consumed, the fruit proportion in the diet remained large every month. As a summary, even though this particular habitat is fragmented, it appears to provide sufficient diversity to compensate for the seasonal variability of some important species in the diet. This hints toward the need of further analyses to better understand the link between diet variability and spatio-temporal availability of particular food resources, which would provide additional insights into ecological flexibility of bonobos.

# 00334

## The timid invasion

Oral

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### Abstract

Biological invasion processes create differential selection pressures within invasive populations. Along the expansion edge, the ability to disperse into a novel species community is the main determinant of fitness, while in established core areas competition with conspecifics is an important fitness determinant. We investigated dispersal-related behaviour of bank voles (*Myodes glareolus*) in an invasive population accidentally introduced to a vole-free Ireland a century ago, and currently expanding its geographic range at a rate of 2-3 km per year, and the behaviour of the native wood mouse (*Apodemus sylvaticus*), the only native small rodent species. We hypothesized that voles at the edge of the expanding distribution may have developed behavioural phenotypes affecting their dispersal abilities. We measured behaviour of rodents at forested sites, invaded by bank voles in the previous 1-4 years (4 edge sites), two sites occupied for over 80 years (2 source sites), and 2 pre-invasion sites. In the source populations, bank vole males, which are the dispersing sex in rodents, took more risk and were more active than females, while at the edge they were less risk-taking and less active than females. Furthermore, males at the edge took less risks compared to males at the source. In wood mice, no behavioural adaptations to the vole invasion were observed but the wood mice population size was reduced in the presence of voles. Voles, at the expansion edge, took more risks when tested repeatedly, while voles from the source populations were constant in their behaviour. Thus, we found that voles in the expanding population showed risk averse and timid behaviour, perhaps to avoid competition with other rodent species or evade predation, and individuals were more flexible in behaviour at the edge compared to the source. Both traits may be beneficial when rodents expand into ranges void of conspecifics, and important in local extinction and colonisation dynamics, but under negative selection once populations become established. Risk avoidance together with behavioural flexibility may contribute to successful establishment of rodent populations after displacement worldwide.

**00343**

## **Harmonic radar tracking reveals far-reaching impacts of light pollution on moths**

Oral

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### Abstract

Over the last years, the accelerating decline of insects has become a major topic in nature conservation. Recently, light pollution has been suggested as a possible driver for insect decline in general and decline of nocturnal moths in particular. Since moths are important components of almost all terrestrial food webs and play a crucial role as nocturnal pollinators, it is essential to understand the underlying causes to counteract their decline. Using harmonic radar, we recorded trajectories of free-flying male moths and were thus able to ask for the first time whether their flight behaviour is influenced independently of their arrival at a light source. We found that only 4% of flights ended at one of the six streetlights that were evenly arranged in a circle around the release site in a distance of 85m. Nevertheless, the streetlights had a significant impact on flight behaviour as we observed a barrier effect on lappet moths (*Lasiocampidae*) and an increased tortuosity of flights for lappet moths and hawk moths (*Sphingidae*). In addition, the moon as a natural light source played a key role in orientation performance. We conclude that light pollution affects the orientation of moths considerably beyond previous estimates, with far-reaching consequences for survival and mating success.

00408

## Home range overlap between the invasive species *Callinectes sapidus* and the indigenous *Eriphia verrucosa* by acoustic telemetry in Acquatina lagoon (Frigole, Lecce)

Oral

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### Abstract

Whatever interaction is considered, at both intra- and inter-specific level, individuals interact in space. By definition, interactions occur where the home ranges of two individuals of the same or different species overlap in space. Therefore, those factors that affect the surface area of the individual home ranges and likelihood of their overlap also affect the probability of inter individual interactions and the resulting impacts on individual fitness, population phenotype arrangements and population dynamics. However, in aquatic ecosystems the experimental analysis of the degree of inter individual home range overlap is relatively limited. This study is based on behavioral observations of an invasive species *Callinectes sapidus* and an indigenous one *Eriphia verrucosa*, similar in size but with different movement behaviour. The study has been performed in an internal branch area of Acquatina Lagoon (Frigole, SE Italy), separated from the rest of the basin with a seaneet. A fine scale acoustic telemetry was used to assess individual movement and space use behaviour and to estimate the individual home ranges and their relative intra and interspecific overlap. During the detection period, the individuals used almost the entire available area; moreover, it seems no evidence that the experimental setup limit individual movement. Individual crabs differed in their detection patterns and data for species were averaged; average individual daily home range size significantly differed between species despite the similarity in size, with larger home range areas for *C. sapidus* (8214 m<sup>2</sup>) than for *E. verrucosa* (300.08 m<sup>2</sup>). Moreover, allometric scaling of individual home range with individual body size was observed only for the invasive species ( $y=4.44x-6.59$ ;  $R^2=0.47$ ; log-transformed data). The average home range overlap at interspecific level was 0.55 ([0.19, 0.78] 95% confidence interval). The home range overlap at intraspecific level for *C. sapidus* (0.62 [0.24, 0.81]) was greater than for *E. verrucosa* (0.31 [0.06, 0.75]). This approach can be a good basis for future studies for examining individual variability and study population patterns in the complexity of spatial use within home ranges, establishing a link between space use behaviour and intra- and inter-specific coexistence relationships among individuals of similar sizes and different home range.

**00468**

## **Overlapping territories in a small wintering population of wandering tattler in French Polynesia**

Oral

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### Abstract

The competition for resources in populations is one of the major drivers of population dynamics, especially through survival and reproduction. In the case of the long-distance migratory species, which completely change leaving sites between the breeding and wintering season, there are additional constraints on all the sites they visit. The reproduction success depends on the nutritive quality of the stopover and wintering season. Moreover, during the wintering, survival is driven only by competition for resources. It is particularly the case for the shorebirds, which breed in Alaska and winter in the Pacific area. During the wintering, these species are broadly studied on shores, and wetlands habitat and the territoriality behaviour are well documented. However, many birds stay on tiny islands while wintering in the Pacific area. In consequence, understanding the strategies of these species on islets about the competition seems important in biodiversity conservation for these species, which globally decline dramatically.

Thanks to innovative technology, we have tracked the movement of about half of the population of a little territorial shorebird on a tiny island of the Tuamotu archipelago. Hence, in collaboration with the Max Planck as a part of a proof of concept and a research program to study the birds' behaviours in the face of natural catastrophe, we deployed many Icarus GPS beacons in the Pacific area for the first time, and some of them on 15 wandering tattlers during one night in January 2021 on Tikei. These beacons sent data for several months. The synchronous locations of the birds make it possible to study their territoriality for the first time in an island context. We can thus show through a kernel analysis and an analysis of distances between birds that although the birds use a large part of the island coast as their home range, their core area seems to be much more private and defended from competitors.

These results provide new insights into the territoriality of wandering tattlers during wintering on uninhabited Polynesian islets and suggest the importance of preserving these habitats for the conservation of this shorebird.

00587

## Effects of land use intensity on pollinator behavior in agricultural landscapes

Oral

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### Abstract

Pollinators provide essential ecosystem services and are currently threatened by a variety of anthropogenic influences, such as habitat loss, limitation of floral resources, exposure to pesticides and changing environmental conditions. In agricultural grasslands, these stressors can be caused by the intensification of land use, e.g. mowing events or heavy fertilization. Such land use factors can decrease pollinator health and lead to changes in pollinator behavior, like impaired foraging ability or increased floral handling time, which might ultimately result in a reduced provision of pollination services.

In the Schwäbische Alb region in the southwest of Germany, we conducted behavioral observations of two pollinator species (*Bombus lapidarius* and *Episyrphus balteatus*) on 50 grassland plots of the Biodiversity Exploratory, a research platform providing plots with varying land use intensity embedded in an agricultural landscape. We used a field observation software to track time spend on plants, numbers of flowers visited per plant individual. Further, we registered distance between two plants, flight duration and plant species visited.

Results indicate that biotic factors such as the plant species visited or plant species composition on a plot, play the most important role explaining difference in pollinator behavior. In data subsets on plant species level, abiotic factors such as temperature explain most of the behavioral parameters, which may either be due to direct effects on the pollinators or due to indirect effects, like altered nectar production of the plants. Interestingly, results for bumblebees and syrphid flies are often different. Our results show that factors that are influenced by land use intensity, such as plant diversity or plant identity do have an effect on pollinator behavior.

00677

## Personality relates to both past and future dispersal in a wild bird population

Oral

T. Tamin <sup>1</sup>, J. Morinay <sup>2</sup>, M. Germain <sup>2</sup>, C. Récapet <sup>3</sup>, B. Doligez <sup>1</sup>

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Abstract

Species have now to adapt at habitat deterioration, fragmentation or climate change and one of the possibility of adaptation for individuals is dispersal behaviour. Dispersal is defined as the movement of an individual from its native site to its first breeding site (natal dispersal) or between two consecutive breeding events (breeding dispersal) and it is considered as a major life history trait that could impact many ecological and evolutionary processes. However, because dispersal could be costly for individuals, many studies clearly identified that dispersal could be link with other traits as behavioural traits in order to alleviate these costs. Thus, link between dispersal and behavioural traits could form a 'dispersal behavioural syndromes' which could impact the dynamics of spatially structured populations. Despite possible crucial consequences, very few studies investigated a possible link between dispersal and boldness in a context of nest defence and even less between a boldness-aggressiveness syndrome and dispersal tendencies. Here we tested possible links between dispersal tendencies and behavioural traits and syndrome in a population of a small migratory passerine bird, the collared flycatcher, *Ficedula albicollis* in two main points. In the first one, we studied the influence of (i) breeding dispersal status and (ii) natal dispersal status on three behavioural traits (i.e. aggressiveness, boldness and neophobia) but also on boldness-aggressiveness syndrome. In the second one, we examined if (iii) behavioural traits and syndrome influenced the future breeding dispersal status of individual and (iv) if behavioural traits and syndrome of both parents impacted the decision of chick natal dispersal. Our results revealed that aggressiveness and boldness were related to the current breeding dispersal status but no relations with natal dispersal were observed. Moreover, we found that boldness and the current breeding dispersal determined the future breeding dispersal status of individual and that boldness-aggressiveness syndrome of both parents influence the dispersal decision of young. Thus, our study pointed out a relation between dispersal status and behavioural traits and syndrome but now, more work is needed to fully assess the possible consequences of a 'dispersal behavioural syndrome' on individual fitness.



# Biodiversity and ecosystem functioning in a changing world (1/4) - Verlaine A 22/11 ; 10:15-12:15

**00011**

## **Climate change affects the potential distribution of biotope with consequences for conservation and restoration**

Oral

S. Rubanschi <sup>1</sup>, W.W. Weisser <sup>1</sup>, C. Hof <sup>1</sup>, S.T. Meyer <sup>1</sup>

<sup>1</sup>Technische Universität München - Freising (Germany)

### Abstract

Anthropogenic climate change and land use threaten biodiversity. As a mitigation strategy, conservation and restoration of biotopes have been proposed. Biotopes are areas characterised by specific species compositions often associated with high biodiversity. Such a strategy requires information on the present and future distribution of biotopes, which is currently limited. Using data from the Bavarian biotope mapping program and the distribution algorithm Maxent, we modelled the potential present and future distribution of 29 biotopes in Bavaria based on environmental variables covering present and future climate, chemical and physical soil properties. We found that for most biotopes, climate variables were more important than soil variables for the biotope distribution and that the area potentially suitable for the biotope was larger than the currently observed distribution. We found that climate change will affect the potential future distribution of biotopes, and change will be larger under a more severe climate change scenario. However, biotopes differed in their sensitivity to climate change with some biotopes even increasing in potential distribution. Based on the modelled results, we give spatially explicit recommendations where to conserve or restore climate change resilient biotopes as a basis for conservation and restoration planning.

00024

## Habitat matters: Patterns in phenology and functional traits of herbaceous plant species from Botanical Gardens and natural habitats

Oral

T.J. Deilmann <sup>1</sup>, J. Ulrich <sup>2</sup>, C. Römermann <sup>2</sup>

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### Abstract

**AIM:** An increasing body of literature indicates that plant phenology is a fingerprint of climate change, resulting in an advance in spring phenology and an overall delayed leaf senescence. Temperature and precipitation have been identified as major drivers of phenological change but it also has been shown that species-specific responses are no rarity. Despite the importance of different abiotic conditions, the influence of habitats on phenology and the link of plant traits to phenology is little studied.

**METHOD:** Therefore, we selected 16 herbaceous species occurring in (i) semi-dry grasslands, (ii) mesophilic grasslands and (iii) the Botanical Garden Jena (Central Germany) to investigate the influence of habitat conditions on both inter- and intraspecific patterns in plant phenology and functional traits. Phenology was monitored on a weekly basis from April to October 2020, and all populations were characterized with respect to whole plant, leaf and floral traits, and abiotic site conditions. We used multivariate statistics (PCA) to analyse species- and habitat-specific patterns in phenology and traits. We ran boosted regression trees (BRT) to investigate the relative impact of traits on flower phenology (first flowering day, maximum flowering intensity, flowering duration, and autumn phenology (start and peak of senescence, fruiting) accounting for different habitat conditions.

**RESULTS:** The PCAs clearly indicated that local habitat conditions had a stronger impact on functional trait patterns, compared to phenology in all populations growing in the three habitats. Populations in mesophilic grasslands showed a rather consecutive flowering pattern indicating temporal niche segregation whereas the populations of the same species displayed flowering synchrony in semi-dry grasslands. The BRTs showed that reproductive traits such as generative height, flower density and flower size were important parameters in influencing both flowering and autumn phenology. The relevance of the predictors as well as the direction of influence depended on both the habitat and the phenological trait.

**CONCLUSIONS:** We concluded that habitat conditions strongly affect the phenology and functional traits as well as their associations of grassland species on the local scale. Thus, local information on the habitat should not be neglected when studying phenology, functional traits or their associations also in large-scale studies.

00045

## Sequencing in the dark: unknown groundwater diversity revealed by environmental DNA metabarcoding

Oral

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<sup>1</sup>Eawag-Swiss Federal Institute Of Aquatic Science And Technology, Department Of Aquatic Ecology - Dübendorf (Switzerland)

### Abstract

Despite being the most important source of freshwater on the planet, groundwater is severely endangered by climate change, agriculture, and industrial mining. It is thus extensively monitored for pollutants as well as for any decline in quantity. The organisms living in groundwater, however, are much less surveyed and little is known about the fauna inhabiting underground habitats. Reasons for this lack of knowledge are the difficulty to access groundwater, and the apparent scarcity of organisms, both prohibiting sampling. One method to overcome these issues is the use of environmental DNA (eDNA) metabarcoding. In this study, we aimed at evaluating the possibility of using eDNA metabarcoding for the study of organisms living in aquifers. We sampled water in 20 drinking water wells in Switzerland. For each site, an extensive sampling and lab protocol was performed, including a high number of replicates per site. After amplifying and sequencing a portion of the COI mitochondrial gene, only 7% of the reads produced could be assigned a taxonomic name. After careful evaluation of the unassigned reads, we identified these sequences as true COI sequences belonging mostly to diverse eukaryotic groups, yet not present in the reference databases. Within assigned sequence, some key taxa were successfully retrieved such as amphipod species from the genus *Niphargus*, known to be present in the study area. Our dataset also included DNA from terrestrial organisms and soil organisms that could have been washed out from the surface. Our results show that a high number of organisms living in groundwater are still unknown or not referenced in public databases, which could challenge the use of eDNA metabarcoding to study groundwater biodiversity. Importantly, however, our protocol retrieved the expected species which shows that eDNA can already be very useful when targeting specific organisms with dedicated approaches.

**00059**

## **From shorebird paradise to white geese heaven: how land use in the south changes life in the Arctic**

Oral

J.L. Martin <sup>1</sup>, T. Daufresne <sup>2</sup>, C. Anderson <sup>3</sup>, J. Rausch <sup>4</sup>, P.A. Smith <sup>5</sup>

<sup>1</sup>Cefe/cnrs - Montpellier (France), <sup>2</sup>Inrae - Montpellier (France), <sup>3</sup>Carleton University Giel - Ottawa (Canada), <sup>4</sup>Environment Canada And Climate Change - Yellowknife (Canada), <sup>5</sup>Wildlife Research Division, Eccc - Ottawa (Canada)

### Abstract

Arctic ecosystems are far removed from the direct effects of the soaring human population because they are remote and sparsely inhabited. However, ironically, trends in recent decades suggest that Arctic ecosystems may undergo the fastest and most radical changes on the planet as a consequence of human activities. This is in particular because of their sensitivity to current anthropogenic changes in global climate. These climate induced changes in Arctic ecological conditions have rightfully attracted the attention of the research community, possibly, however, at the expense of research on other forms of anthropogenic disturbance in the Arctic. One of the most dramatic examples is the explosion of arctic-nesting snow geese populations. Their numbers soared from less than 100 000 individuals to possibly over 17 million in only a small number of decades. This resulted from changes in agricultural practices and of the ability of these species to shift their wintering grounds to these novel, man-made habitats. Our study is an empirical test that repeats detailed, ground-based data collection carried out 25 years ago in an Arctic location before geese population expansion, to evaluate the cascade of changes in habitats and avifauna that have occurred since, and the role played in these changes by changes by intensive goose grazing.

**00060**

# **Community-level responses to land-use and climate change at long and short temporal scales**

Oral

T. Montràs-Janer <sup>1</sup>, A. Auffret <sup>1</sup>

<sup>1</sup>Swedish University Of Agricultural Sciences - Uppsala (Sweden)

## Abstract

Global warming and habitat loss are recognised as the most important threats to biodiversity. Yet, due to the lack of historical land-use data, land-use change is generally inferred using proxies and the potential for habitat destruction to interact with increasing temperatures remains largely unknown. Here, we use historical land-use of Great Britain, together with comprehensive climate, species observations from British atlases and national recording schemes, and microclimate temperature, to investigate how changes of land-use and climate and their interacting effects drive changes of taxonomic richness, homogenization and community adaptation to warmer climates in birds, butterflies, and plants over 50+ (1960s-2010s, long-term) and 20 years (1990s-2010s, short-term), at the 10-km square grid cell resolution. Our study confirms anthropogenic land conversion (i.e., loss of semi-natural open habitat and its conversion to more intensive land uses) and warming temperatures as driving mechanisms of community reorganisation across taxa at both long and short temporal scales, leading to increased richness, decreased beta diversity, and an overall taxonomic homogenization of communities at the national level. However, we find these trends weaker in grid cells containing higher levels of open habitat to start with, at both the long- and short-term, which together with the increasing importance of open habitat for local contribution to beta diversity, strongly indicates the importance of these habitats for biodiversity. We also reveal the importance of baseline climate and land-use determining community change over time, especially over the short-term where community shifts may reflect the result of lagged responses to past environmental change and to increase intensification of land-use. Our results provide limited evidence for interacting effects of environmental changes and suggest that microclimate refugia play a larger role in mediating community change than land-use – climate interactions. This study reveals that biodiversity change is spatially structured, thus other factors aside from land-use, climate and microclimatic heterogeneity are also important for determining shifts in biological communities.

**00071**

# **Mycorrhiza in Tree Diversity-Ecosystem Function Relationships: the first seven years of the tree diversity experiment MyDiv**

Oral

O. Ferlian <sup>1</sup>, N. Eisenhauer <sup>1</sup>

<sup>1</sup>German Centre For Integrative Biodiversity Research (idiv) Halle-Jena-Leipzig - Leipzig (Germany)

## Abstract

The widely observed positive relationship between plant diversity and ecosystem functioning is thought to be driven by complementary resource use of plant species. Biotic interactions among plants and between plants and soil organisms are suggested to drive key aspects of resource-use complementarity. The young tree diversity experiment MyDiv aims to integrate biotic interactions across guilds of organisms, more specifically between plants and mycorrhizal fungi, to explain resource-use complementarity in plants and its consequences for competition and multitrophic interactions. Our overarching hypothesis is that ecosystem functioning increases when more plant species associate with functionally dissimilar mycorrhizal fungi (arbuscular and ectomycorrhizal fungi). Here, we present results from the first seven years of MyDiv. We investigated tree mycorrhization with classical and novel techniques as well as different ecosystem functions ranging from tree productivity to herbivory and energy fluxes in the food web as affected by tree species richness and mycorrhizal type. The studies largely showed that tree species richness and identity effects dominate over mycorrhizal type effects in the early stage of the experiment. Furthermore, tree communities with two mycorrhizal types experienced rather additive effects that were in between that of arbuscular and ectomycorrhizal communities. We showed that plant communities differ in their preferred fungal communities. Overall, results of the first seven years of the experiment point to strengthening distinct mechanisms of the two mycorrhizal types with time driving life strategies of trees and biodiversity-ecosystem functioning relationships.

**00130**

# **Temperature and resource availability shape biomass and richness of flying insects along an elevational gradient**

Oral

J.M. Kerner <sup>1</sup>, A. Classen <sup>1</sup>

<sup>1</sup>University Of Würzburg - Würzburg (Germany)

## Abstract

Identifying key drivers of insect biomass and richness is essential to effectively halt the ongoing insect decline. We studied insect communities on 31 grassland sites along five elevational gradients in the National Park Berchtesgaden (Germany) as a natural temperature gradient to investigate flying insect richness and biomass, using malaise traps and metabarcoding. We further filtered the data for the functional guilds of pollinators and herbivores, as they deliver essential functions for a well-functioning ecosystem, making it important to also understand their specific drivers. Our results show that temperature mainly determines insect richness, while biomass and richness of functional guilds are driven by both temperature and resource availability (plant/flower richness). Nevertheless, the impact by temperature on functional guilds was considerably stronger than the resource impact, underlining the importance to consider measures for climate change mitigation to conserve pollinator and herbivore richness. We further compared our results from this sampling approach with outcomes of a sweep net monitoring which was carried out in parallel to the malaise trap sampling. Despite differences in richness patterns between methods, we found equal drivers of richness in both cases.

00614

# Eutrophication mitigation in coastal food webs depends on water color

Oral

A. Garnier <sup>1</sup>, Ö. Östman <sup>1</sup>, J. Ask <sup>2</sup>, J. Niu <sup>1</sup>, J. Roth <sup>1</sup>, M. Huss <sup>1</sup>

<sup>1</sup>Swedish University of Agricultural Sciences - Uppsala (Sweden), <sup>2</sup>Umeå Universitet - Umeå (Sweden)

## Abstract

Coastal eutrophication is a concern worldwide, especially so in the semi-enclosed Baltic Sea. Many management actions aim to reduce nutrient loading. A complementing approach, that has been recently advocated, is to restore top-down control by supporting predatory fish and/or limiting the abundance of smaller forage fish. In addition to the problem of eutrophication, climate change is now posing a serious threat to coastal ecosystems. One predicted consequence of climate change in the northern Baltic Sea region is increased precipitation, in turn, leading to increased inputs of dissolved organic matter of terrestrial origin and darkening. The extent to how the resulting darkening would affect eutrophication symptoms and whether the mitigation actions are effective are unknown.

We conducted a mesocosm experiment with pelagic and benthic habitats to investigate the effects of darkening on mitigation actions acting either bottom-up or top-down. First, we initiated eutrophication by nutrient additions in presence of small juvenile fish (*Gasterosteus aculeatus*) in different water color treatments. In a second phase, we carried out mitigation actions by either stopping nutrient additions, by removing juvenile fish, or both.

After three weeks of mitigation actions, we find that reduced nutrient loads was the most effective action independently of darkening, in terms of reducing pelagic algal biomass. In contrast, the effect of juvenile fish removal varied with darkening, being the most efficient in very dark waters. As for benthic algae, nutrient additions and the stop of those additions had only minor effects. We link our results to shifts in the invertebrate prey community.

Overall, our experiment demonstrates that future eutrophication management of northern coastal waters need to take multiple pressures into account, as well as the indirect effects of environmental pressures caused by trophic interactions.



# Biodiversity and ecosystem functioning in a changing world (2/4) - Verlaine A 22/11 ; 13:45-15:45

00571

## **RegioDiv: Genetic differentiation in mixed-ploidy species and consequences for the design of seed transfer zones**

Oral

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### Abstract

The last decades have seen an increasing use of regional seeds in ecological restoration. As in many countries, seed transfer in Germany is based on a seed transfer zone system. So far, seed transfer zones in Germany are largely based on abiotic parameters and it is largely unknown to what extent these seed zones also represent the patterns of genetic variation within plant species.

Mixed-ploidy species, *i.e.* species comprising multiple ploidy levels, represent a particularly problematic group for the design of seed transfer zones due to multiple factors: First, the relative abundance and spatial distribution of the ploidy cytotypes and second, the proportions of genetic variation among versus within cytotypes. If not accounted for, these factors might distort or mask underlying (spatial) genetic structure.

The project 'RegioDiv' includes the four mixed-ploidy (2x, 4x) taxa *Campanula rotundifolia*, *Knautia arvensis*, *Leucanthemum vulgare* agg., and *Pimpinella saxifraga*. We analysed samples from more than 400 sites per taxon from across Germany both with genomic SNP markers and flow cytometry.

Here, we ask the following questions: Are cytotypes distributed sympatrically or parapatrically? Are cytotypes genetically differentiated? Do cytotypes show similar or divergent patterns of genetic population structure, isolation-by-distance and isolation-by-environment? What are the consequences for restoration and seed zone design? When ploidy levels are clearly genetically differentiated, we analyse them separately to assess the underlying genetic structure. From there, we draw conclusions for the evaluation of seed transfer zones.

00132

# How does niche differentiation among producers and consumers influence the diversity-productivity relationship?

Oral

A. Amyntas<sup>1,2</sup>, E. Berti<sup>1,2</sup>, B. Gauzens<sup>1,2</sup>, G. Albert<sup>1,2</sup>, U. Brose<sup>1,2</sup>

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Abstract

Species-rich communities have shown increased ecosystem functioning such as higher primary productivity or more effective control of herbivores by predators. Additionally, experiments demonstrated that the positive relationship between diversity and ecosystem functioning tends to become steeper over time. One mechanism proposed to explain this change is the reduction of niche overlap within producers and consumers as communities transition to later successional stages. The resulting decrease in competition is hypothesized to be one of the key drivers behind the strengthening of the diversity-functioning relationship. Here we examine how niche differentiation in consumer and producer communities would affect the plant diversity-productivity relationship by combining a food-web assembly model with a bio-energetic model of community dynamics. Starting from a regional pool of species and their potential interactions, we constructed viable local communities that varied in plant richness and niche overlap among species, i.e. with unrestricted or restricted linkage similarity among consumers, crossed with high or low interspecific competition among plants. Then we simulated community dynamics to examine how the different scenarios modify the plant diversity-productivity relationship. Reduced competition had generally minor effects on primary productivity compared to the effect of plant richness. Moreover, we found that a reduction of similarity among consumers did lead to marginally higher productivity in plant-rich and lower in plant-poor communities on average but there was considerable variation in the sign and strength of this relationship and this was more pronounced in communities with fewer plant species. Contrary to our expectations, the reduction of inter-specific competition among plants resulted on average in lower primary productivity across the plant richness gradient. Deciphering the role of competition in ecosystem processes will inform our understanding of how community change over time can modify the functioning of ecosystems which in turn has implications for conservation versus restoration decisions.

00143

## Tree diversity and mycorrhizal fungi co-determine multitrophic ecosystem functions

Oral

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<sup>1</sup>Idiv/ University Of Leipzig - Leipzig (Germany)

### Abstract

The relationship between biodiversity and ecosystem functions (BEF) in forests remains less well understood compared to grasslands. For example, tree identity has been suggested to play a role as important as species richness and different studies have reported opposing results. Such inconsistent findings in forest BEF studies may be better understood by considering critical biotic interactions of trees. This study investigates the role of tree-mycorrhizal interactions that may shape forest BEF relationships. To achieve that, we used a field experiment (MyDiv) that comprises ten tree species associated with either arbuscular mycorrhizal (AM) or ectomycorrhizal (EcM) fungi to create gradients in species richness (1, 2, 4 species) and differently mycorrhized communities. We investigated the effects of tree species richness and mycorrhizal types on crucial ecosystem functions (foliage damage, predation, and soil fauna activity) and their correlations. We further investigated how forest characteristics mediated the effects. Compared to monocultures, 4-species mixtures with both mycorrhizal types experienced significantly lower foliage damage. The mixtures dominated by EcM fungi supported significantly higher predation rates, and this effect strengthened with tree species richness. The effects of tree species richness on soil fauna activity were negative across all mycorrhizal types but limited to the deeper soil layer. Furthermore, species richness and mycorrhizal types strongly shaped the correlations among the targeted functions. They were strongly mediated by both variation in tree sizes and canopy structure, which was largely driven by mycorrhizal types. In addition, mycorrhizal types influenced average tree size and further affected foliage damage. Overall, our study showed that the expected effects of tree richness were only found in plots with both mycorrhizal types and in the communities dominated by EcM, which could be explained by the variations in tree size and canopy structure. Our results highlight the importance of forest characteristics and biotic interactions in trees for ecosystem functioning and contribute to broadening the mechanistic understanding of BEF relationships in forests.

00159

## Climate and land use impacts on pollinator diversity differ among taxa and scales

Oral

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Abstract

Changes in climate and land use are major threats to pollinating insects. To date, most studies have considered climate and land use as independent factors, but many theoretical studies and few empirical ones have pointed out the importance of accounting for their interactive effects. Although it is assumed that land-use factors can intensify or buffer climate change effects, empirical evidence is largely missing. In our study, we unravel the joint effects of climate and land use on several pollinator taxa using a multiscale space-for-time approach across large climate and land-use gradients in a temperate region. For this, we used DNA metabarcoding of Malaise trap samples and trap nest data collected in 179 study plots embedded in 60 study regions across Bavaria (Germany). Metabarcoding data yielded 3,218 flower-visiting species from seven different taxa, and trap nests contained 13,266 nests from 32 bee species. Metabarcoding results revealed climate-land-use interactions at regional but not local scales, affecting pollinator community composition, gamma diversity, and beta diversity (community dissimilarity) of several pollinator taxa. For instance, warmer climates promoted pollinator diversity in forest landscapes but not in cities. Both metabarcoding data and trap nest data agreed on bee communities suffering from climate warming in urban regions, but trap nest data additionally showed high urban temperatures to reduce bee abundance at a local scale. In summary, we found taxon-dependent negative effects of climate and land-use intensity at multiple spatial scales, that point out management options to mitigate impacts of climate change on pollinators and their ecosystem services.

00178

## Behavioural and immunological defense traits of *Lobesia botrana* larvae are affected by host plant phenology and cultivar as well as indirectly by atmospheric CO<sub>2</sub> concentrations

Oral

C. Becker <sup>1</sup>, A. Rummel <sup>1</sup>, A. Reineke <sup>1</sup>

<sup>1</sup>Hochschule Geisenheim University - Geisenheim (Germany)

### Abstract

The multivoltine European Grapevine Moth, *Lobesia botrana*, is an important insect pest in vineyards worldwide. To avoid falling prey to predatory arthropods and parasitic wasps the larvae employ behavioural and immunological defense mechanisms. Their efficacy can be affected by insect diet. Rising atmospheric carbon dioxide (CO<sub>2</sub>) concentrations associated with climate change can alter host plant quality for herbivores. Will this affect larval defenses?

In a combination of field and laboratory experiments, we studied the impact of elevated CO<sub>2</sub> concentrations, larval development, grapevine phenology and cultivar on defense traits of *L. botrana* larvae, *i.e.* larval silk yarn length, yarn production rate, escape velocity, escape rate, twisting behavior, haemocyte concentration, pro-/polyphenoloxidase activity and successful development into adults after injury. In the field, larvae were feeding on *Vitis vinifera* 'Riesling' or 'Cabernet Sauvignon' in three different phenological stages (inflorescences, peasized berries, berries changing color) under ambient or elevated CO<sub>2</sub> concentrations in the Geisenheim VineyardFACE (Free-Air Carbon dioxide Enrichment facility in the vineyard). In the lab, larvae were feeding on standard artificial diet under ambient or elevated CO<sub>2</sub> concentrations to study the direct effect of CO<sub>2</sub>. To study the indirect effect of CO<sub>2</sub>, larvae were feeding on artificial diet containing grapevine reproductive organs harvested in the VineyardFACE. Additionally, we assessed the impact of larval development.

Our field experiments showed a strong impact of plant phenology on traits associated with both behavioural and immunological defense while cultivar and CO<sub>2</sub> concentration rather affected immunological defense. Our lab experiments largely agree with this and additionally show an indirect effect of CO<sub>2</sub> on behavioural defense. No direct effect of CO<sub>2</sub> was observed. Larval development affected some behavioural and immunological traits.

Our experiments suggest that the changes in defense traits observed in the field are largely plant quality-mediated bottom-up effects. Varying larval development may play a role. Projecting approximately 50 years into the future, we may indeed expect some impact of elevated CO<sub>2</sub> concentrations on larval defense against natural enemies. Interestingly, already now, during one season, one generation may defend themselves more successfully than others depending on grapevine phenology. This should be an interesting topic for further studies.

**00061**

# **Temporal Dynamics of Global Biodiversity : Controversies, Biases and Challenges**

Oral

**M. Boënnec <sup>1</sup>, V. Devictor <sup>1</sup>, V. Dakos <sup>1</sup>**

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## Abstract

Populations and ecological communities are changing worldwide exhibiting a mixture of increasing, decreasing or no change trends. However, the extent of these changes is still debated. Our work aims to characterize the debate opposing a declining picture of biodiversity against a more nuanced one. We also aim to identify potential biases and challenges compromising current estimates of global biodiversity dynamics. We conducted a systematic review on existing studies documenting the temporal dynamics of global biodiversity. Biodiversity is defined here at species, communities and population level. We classified the differences among approaches, data and methodology used by the reviewed papers to reveal common findings and sources of discrepancies. We identify the prevalence of two main approaches : one based on aggregating local or regional results into meta-analyses to establish global conclusions, the other based on direct global data analysis. While half of the reviewed papers identifies a general decline in global biodiversity, more than a third draw more nuanced conclusions. This difference in the conclusions varies according to the type of approach (e.g. aggregation of global results being more often prone to conclude that biodiversity is declining); according to the method (e.g. global indices drawing more alarming conclusions than classical statistical models); and according to the data (e.g. the proportion of mixed results increasing with the length of the time series). We also confirm serious taxonomic and geographical biases and gaps in biodiversity data as well as shortcomings in the assessment of temporal biodiversity patterns. Remarkably, biodiversity dynamics is always assumed to be linear while the stability or even non-linear trends are largely overlooked. Overall, this work proposes common pitfalls and promising perspectives to estimate global biodiversity dynamics in a changing world.

## **Biodiversity and ecosystem functioning in a changing world (3/4) - Verlaine A 22/11 ; 16:15-18:15**

**00285**

### **Megafauna extinctions over the late Quaternary have strongly reduced mammalian consumption of primary productivity**

Oral

R. Pedersen <sup>1</sup>, S. Faurby <sup>2</sup>, J.C. Svenning <sup>1</sup>

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#### Abstract

How much stronger would the effects of herbivorous mammals be in natural ecosystems without human-linked extinctions and extirpations? Many species have had range contractions, and numerous species have gone extinct due to human pressures, so herbivore impacts in seemingly natural ecosystems likely deviate from their pre-anthropogenic state. We quantified and mapped plant consumption by all late-Quaternary terrestrial mammals in natural areas based on both current and estimated natural ranges, i.e., in the absence of range contractions and extinctions. We found that wild mammals consume 7.2% of net primary productivity in current natural areas, and that this would be much higher in the absence of extinctions and extirpations, namely 13%, i.e., a 45% reduction in consumption rate. We saw similar declines in herbivory in wilderness areas. Our results show that the effects of mammalian herbivores have been strongly reduced by prehistoric and historic species losses even in wild areas.

00312

## How does food restriction impact nutrient cycles through animal physiology?

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.  
Ecophysiology

Oral

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Abstract

Element cycles in ecosystems are impacted by animal communities in various ways. There is the consumption of a resource, its use for growth and maintenance, and the release of wastes. The quantity and quality of resources affect how growth, maintenance, and the release of wastes work in both quality and quantity. These processes also depend on the demographic and physiological characteristics of the consumer. Although the effect of resource quality on organismal and waste chemical composition has been thoroughly investigated, and in various taxa, the influence of quantity, or food limitation on this elemental mass-balance has been poorly documented. However, there are good arguments to suppose an adaptive response to food limitation in assimilation and growth efficiency to maximize energy and nutrient extraction from food when needed. This, in turn, can impact the quantity and quality of biomass fluxes through the animal, and finally, the impact of the consumer on the biomass dynamics.

Here, we tested the link between food limitation and assimilation and growth dynamics with special focus on major elements (C, N, P, S, Na, Mg, K, Ca). We used a polyphagous pest insect larvae (*Spodoptera littoralis*) fed at various food levels, from high restriction to ad libitum levels. Our hypothesis was that the individual should invest more energy in digestion when facing food restricting conditions, decreasing the amount of wastes produced and possibly changing the balance between elements. In the present study, there was indeed an increase in assimilation efficiency for low food provision levels. Growth efficiency, on the other hand, was higher for intermediate food levels, supposedly because very low intake means not enough energy to fuel the growth process, which resulted in poor growth efficiency despite high assimilation efficiency. As a result, both very low and very high mass-specific intake rates corresponded to lower growth efficiency than intermediate ones.

The dynamics of elements (C, N, P, S, Na, Mg, K, Ca) assimilation and wastes were also impacted by food limitation. We discuss the implications of these results in the context of nutrient cycling in terrestrial ecosystems.



00353

## Avian insectivory is not mediated by bird acoustic and functional diversity along a wide latitudinal gradient

Oral

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Abstract

Biodiversity increases towards the tropics. It has long been assumed that this pattern resulted from an increase in the intensity of biotic interactions towards lower latitudes. Yet, this view is being challenged. Pluralistic research is needed to elucidate the mechanisms underlying latitudinal variation in biodiversity and biotic interactions, which implies a sound examination of an ecological force overlooked so far: predation. In this study, we asked whether more diverse communities of insectivorous birds impose a stronger predation pressure on prey and whether this diversity-function relationship varies with latitude. We deployed artificial caterpillars in 138 oak trees along a 19° latitudinal gradient in Europe to quantify bird predation rates. We used passive acoustic monitoring devices to characterise the acoustic diversity around oaks as well as the species and functional diversity of insectivorous birds. Avian predation rates increased with latitude and percentage of forest cover. The functional diversity of insectivorous birds increased with increasing temperature, but had no effect on avian predation rates. The acoustic diversity was influenced by percentage of forest cover, but was independent of insectivorous bird diversity. Acoustic diversity had no influence on avian predation rates. Contrary to our predictions, latitudinal clines in predation rates were not associated with changes in bird diversity or acoustic diversity.

00356

## Uncertainty on migration: selecting predictable resources in unpredictable conditions

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.

Behavior: Migration And Movement

Oral

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Abstract

Environmental and climatic variation drive animal migration. Animals must adjust their behavioural strategies, e.g., habitat selection, to match best the variation in resources; resources whose value likely varies with conditions, such as weather. For example, climate change makes processes, such as snowmelt and the emergence of vegetation less predictable at the scale of months or weeks. Whereas climate change makes meteorological conditions unpredictable – or dynamic – at the scale of days and hours. The profitability of selecting any particular resource may vary by the local meteorological condition. We studied the impact of dynamic weather conditions on fine scale movements strategies and resource selection during spring migration of adult female woodland caribou (*Rangifer tarandus*). We assessed the role played by static resources such as open, lichen, and closed forest and their role in a context-dependent of dynamic weather conditions, including temperature, precipitation, and changing snow, i.e., snow water equivalent. We tested the role of static resources and dynamic conditions in three contexts: (1) whether caribou were encamped or moving behavioural using hidden Markov models; state-specific habitat selection for, and the interaction between, resources and conditions while (2) encamped and (3) moving. Weather conditions influenced the probability of moving or staying encamped, and the probability of selecting for a resource, which likely reflects the profitability of a given resource in a particular condition. The probability of staying encamped in the forest increases as the temperature increases. But also, the probability of selecting an open area is higher when precipitation is lower. We highlight that meteorological conditions modify the selection of a resource and likely its profitability. Thus, its utility to a consumer is increasingly susceptible to climate-change induced effects.

00419

# The effects of Artificial Light At Night on plant-insect interactions

Oral

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Abstract

**Presentation Title:** The effects of Artificial Light At Night on plant-insect interactions

**Robin Heinen**<sup>1</sup>, Oriana Sanchez, Sarah Sturm, Zoë Pfeiffer, Martijn Bezemer, Johannes Kollmann, Michael Schlöter, Jörg-Peter Schnitzler, Corina Vlot & Wolfgang Weisser

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**Abstract**

Artificial Light At Night (ALAN) is increasingly present in terrestrial ecosystems worldwide. Although many studies show that light pollution has direct devastating consequences for animal physiology, behavior and fitness, surprisingly little is known about the effects of ALAN on plants and the associated phytobiome. Reductions in ALAN are commonly suggested as potential solutions to mitigate ecological effects, but the effects of such an approach have not been studied. In a climate chamber facility, we exposed plants to fully lit, fully dark nights, or an intermediate where only the first half of the night was lit, and then introduced aphids to the plants. We found that ALAN had negligible effects on plant growth, but consistently suppressed aphid colony formation over time. Surprisingly, the suppressive effects of ALAN were strongest under intermediate ALAN treatment, suggesting that the effect of ALAN mitigation may stress aphids more than ALAN itself. We quantified defense gene expression in the plants, to show that ALAN suppressed defenses, but strongly correlated with aphid numbers, suggesting that the effects of ALAN on plant-aphid interactions are behavioral, rather than plant defense-mediated. ALAN affects plants and insects in complex ways, and mitigation will be more complex than flipping the switch.

00432

## Relationship between microbial diversity and susceptibility to antibiotic resistance invasion in epilithic biofilms

Oral

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Abstract

According to Mallon et al. (2015), the invasion of microbial communities by other microorganisms consists of a sequence of events: introduction of an invader, its establishment, growth, and spread, ultimately resulting in an altered functioning of the native community. Several parameters have been reported as determinants of invasion success, as the invader must overcome the "biotic resistance". The persistence of invading organisms depends on their ability to exploit the resources made available in vacant ecological niches. As a consequence, the susceptibility to invasion is stronger when diversity is low as a higher number of niches might be vacant. We hypothesized that bacterial invasion is a prerequisite to antibiotic resistance dissemination as the donor needs to settle first in the community. We developed a project to study the effect of biodiversity on the susceptibility of microbial communities to invasion by antibiotic resistance genes after exposure to anthropogenic pressures. To do this, we selected four rivers at the head of watersheds with different levels of diversity depending on the physico-chemical conditions of the environment. Sampling was carried out on epilithic biofilms along a continuum starting from areas with low anthropization (head of watershed), passing by areas with intermediate pressure (rural activity zone) and eventually finishing in urban habitats. The chemical composition of these streams was characterized with respect to their nutrient resource, where a natural pH gradient had already shown an impact on macroorganism diversity. The screening of about 50 antibiotic resistance genes along this continuum, carried out by high-throughput quantitative PCR, confirmed the entry of some of the genes as soon as the first anthropic pressure. In parallel, the structure of the bacterial communities was established by metabarcoding on the 16S rRNA gene, showing a variation in the microbial diversity of biofilms between streams. Our data allowed establishing a relationship between microbial biodiversity, and the qualitative and quantitative increase of antibiotic resistance genes under anthropic pressure.

00433

## Tree growth resistance and resilience to the 2018-2020 drought as modulated by tree diversity and mycorrhizal associations

Oral

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Abstract

The frequency of consecutive drought years is predicted to increase due to climate change. Strong negative impacts of the unprecedented 2018-2020 drought years were observed across Central European forests. Mixing tree species is proposed to increase the temporal stability of tree communities and mitigate drought impacts. However, this promising diversity effect has not yet been investigated with the focus on consecutive drought years and on how responses are modulated by different tree mycorrhizal associations suggested to aid water uptake from soils. With this study, we aim at answering the question of whether tree diversity can increase growth resistance and resilience to consecutive drought years using inventory data (2015 – 2021) of a young tree diversity experiment in Germany (MyDiv). The experiment manipulates tree species richness (1, 2, 4 species) and tree mycorrhizal type (communities containing either arbuscular mycorrhizal (AM) or ectomycorrhizal (EM) tree species, or both). For all tree communities, we calculated growth responses as basal area increments (BAI) for each drought year relative to pre- and post-drought conditions. Initial results indicate that mixed communities were in general not more resistant to drought than monocultures. However, EM-associated tree communities showed higher resistance to the drought years than communities associated predominantly with AM. In a future project, we will use a functional approach with tree species traits related to drought tolerance and the leaf economic spectrum to gain more insight into the underlying processes behind observed effects. Moreover, the inconclusive results at the tree community level indicate that analyses at smaller spatial scales are needed for a more accurate assessment. Therefore, we will additionally focus on the population and individual tree level, i.e. on how tree populations and individuals respond to drought relative to the diversity, mycorrhizal association type, and size structure of their local neighborhood. This study contributes toward understanding the relevance of tree diversity and belowground mycorrhizal associations for forest responses to drought.

00435

## Nomadic ungulate movements under threat: Declining mobility of Mongolian Gazelles in the Eastern Steppe

Oral

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### Abstract

Long distance movements of ungulates are threatened by increasingly fragmented and disturbed habitats. While the effects of impermeable barriers on ungulate migrations have been well researched, longitudinal studies that quantify continuous declines of long-range movement in response to gradually increasing disturbance are less common.

We investigated changes in the movement behaviour of Mongolian Gazelle *Procapra gutturosa*, a nomadic ungulate species native to the Mongolian steppe. The Mongolian Steppe Ecosystem is currently undergoing a rapid transformation characterised by increases in linear infrastructure development, extractive industries and traffic, driven by the economic growth of Mongolia. Using GPS tracking data collected from 62 individuals between 2007 and 2020, we employed generalized linear mixed models and generalized additive models to assess how anthropogenic and environmental factors affected long-distance movements of Mongolian Gazelle. Furthermore, we used barrier behaviour analyses and multinomial logistic regression to classify and compare behavioural responses of gazelle between different types of linear infrastructure.

The distances covered by long-distance movements of Mongolian Gazelle declined substantially during the studied period, while controlling for concurrent changes in environmental factors such as vegetation greenness that often drive ungulate migration behaviour. Furthermore, we found that gazelle movements decreased close to linear transportation infrastructure. Gazelles were more likely to avoid asphalted roads than to cross them, and the probability to display avoidance was comparable between asphalted roads and impermeable fences in the same region. The observed declines in mobility and the avoidance behaviours near linear transportation infrastructure were less pronounced in winter than during the warm season.

Our findings suggest that the observed decrease in gazelle mobility may be related to increases in road development or traffic volumes in the Mongolian Steppe. Our study contributes new insights on how gradually decreasing landscape permeability affects highly mobile ungulate populations, as gradual decreases of ungulate mobility over more than a decade have rarely been quantified. Furthermore, we provide evidence that effects of semi-permeable barriers also extend to nomadic ungulates, even though they are thought to be more resilient to anthropogenic impacts than their migratory counterparts.

# Biodiversity and ecosystem functioning in a changing world (4/4) - Verlaine A 23/11 ; 10:00-12:00

00518

## Resource and animal-induced competition jointly drive plant diversity-productivity relationships

Oral

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Abstract

The importance of biodiversity for providing ecosystem functions and services important to human wellbeing is well documented. However, despite the abundance of research on biodiversity-ecosystem functioning (BEF) relationships in general and diversity-productivity relationships in particular, their underlying mechanisms are insufficiently understood. While such relationships may support the argument for conserving biodiversity, the lack of a mechanistic understanding hampers the effectiveness of any future restoration efforts and prevents us from accurately predicting ecosystem responses to a changing world.

We address this issue by investigating two major drivers of plant diversity-productivity relationships in an in-silico biodiversity experiment. By explicitly integrating space-use in our models, we are additionally able to examine how processes at different spatial scales culminate in patterns at the ecosystem level. In particular, we consider the effects of (1) plant competition for resources with their neighbors and (2) multi-trophic interactions with complex animal communities at different spatial resolutions. By varying the strength of resource competition we can show that interactions between plants – even if only competitive – are a fundamental requirement for positive diversity-productivity relationships to emerge. In diverse communities, competition for resources allows plants to optimize the community's resource-use and thereby increase its productivity. When embedded in multi-trophic animal communities, strong resource competition is mitigated, reducing competitive exclusion. However, if herbivores induce strong apparent competition between plants, this may lead to negative diversity-productivity relationships. In contrast, lower levels of apparent competition due to a higher heterogeneity in how animals use space leads to more positive diversity-productivity relationships than in plant communities without animals. Taken together, our findings highlight that positive plant diversity-productivity relationships arise from local interactions between plants. These interactions, however, are modified by processes at higher trophic levels and depend on how animals integrate effects over larger spatial extents. A careful consideration of multi-trophic processes is therefore required to successfully disentangle the mechanisms shaping BEF relationships.

00521

## Effects of plant diversity on species-specific herbivory – Patterns and Mechanisms

Oral

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Abstract

Invertebrate herbivory can shape plant communities by posing stronger impacts on growth and fitness on some plant species in comparison to others. Previous studies showed that herbivory varies among plant species and that species-specific herbivory is modulated by the diversity of the surrounding plant community. However, the underlying mechanisms explaining this variation are still poorly understood. In this study we investigate how plant traits and plant apparency explain differences in herbivory among plant species and explore the effect of plant community diversity on these species-specific relationships. We found that species differed in the herbivory they experienced. Forbs were 3-times more damaged by herbivores than grasses. Variability within forbs was caused by differences in plant cover, leaf N-concentration and leaf dry matter content (LDMC). Furthermore, herbivory on 15 plant species were positively and nine species negatively affected by an increase in plant diversity. Variation among forb and grass species in their response to changing plant diversity was best explained by species' physical resistance (forbs) and biomass (grasses). Overall, our results show that herbivory and diversity effects on herbivory differ among species, and that, depending on the functional group either species-specific plant traits or appearance are driving those differences. Thus, herbivory might change plant community composition by targeting plants with specific species properties, especially, palatable forbs or abundant grasses, which could have different implications for grasslands dominated by either forbs or grasses.



00583

## It's about timing – Phenological asynchrony in leaf development can improve nitrogen uptake of diverse tree communities

Oral

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Abstract

Biodiversity positively influences biomass production in several terrestrial ecosystems including forests. Numerous studies have explored the mechanisms underlying the diversity-productivity relationship, however, mechanistic understanding of these relationships in woody ecosystems is accumulating only recently. Here, we tested whether temporal complementarity in leaf phenology prolongs the active season length, defined here as time between leaf emergence and leaf abscission, of diverse communities. We further hypothesized that temporal niche separation increases nitrogen (N) capture in more diverse communities.

We recorded leaf phenology for each species in four replicates of 22 tree communities during the 2018 growing season in Sault Ste Marie, Ontario, Canada. Communities were distributed along orthogonal gradients in species richness (SR) (one to six species) and functional diversity (FD). The plant area index (PAI), a measure of canopy density, of each of the 88 plots was measured weekly to biweekly and leaves were sampled for N analyses at peak PAI in the following growing season.

The timing of species leaf emergence was independent from the tree community and diversity in all species. At the community level active season length, maximum PAI and cumulative PAI over the active season increased logarithmically with SR and linearly with FD. Leaf N concentration increased with SR and FD in two species and remained constant in four species. Combined with the higher PAI, this translates into a higher canopy N content in diverse mixtures.

We conclude that the higher likelihood of including phenologically different species in diverse mixtures results in complementary effects on light capture and N uptake. Communities comprising species that differ in the timing of leaf development and persistence support longer leaf area duration and capture more nitrogen than monocultures. Both phenomena can help to explain the higher biomass production of species-rich stands through increased seasonal photosynthetic C gain. This knowledge can be used to optimize biomass production in plantations and reduce N leaching.

00605

## How repeatable are communities in *Fomes* polypores?

Oral

A. Ardanuy<sup>1</sup>, O. Rose<sup>2</sup>, C. Bouget<sup>3</sup>, A. Brin<sup>4</sup>, F. Laroche<sup>1</sup>

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Abstract

Coexistence of species within communities is thought to result from the joint effect of stochasticity, equalizing mechanisms and stabilizing mechanisms. Stabilizing mechanisms, such as niche differences, may generate predictable functional structures of communities.

Here we tested this assumption on feeding guilds of coleopteran communities within *Fomes* polypores. We examined whether those communities presented a repeatable functional community at distinct sampling scales in five sites using constrained null models. The scales considered were polypore, plot and site. For each scale, we tested whether the functional structure in terms of feeding guilds was more repeatable among units than expected by chance, and assessed whether such repeatability was stronger than the one observed at species level. In parallel we examined the species structure within guilds, and tested whether species turnover differed among guilds with different trophic position (fungivorous and predatory).

Our preliminary analysis shows that coleopteran communities within polypores varied significantly among plots at species level, with larger  $\beta$ -diversity than those of null communities, while feeding guilds did not. This suggests that these coleopteran communities present functional redundancy. At the next organisation level, plot scale, the coleopteran community  $\beta$ -diversity matched that of null communities from both species and feeding guild perspective. At the global scale both coleopteran communities and feeding guilds showed structure at site scale, with larger  $\beta$ -diversity than randomised null communities. When exploring species co-existence within feeding guilds, our analysis showed greater  $\beta$ -diversity for fungivorous species than for the null model communities at plot scale, while predatory species showed the opposite trend. This indicates that these feeding guilds diverge in their response to plot structure. At global scale our analysis showed similar diversity patterns for fungivorous than at plot scale, and no divergence from the null communities for predators.

Our results support the idea of a repeatable structure of coleopteran communities at polypore scale with exchangeable species composition given a local species pool. We speculate that differences in feeding guilds  $\beta$ -diversity patterns are due to the predatory guild comprising more habitat generalist species - which may be favoured in fragmented systems - than the potentially more habitat obligate fungivorous guild.

00150

## Impact of freshwater shipping on biodiversity is context dependent

Oral

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### Abstract

Europe's freshwater biodiversity is rapidly declining in response to several threats including climate change, nutrient deposition, infrastructure development, and navigation/shipping traffic. The effect of navigation on Europe's waterways is particularly interesting because the Green Deal considers it among the best alternatives for future sustainable transport. However, our understanding of inland navigation's impact on biodiversity, and the infrastructure required to support it, is incomplete, with most research remaining at the localized level, largely consisting of case studies or small-scale field studies. We therefore lack a generalizable understanding of how inland aquatic navigation, and navigation infrastructure impact biodiversity at the European scale. Our work aimed to identify the relationships between navigation/infrastructure and native vs. invasive biodiversity. Additionally our research focused on the context dependencies of these relationships, to better understand what factors may promote further degradation, or potentially mitigate navigation's impact. To address this, we conducted a data synthesis project utilizing several localized biodiversity datasets across Europe on fish, macroinvertebrates, and plants, within the last thirty years. These biodiversity datasets were linked spatially with data on shipping frequencies and infrastructure densities across Europe. Additionally we linked our data with land use data at the landscape scale and riparian habitat characteristics at the local scale to quantify context-dependencies. We found that high shipping traffic was associated with an increase in invasive species densities, however when shipping traffic was low and the riparian zone was largely intact, native species dominated. Additionally, we found navigation infrastructure density to decrease native species richness, with increasing severity in more artificial landscapes, but have no impact on invasive species. These results highlight the impact of navigation on native biodiversity - including a potential facilitation role in invasive species distribution - and the need to preserve riparian zones in heavily trafficked waterways as Europe increasingly relies on inland navigation. To promote native species and slow the spread of invasives, we should adapt waterway management and increase the coverage of protected riparian areas, with a focus on regions of intense shipping traffic, and highly artificial environments such as urban centres and agricultural landscapes.

**00454**

## **Ambient and substrate energy influence decomposer community diversity differentially across trophic levels**

Oral

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### Abstract

The species-energy hypothesis predicts increasing biodiversity with increasing energy in ecosystems. Proxies for energy availability are often grouped into ambient energy, (i.e., solar radiation, temperature) and substrate energy (i.e., non-structural carbohydrates or nutritional content). The relative importance of substrate energy is thought to decrease with increasing trophic level from primary consumers to predators, with reciprocal effects of ambient energy. Yet, empirical tests are largely lacking. To show differential effects of energy types between trophic levels on decomposer communities, we compiled data on 332 557 deadwood-inhabiting beetles of 901 species reared from wood of 49 tree species along a latitudinal gradient in Europe. Using host-phylogeny-controlled models, we show that the relative importance of substrate energy versus ambient energy decreases with increasing trophic levels: the diversity of zoophagous and mycetophagous beetles were determined by ambient energy, while non-structural carbohydrate content in woody tissues determined that of xylophagous beetles. Besides the influence from energy related measures, diversity was positively affected by co-variables like deadwood amount, while effects of deadwood decay stage varied between trophic levels. We therefore show that influence of substrate energy on decomposer communities is depended on trophic levels, which need to be considered when trying to predict biodiversity.

**00657**

## **Insect houses attenuate negative effects of urbanization on cavity-nesting bee and wasp abundance**

Oral

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### Abstract

Nesting aids for cavity-nesting bees and wasps, also known as insect houses, aim to support bee and wasp populations by providing nest sites, but their conservation value is still debated. Urban areas, for example city centers can be expected to provide fewer nest sites for cavity-nesting bees and wasps than more rural areas, for example suburbs. Therefore, insect houses should support bee and wasp populations especially in highly urbanized areas. In a citizen science project, we used standardized trap nests to sample cavity-nesting bees and wasps. Traps were installed at 240 school buildings across Germany for one year. We reared cavity-nesting bees and wasps from trap nests. In addition, we assessed the presence of other insect-houses that were installed independent of our sampling by citizens before the beginning of our project. As a measure of urbanization, we calculated the percentage of sealed surface for each site. Bee abundance in trap nests decreased with increasing urbanization, but only if insect houses were absent. Wasp abundance declined independent of the presence of insect houses but was generally lower when insect houses were absent. Therefore, insect houses supported bee and wasp populations and nest sites were likely the limiting factor for their abundance, especially in urban areas. This attenuation of negative urbanization effects also indicates that flowers as food resources for bees were not limited even in urban areas, but urbanization decreases nest and food resources of wasps. In conclusion, insect houses support local bee and wasp populations and are thus a conservation measure.

**00597**

## **Pollen limitation, local resource availability and pollinator community composition affect the fertilization success of *Scabiosa ochroleuca***

Oral

C. Dominik <sup>1</sup>, S. Wogram <sup>1</sup>, S. Michalski <sup>1</sup>, O. Schweiger <sup>2</sup>

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### Abstract

Habitat fragmentation, intensive agriculture, and climate change are major threats to biodiversity and the provision of ecosystem services, such as pollination. Because most of flowering plants rely on pollinators for reproduction, the decline of insects and particularly wild bee species may negatively alter plant reproduction and floral resource availability. How pollen limitation affects plant reproduction has been studied extensively via independent experiments comparing seed sets of naturally exposed flowers to pollination with supplemented pollinated flowers. Yet, relationships between landscape intensification, pollination and pollen limitation have been found to be highly context-dependent.

In this study, we used *Scabiosa ochroleuca*, a perennial herbaceous plant species ranked as endangered in the German red list, as our focal species to disentangle the effects of landscape structure, local resource availability, and pollinator community composition on pollen limitation and seed set. Within the EU project Safeguard, a total of 160 seed sets from individual plants were collected in multiple porphyry landscapes in Central Germany. To assess pollen limitation, we conducted pollen supplementation experiments, and collected fruit sets from control plants and plants given supplemental pollen. We assessed pollinator community composition by performing transects, resource availability by flower surveys, and landscape structure by extracting respective metrics from habitat maps.

Here, we present preliminary results showing how pollinator community composition, local and landscape factors, and their interactions influence fertilization success of *S.ochroleuca*. Further, our results contribute to a better understanding of how wild bee species decline and increasing isolation may impair reproductive success of an endangered entomophilous plant species, which may lead to an elevated risk extinction in small populations.

# Biogeochemical cycles and ecosystem ecology in a changing world - Salle 11+12 24/11 ; 13:45-15:45

**00127**

## **Impact of mesozooplankton diversity on the ecosystem functioning in the Sargasso Sea, using molecular and imaging data**

Oral

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### Abstract

Mesozooplankton play an important role in pelagic ecosystems. Linking primary producers and higher trophic levels, they are also involved in the biological carbon pump through the production of particles sinking into the deep ocean. This carbon flux is amplified by the diel vertical migrations (DVM) of some mesozooplankton taxa. Recent methods, like quantitative imaging, produce an enormous quantity of data at the individual scale. Then, data can be used in a trait-based approach in order to better understand how an ecosystem works. Additionally, high throughput sequencing of environmental DNA permits the rapid identification of species at a community-level. Thus, metabarcoding can provide a complementary vision to the functional approach.

In this study, we investigate variations of the morphological and taxonomic facets of mesozooplankton diversity, and link its realized and potential traits with environmental and/or ecosystem's functioning changes.

We analysed 69,950 individual images of mesozooplankton, obtained by the Zooscan, together with the 225 most abundant unique 18S V1V2 sequences, acquired by metabarcoding. Data were sampled monthly, during the day and at night, between March-2016 and May-2017, in the first 200 m of the water column at the Bermuda Atlantic Time-series Study. A morphological space was created based on 18 morphological descriptors from the entire set of images to identify the main morphological traits that vary in the mesozooplankton community.

Our results showed that environment variations structured the taxonomic composition of mesozooplankton, but did not affect the overall morphology of the community. Three distinct communities were defined based on taxonomic composition, and succeeded one another throughout the study period. A co-occurrences network was built from metabarcoding data and 6 groups of taxa (or "modules") were identified. These were linked to changes in ecosystem's functioning and/or in the community's morphology. DVM importance was confirmed by the existence of a module with taxa preferentially sampled during the night, and by a darker opacity for migratory organisms that was linked to higher carbon export.

**00189**

## **Effect of anthropogenic and biological stressors on methane production, oxidation and emissions in ponds**

Oral

C. Ganglo <sup>1</sup>, C. Mendoza-Lera <sup>1</sup>, A. Manfrin <sup>1</sup>, A. Lorke <sup>1</sup>

<sup>1</sup>University Of Koblenz Landau - Landau In Der Pfalz (Germany)

### Abstract

Methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>) are potent greenhouse gases (GHGs) that contribute to climate change. Ponds are important hotspots of GHGs emissions. Our previous field study indicated elevated CH<sub>4</sub> from ponds treated with the mosquito control biocide *Bacillus thuringiensis israelensis* (Bti) in comparison to untreated control ponds. The higher emissions rates were attributed to a reduction in the density of chironomids by Bti and a decrease in bioturbation, which is the biological reworking of the sediment matrix and ventilation of the sediment by these organisms. This study uses laboratory microcosm experiments to investigate how bioturbation by *Chironomus riparus* larvae and the presence of Bti impact GHGs production and release from pond sediments. Our results indicate that bioturbation increased the methane efflux and sediment oxygen uptake. However, application of Bti led to higher production of CH<sub>4</sub> and CO<sub>2</sub> in the experimental microcosms, also in the absence of chironomids, suggesting a direct effect of Bti on microbial communities and activity. Our findings point to cascading effects on pond carbon cycling through chironomid activities and highlight the underestimated role of widespread application of biocides in biogeochemical cycling in these ecosystems.



**00331**

# **Stoichiometry of spatial flow drives the productivity of aquatic-terrestrial meta-ecosystem**

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.  
meta-ecosystem

Oral

**B. Pichon<sup>1</sup>, T. Elisa<sup>1</sup>, G. Lacroix<sup>1,2</sup>, I. Gounand<sup>1</sup>**

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Abstract

Ecosystems are open and connected at the landscape extent by species dispersal, subsidies, and energy flows. These spatial interconnections impact local ecosystems' functioning and stability. Theoretical studies mainly focused on the role of species dispersal and the quantitative effect of resource flows. Yet, resource flows also differ in their quality. For instance, plant litter, which fuels streams, is rich in carbon while fish or emerging aquatic insects can provide as much as 25% of the nitrogen budget to riparian forests. Moreover, terrestrial, and aquatic assemblages differ in their resource limitation, which suggests that the impact of resource flows at the meta-ecosystem scale may strongly depend on both the quality of resources and the resource needs of local communities. Here, we developed a novel stoichiometric meta-ecosystem model coupling an aquatic and a terrestrial ecosystem to investigate how stoichiometry of subsidies mediates the response of the meta-ecosystem to subsidy flows. We hypothesize that cross-ecosystem subsidies relax local ecosystem limitations and lead to higher levels of productions. We found that the stoichiometry of subsidies interacts with resource limitation of local communities in determining the production in local ecosystems. Moreover, spatial flows can increase production at the meta-ecosystem scale. Finally, by quantifying the feedbacks induced by subsidy flows, we suggest complementarity in resource use between ecosystems. We emphasize the importance of stoichiometry in driving the dynamics of coupled ecosystems and suggest that new studies on stoichiometry at the landscape extent should be proposed to build a more integrative spatial ecology.

**00368**

# **Drone-based thermography for assessing evapotranspiration from mosaic landscapes**

Oral

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<sup>1</sup>University Of Göttingen - Göttingen (Germany)

## Abstract

Evapotranspiration (ET) is a central flux in hydrological cycles, is important in climate regulation, and may strongly be affected by land-use change. Established methods for ET assessments include ground-based and spaceborne approaches, which can be limited in spatial or temporal resolution, or due to cloud cover. Near surface-flying drones equipped with adequate sensors and a modelling framework may help to bridge gaps. We tested drone-based thermography with subsequent energy balance modelling (DATTUTDUT) against well-established ground-based methods, and derived ET characteristics in a mosaic landscape in the lowlands of Sumatra. For an oil palm plantation equipped with an eddy-covariance reference system, we observed a very high agreement between the two methods yielding statistical interchangeability. The coverage of spatial heterogeneity was tested using sap flux methods as a reference in forests and oil palm agroforests and likewise yielded convincing results. ET rates predicted by the drone-based method were quite similar for oil palm plantations and rainforest. In a more detailed study in the rainforest, we found interactive effects on ET by site characteristics and season. In a heterogenous mosaic landscape, we found only minor edge effects between oil palm and secondary forest and quantified how exposed soil in oil palm plantations and logged forest reduced ET. Overall, we conclude that ET derived from drone-based thermography is very reliable and complements available methods for ET studies. Moreover, this method is promising to assess ET variability over heterogenous landscapes with opportunities for fine grain spatial analyses.

**00585**

## **Extracellular oxidative metabolisms (EXOMET): an emerging concept**

Oral

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Abstract

Given the complexity of the respiratory machinery, it is believed that oxidative metabolisms are strictly intracellular processes because the cell is considered to be the minimal unit capable to achieve the cascades of biochemical reactions. However, this paradigm is challenged by recurrent observations of persistent substantial CO<sub>2</sub> emissions in soil microcosms where sterilization treatments (e.g.  $\gamma$ -irradiations) reduced microbial activities to undetectable level. From our observations, we proposed the concept of EXOMET (Extracellular Oxidative Metabolisms) which explores the hypothesis that non-cellular but complex oxidative processes perform the complete oxidation of organic matter into CO<sub>2</sub>. Overall our work highlights that EXOMET accounts from 16 to 48% of CO<sub>2</sub> fluxes from sterilized soils. Moreover, the EXOMET provides new perspectives on the chemical reactions that may occurred during the prebiotic world. Our concept is now supported by a consistent array of experiments including the isotopic monitoring of CO<sub>2</sub> emissions over several years, an identifiable isotopic signature, electronic transfers, and the monitoring and identification in nuclear magnetic resonance of the dynamic of molecules after citrate or glucose supply in sterilized soils.

00586

## Pollen-based land-cover change in Europe over the Holocene – exploring the resilience of vegetation communities and species dynamics through time

Oral

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Abstract

It is crucial to improve our understanding of landscape and land-use histories in Europe during the Holocene to evaluate the effects of future climate and land-use change on European ecosystems, landscapes and biodiversity. As part of the Terranova project (H2020-msca-itn-2018), we present here the “third generation” of pollen-based estimates of plant cover in Europe over the Holocene using the REVEALS model (Sugita 2007). This model corrects biases caused by inter-taxonomic differences in pollen production and dispersal in pollen records. The new reconstruction improves the spatial cover of the first and second generation of REVEALS reconstructions (Trondman et al. 2015 and Githumbi et al., 2021, respectively) with a large number of additional pollen records, in particular from the Mediterranean area (Italy, Spain, Portugal). The regional vegetation abundance is estimated for 31 taxa at a spatial resolution of 1°x1° (ca. 100 km x 100 km) for consecutive time windows over the last 11.7 ka BP (500 years from 11.7 to 0.7 ka BP and higher time resolution from 0.7 ka BP). This new dataset provides unique possibilities to explore spatial-temporal changes in past land cover and biodiversity over long time periods. According to the identification of seven biogeographic regions during the Holocene and its movements and shifts from the last glacial maximum to the present time (Röhm et al., in prep), REVEALS estimates are explored. This analysis is performed at the level of species and biogeographic regions in Europe, to analyse biodiversity and to understand which species or groups of species are consistent in time and space and which of these have migrated. The challenge is to determine whether it is the stability in time and space of species or their flexibility to environmental changes that makes them resilient. Furthermore, knowing the importance of this long-term dataset, there is a need to analyse whether the recent changes are a continuum of the general trend of the Holocene or are traits of the Anthropocene for conservation ecology in the face of environmental changes.

**00620**

## **Are western European oak forests man-made construction? The pedoanthracological's perspective**

Oral

T. Feiss <sup>1</sup>, V. Robin <sup>2</sup>, D. Aran <sup>2</sup>, J. Levillain <sup>3</sup>, J.L. Dupouey <sup>3</sup>

<sup>1</sup>CNPF IDF - Orléans (France), <sup>2</sup>LIEC - Metz (France), <sup>3</sup>SILVA - Champenoux (France)

### Abstract

Beech is the most competitive tree species in central European temperate deciduous forests. However, locally oak trees are often dominant. Their distribution and frequency are influenced by on-going and past forest management. On the Lorraine plateau, oak trees, while supposed to be the dominant tree species only on hydromorphic soils, are also currently dominant on well-drained forest stands, where theoretically beech trees should dominate.

To test the hypothesis that past forest management on well-drained stand induced the substitution of beech by oak, we conducted a soil charcoal analysis study in 19 sites of mature oak stands on the Lorraine plateau by digging trenches of 10 m of length to determine the pedological context and to sample the soil. Macroscopic charcoal assemblages were extracted of the samples by wet and dry sieving. The charcoal pieces were taxonomically identified.

The results based on 5 645 charcoals and 18 taxa clearly highlight the high potential of the Lorraine plateau in soil charcoal analysis. The charcoals of oak are everywhere. The oak is the dominant genus of the charcoal assemblages (57.5%). The beech is the third most common species within the assemblages (8.9%), also identified in all sites. The 72 radiocarbon dates obtained so far indicate that i) the fire events cover the period Copper Age – Modern Times, ii) oaks correspond to the oldest fires, iii) beech is the only taxa to burnt during the middle part of the Bronze Age and iv) afterward oak and beech have been growing together or alternately.

These results provide new arguments to the hypothesis that the historical forest management influenced the current distribution of forest species to a state that does not reflect the natural potential of the mature forest of the Lorraine plateau.

**00667**

## **Nutrient distribution by wildlife - insights gained through mechanistic modelling.**

Oral

E. Le Roux <sup>1</sup>, A. Abraham <sup>2</sup>, Y. Malhi <sup>3</sup>

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### Abstract

Nutrients form the basis of food webs, and their distribution will influence ecosystem productivity and species composition. Animals can alter this distribution by eating in one place and defecating and dying in another. Recent modelling attempts that quantify this nutrient redistribution function, agree that animals play a decisive role in shaping the nutrient landscape. Yet the mathematical models that have been used, describe the system in broad strokes. It gives predictions on the average impact that an average animal will have on a static landscape over long time scales and large areas. But these models lack the precision necessary to predict the consequences of wildlife management decisions at smaller scales. We developed an individual-based model capable of incorporating animal behaviour and flexibility in decision-making responses to a continuously changing nutrient environment. We show how species that vary in body size distribute nutrients differently and how particular changes to community composition alter the nutrient landscape. Our model also shows the consequences that animal behaviour, such as selective feeding, may have on their capacity to redistribute nutrients.

**00019**

## **Phylogenetic endemism of the world's seed plants**

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.

Macroecology

Oral

L. Cai <sup>1</sup>, H. Kreft <sup>1</sup>, P. Weigelt <sup>1</sup>

<sup>1</sup>Biodiversity, Macroecology And Biogeography, University Of Göttingen - Göttingen (Germany)

### Abstract

Assessing phylogenetic endemism (PE), i.e. taxa that are geographically restricted and evolutionarily unique, is vital to understanding the underlying processes of biogeographic patterns and for conservation planning. In this study, we quantified PE for a continuous scheme of geographic regions worldwide and identified centers of paleo- and neo-endemism. To this end, we combined distribution data for almost 340,000 seed plant species across 981 mainland regions and islands worldwide from the World Checklist of Vascular Plants (WCVP) and the Global Inventory of Floras and Traits (GIFT) with a recent mega-phylogeny of seed plants. Using generalized linear models, we assessed the importance of present climate, environmental heterogeneity, geographic isolation and past environmental change since the Pliocene for shaping patterns of PE as well as centres of neo- and paleo-endemism.

We identified ten hotspots of seed plant PE for island and mainland regions respectively. Southern Hemisphere islands showed highest PE globally, while PE peaked in tropical mountain regions on the mainland. Regions identified as centres of paleo-endemism included regions with tropical moist forest (e.g. Amazonia) and ancient continental fragment islands, while regions harboring both high paleo- and neo-endemism were found in many remote oceanic islands and regions with Mediterranean-climate.

Global variation in PE was best explained by a combination of past and present environmental factors. Geographic isolation and environmental heterogeneity emerged as primary drivers promoting high PE, while present climate and long-term climatic stability showed a significant positive effect on PE. The effects of environmental conditions on PE varied with geographic isolation, highlighting the unique biogeographic dynamics on islands. While long-climatic stability promoted the survival of paleo-endemism, oceanic islands which are isolated since their formation harbored higher neo-endemism indicating that the spatial concentration of paleo- and neo-endemism is driven by historical drivers.

Our study provides new insights into the evolutionary underpinnings of biogeographic patterns offered by evaluations of global patterns of PE, and serves as a key resource for global conservation prioritization by identifying areas of high evolutionary and biogeographic uniqueness.

**00055**

## **Plant size distribution on islands: from theory to prediction**

Oral

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### Abstract

Plant size distribution relates to many important ecosystem properties such as productivity, biomass, carbon storage capacity. Therefore, it is important to understand what are the determinants of plants size distribution. Indeed, several studies already observed that plant size distribution is associated with island area and isolation. However, in order to move from observations to predictions, we need a mechanistic understanding. A promising venue is to improve a simple yet powerful model of species diversity, the Theory of Island Biogeography (TIB), that has been developed over 60 years ago. TIB and follow-up models uses island area and isolation to define a balance between species immigration and extinction. TIB gives an estimate of species richness on islands, but relies on the assumption that species are functionally equal. This means that every individual has equal chance to arrive and persist on the island, no matter its size or other traits. Nonetheless immigration and extinction scale with plant size. Therefore, island biogeography models could (and should) be improved by incorporating allometric (size related) components. We applied allometric TIB model for several oceanic islands and their flora. We used the information on floras and traits available in GIFT database. We found out that an updated allometric model not only improved predictions of diversity dynamics, but also provided valuable information on the size distribution of plants on islands.



**00096**

## **Biogeography of alien bird diversity on islands through the lens of functional and phylogenetic diversities**

Oral

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### Abstract

Understanding global distribution patterns of biodiversity on insular ecosystems has been a major question in ecology, largely addressed by the theory of island biogeography. Yet, human activities have reshaped the evolutionary processes that drove biotic assemblages, especially with the increasing introduction of alien species by humans. As a consequence, the main drivers responsible of the alien species richness on islands include biotic factors (e.g., native taxonomic richness), biogeographical context (e.g., island isolation) and human factors (e.g., human population size). However, previous studies neglected other diversity components such as phylogenetic and functional alien diversities, despite their importance in native community response to biological invasions. Here, we provide the first assessment of phylogenetic and functional diversities of alien birds on islands. Specifically, we aim to evaluate how biotic, biogeographic and human contexts structure the current distribution of alien bird diversities. After compiling ecological and evolutionary data for alien birds occurring on more than 1,600 islands, we calculate functional and phylogenetic diversities and associated null models to assess how the alien assemblages are characterized in terms of traits and evolutionary history, beyond their taxonomic richness. We also build structural equation models to better disentangle the effect of biogeographical, biotic and human-related variables on the phylogenetic and functional structure of insular alien assemblages. Overall, we believe that integrating the multiple facets of diversity will help describing the dynamics of biological invasions, and contribute to the global comprehension of their impacts on islands.

**00099**

## **Plant diversity across deserts: towards a synthesis**

Oral

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### Abstract

Desert areas cover almost one third of the terrestrial surface on Earth, however they are still severely underrepresented in global analyses of plant species distributions. Knowledge about their plant species richness and functional diversity as well as its environmental drivers is still lacking.

Combining published floras available in the Global Inventory of Floras and Traits (GIFT), we built a harmonized dataset with distribution of around 40,000 plant species distributed over more than 120 deserts. We first assessed the plant richness and functional diversity of vascular plants in desertic areas, and then evaluated how environmental characteristics differed across deserts worldwide. In a second step, using a comprehensive set of environmental variables, we assessed what were the main drivers of both facets of diversity.

We hypothesized that both taxonomic and functional diversity would be positively influenced by the amount and stability of precipitation, as well as by the elevational range, soil diversity and age of deserts. Results based on available floras provided support for some the above-stated hypotheses. Annual precipitation and its inter-annual variability turned out to be the strongest predictors of diversity, while results differed for functional diversity.

This global synthesis assesses the environmental, taxonomic and functional diversity of deserts worldwide and also provides important new insights on the drivers of plant diversity in one of the largest biomes.

**00138**

## **Environmental drivers of colour variation in Anurans**

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.

macroecology, phenotypic variability

**Oral**

**R. Laumeier<sup>1</sup>, M. Brändle<sup>2</sup>, M.O. Rödel<sup>3</sup>, S. Brunzel<sup>4</sup>, R. Brandl<sup>2</sup>, S. Pinkert<sup>2</sup>**

<sup>1</sup>Philipps University Marburg, Fachhochschule Erfurt - Marburg, Erfurt (Germany), <sup>2</sup>Philipps University Marburg - Marburg (Germany), <sup>3</sup>Museum Für Naturkunde Berlin - Berlin (Germany), <sup>4</sup>Fachhochschule Erfurt - Erfurt (Germany)

**Abstract**

Ectotherm organisms, such as frogs (Anura), need to absorb energy from their environment to reach body temperatures that allow them to be active. Through both macroecological analysis and physiological experiments it is well-documented that climatic factors shape the distribution and abundance of frogs, but the mechanisms that link climate and their distributions remain, thus far, largely unknown. Here we investigated the relationships between temperature and productivity with the colour variation in 3,059 anuran species at a global extent to test for the importance of colour-based thermoregulation and pathogen resistance. We show that anurans are on average darker colored in colder environments and environments with a higher pathogen pressure (warm and wet). Thereby we provide the first global scale analysis of color variation for any ectotherm taxon and the first large-scale evidence for the importance of colour-based thermoregulation and pathogen resistance in Anura. Our results have important implications for understanding and forecasting the threat of anuren and other ectothermic species in the face of climate change and pandemics such as the Amphibian chytrid fungus disease.

**00167**

# **The environmental stress hypothesis fails to explain the plasticity of seed crop variability**

Oral

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## Abstract

For many long-lived plant species, population-level seed production is highly variable between years. There is growing evidence that temporal seed crop variability (“masting behaviour”) varies between species in a way consistent with economies of scale and environmental gradients. How intra-specific variation in masting behaviour varies across environmental gradients, however, is much less understood. Historically, a lack of long-term time-series of seed production, and/or the limited spatial coverage of such data have hindered the analysis of these patterns.

From a theoretical perspective, masting behaviour should be most pronounced when populations face challenging growing conditions and significant resource limitations (i.e. the environmental stress hypothesis). Under challenging conditions, the frequency of reproductive failure is expected to be high, which increases seed crop variability. Congruently, the increased resource use efficiency obtained by increasing seed production variability is also expected to yield the highest fitness benefits.

We used the largest global-scale dataset on annual seed production in plants, MASTREE+, to explore how much intra-specific variation exists in the masting behaviour of 20 species covering two continents, by analysing 448 seed crop time-series longer than 10 years. Subsequently, we investigated how climate gradients related to this observed intra-specific variability in masting behaviour

Multivariate analysis of seed production time-series revealed substantial intra-specific variation in masting behaviour. Surprisingly, we failed to detect a clear relationship between the climatic marginality of plant populations and masting behaviour. Our findings underline the importance of moving away from a binary or single-metric understanding of masting. Moreover, our analysis reveals that processes other than marginality might be responsible for the observed variability in seed production.

As the ability of plant populations to regenerate, recover from disturbance and migrate in response to changing climate niches depends on seed production variability, it is critical to further examine the observed spatial complexity of masting behaviour. This would allow us to more accurately model climate change related effects on plant demography.

**00221**

# **Contrasting effects of productivity and temperature obscure the latitudinal gradient of body size variation in Odonata**

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.  
Macroecology and phenotypic variability

**Oral**

**L.A. Mähn <sup>1</sup>, R. Brandl <sup>1</sup>, S. Pinkert <sup>1</sup>**

**<sup>1</sup>Philipps University Of Marburg - Marburg (Germany)**

**Abstract**

Latitudinal body size-clines found in many animal taxa are primarily discussed in the context of thermoregulation, sensu Bergmann. However, body size patterns are ambiguous in ectotherms and this heterogeneity remains poorly understood. Here, we hypothesise that contrasting effects of thermoregulation and resource constraints obscure latitude-size relationships. Specifically, using data for 42% of all odonates for phylogenetically and spatially comparative analyses, we tested whether the body size of species increases with decreasing temperature and increasing productivity. We found strong but contrasting effects of temperature for dragon- and damselflies and consistent positive effects of productivity that explained 35%-57% of the size variation. Latitude-size relationships were inconsistent and comparatively weak. Thus, interpretations of latitudinal-size gradients are prone to underestimating the functional significance of thermoregulation and neglecting the general ecological importance of productivity. By scaling up support from smaller and experimental studies, we emphasize that physiological mechanisms will drive common responses to climate change.

**00250**

# **Evolutionary assembly of trees in mountains across the globe**

Oral

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Abstract

For over two centuries, scientists have been captivated by mountains as biodiversity laboratories, where one can explore how environmental conditions, habitats, and communities change with elevation over short geographical distances. However, how clades have established and evolved across mountain regions remains unclear. Here, we analyze the evolutionary relationships of tree species compared to their regional floras and the whole global floras. Additionally, we test if changes in phylogenetic diversity along elevation gradients are consistent with two fundamental evolutionary hypotheses: Tropical Niche Conservatism (TNC) and the Out of The Tropics hypothesis (OTT). Using a comprehensive plot dataset from mountain regions worldwide, we quantify taxonomic and phylogenetic diversity at both alpha and gamma scales. We derived phylogenetic relatedness across elevations from regional species lists and found tree communities in higher elevations are more closely related than their respective regional floras. Moreover, the degree of phylogenetic clustering of tree communities across elevations in tropical mountains exceeds that in temperate mountains. These results lend strong support for the TNC as the dominant evolutionary mechanism shaping tree community assembly on mountains worldwide. Our results highlight the vulnerability of mountain forests to global change drivers and emphasize the need to protect these ecosystems worldwide.

00360

## Müllerian mimicry in neotropical butterflies: One force to shape them all, and in the jungle bind them.

Oral

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Abstract

Understanding mechanisms of species distributions and coexistence is both a priority and a challenge for biodiversity hotspots such as the Neotropics. Within an ecological guild, competition for resources is expected to drive local species exclusion and divergence along multiple ecological dimensions. Alternatively, positive interactions among species may counteract competition, favoring species cooccurrence and ecological similarity, thus supporting high local biodiversity.

We investigated whether positive interactions can outweigh the effects of competition in mutualistic communities at a macroecological scale. We explore this question using Müllerian mimicry in neotropical butterflies as a textbook case-study. We focused on the Ithomiini tribe (Nymphalidae: Danainae) and Heliconiini tribe (Nymphalidae: Heliconiinae), two emblematic and historical examples of mutualistic interactions among defended prey species harboring similar warning signals. All species present such aposematic patterns with shared signals among the two tribes forming groups of species potentially involved in mutualistic interactions and defined as mimicry rings.

Employing species distribution modeling and comparative phylogenetic analyses, we investigated the spatial congruence and climatic niche evolution of comimetic species within and across the two tribes. Firstly, we showed Ithomiini and Heliconiini present different global biodiversity patterns shaped by distinct biogeographical histories with a different region of origin, respectively the Andes and the Amazon Basin, associated with a different ancestral niche. However, both tribes display high diversity and concentration of rare species and mimetic patterns in the Northern Andes, where anthropogenic pressures levels are high.

Secondly, we highlighted the importance of mutualistic interactions in shaping large scale distribution patterns and driving species niche convergence even across those two tribes separated by 85 My of evolutionary time. We showed that co-mimetic species cooccur more than expected at random, within and across tribes. Additionally, our results suggest that mimetic interactions drive the evolutionary convergence of the climatic niche of comimetic species within and even across tribes, thereby strengthening their co-occurrence. Finally, we showed the disjointed distribution pattern of an Heliconiini mimicry ring can be explained by its overlap with the similar and more largely spread Ithomiini ring, highlighting the importance of accounting for all members in a mimetic community to understand biogeographic patterns.

**00385**

## **Island endemism - Speciation happens in company rather than in isolation!**

Oral

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### Abstract

Islands and archipelagos are classic laboratories to study speciation and diversification. Established approaches relate these processes mainly to geographical aspects such as isolation, distances to other habitats or island size and elevation. Besides spatial isolation, obviously ecological isolation within islands is effective. The increasing proportion of endemism with elevation hints at diversifying processes resulting from ecological isolation. However, ecological isolation is also effective between ecosystems. Plant species are not uniformly distributed across isolated islands but rather linked to specific ecosystems. However, the contribution of ecological isolation effects and available area for speciation in ecosystems as well as biotic interactions within ecosystems is widely ignored in island biogeography that is mostly focused on mere physical and climatic site conditions.

Here, I disentangle the patterns of endemism for single island endemics (SIE) and for multi-island (archipelago) endemics (MIE) related to island ecosystems. Ecosystems are functional units within islands that differ considerably in species assemblages and community structure. This study is based on a revision of the Flora of the Canary Islands (Beierkuhnlein et al. 2021) and a new classification, detection, and mapping of ecosystem extent and distribution on all islands based on in-situ monitoring and remote sensing. All plant species were assigned to ecosystems for every island. Plant species are classified into native (non-endemic), archipelago endemics, single island endemics, and alien species. We find correlation of endemism with sizes and fragmentation of ecosystems. Also, endemism within ecosystem is linked with species richness of ecosystems. However, the availability of resources such as light and the life cycles of dominating plant species (e.g. trees) do influence the number and proportion of SIE and MIE plant species within ecosystems. Harsh environments and species-rich coastal ecosystems exhibit a high proportion of native species, but less endemics and alien species.

In conclusion: biotic conditions such as ecosystem structures and diversity add substantially to the explanation of spatial patterns of endemism. Speciation cannot be explained just by physical site conditions such area and isolation of islands or elevational and climatic zones. However, biotic interactions vary in their influence on speciation and island endemism between ecosystems.



**00442**

## **The diversity of interactions complements functional and phylogenetic facets of biodiversity**

Oral

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### Abstract

Because biotic interactions shape community dynamics, ecosystem functioning and have intrinsic conservation value, their local diversity should provide crucial but overlooked information compared to functional and phylogenetic diversity. Here, we leveraged datasets of trophic interactions, functional traits, phylogenies and spatial distributions of >1000 terrestrial vertebrate species across Europe and compared patterns of Interaction Diversity (ID) with functional (FD) and phylogenetic diversity (PD). Controlling for species richness, ID was not correlated with FD nor PD, thus representing a unique but complementary information to the commonly studied facets of diversity. A three-dimensional mapping allowed for simultaneously visualizing different combinations of ID-FD-PD. The spatial turnover between these combinations closely matched the boundaries of biogeographic regions and revealed new, interaction-rich natural areas in the Boreal region. Our study demonstrates that interaction diversity adds unique and relevant information to biodiversity studies, with implications for a better understanding of underlying eco-evolutionary processes and for conservation planning.

**00507**

## **Never put the mountains in a drawer, wrong range character classifications lead to wrong transition rates**

Oral

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### Abstract

Discretizing species localities into presence-absence data for biomes is problematic since many biome borders are defined by biologically determinate climatic thresholds. However, species distributions respond to continuous environmental conditions rather, than to modeled parameters. The alpine biome is a good example: the treeline is the well-defined biome border, yet no conclusive nor detailed description for “alpine species” exist.

Here we present a novel method – available as a R package – that describes plant species distributions relative to the treeline, considering geographical uncertainties and climatic effects on the treeline position. Our results show that this approach is superior in discretizing species records from the alpine arch, compared to other polygon-based methods. Looking at 3.317 species our algorithm classifies 88.15 % correctly, however when using polygons of the thermal belts the misclassification rate is 33.58 % and therefore three times larger. By generating noise on the longitudinal and latitudinal coordinate we tested and confirmed, that the computation of distance to the treeline is insensitive to this problem. Furthermore, we can show, that using a Dispersal-Extinction-Cladogenesis model – based on wrong classified clades – leads to wrongly estimated transition rates, this is the case when basing classifications on a polygon. There is evidence, that this phenomenon is caused by an unbalanced ratio of false positive to false negative classifications.

Finally, the continuous nature of the elevation distribution shows a very distinct pattern when comparing the minimum, median and maximum with each other. These new insights and the freely available algorithm can help to solve the conundrum of “alpine species”.

00544

## Australian harvest termite (*Drepanotermes*) diversification suggests adaptation to past and resilience to future climate change

Oral

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Abstract

The Australian-endemic genus *Drepanotermes*, also known as Australian harvester termites, diverged from Australian *Amitermes* in the late Miocene, over 6 mya. They diversified across the continent during a period of climatic instability and increasing aridification in the Plio-Pleistocene. *Drepanotermes* differ from *Amitermes* in their melanised cuticle, the large number of fierce soldiers and aggressive workers which forage in the open, and their habit of storing harvested grass, leaves, or other plant parts in special chambers within the nest; these are presumably adaptations to conditions in the semi-arid and arid regions of Australia, where they are ecological engineers and keystone species. Some *Drepanotermes* build conspicuous mounds or flat pavements, while other construct entirely subterranean nests. Using species delineation, phylogenetic inference, and ancestral state reconstruction, we investigated the evolution of mound-building in *Drepanotermes* in relation to reconstructed past climatic conditions. Our findings suggest that mound-building evolved several times independently in *Drepanotermes*, and apparently facilitated their expansion into tropical and mesic regions of Australia. Phylogenetic signal of bioclimatic variables, especially of limiting environmental factors (e.g. precipitation of warmest quarter), suggests that climate exerts a strong selective pressure.

Finally, we used environmental niche modeling to predict present and future habitat suitability for eight *Drepanotermes* species. Abiotic factors such as annual temperature contributed disproportionately to calibrations, while the inclusion of biotic factors like predators and vegetation cover improved ecological niche models in some species. A comparison between present and future habitat suitability under two different emission scenarios revealed continued suitability of current ranges, as well as substantial habitat gains for most studied species. Human-mediated climate change is occurring more quickly than these termites can disperse into newly suitable habitat, however their role in stabilizing arid ecosystems may allow them to mitigate effects on some other organisms at a local level.

**00563**

## **The global distribution of plant life-forms is modulated by phylogeny and contemporary climate**

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.  
Functional biogeography; otherwise Big data in ecology

Oral

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Abstract

Plant life-forms represent key functional strategies of plants in relation to their environment and provide important insights into the evolutionary constraints acting on plant traits. Despite being a major facet of plant life-history variation, how plant life-forms are distributed globally and modulated by species phylogeny, and historical and contemporary environmental conditions is poorly understood. Using a novel dataset comprising > 340,000 vascular plants derived from the World Checklist of Vascular Plants (WCVP), we determine the importance of phylogeny, and historical and contemporary climate variables in driving the global distribution of plant life-forms. Results find significant functional differences among regions, mirroring life-form dependent responses of plants to regional environmental conditions. For example, the distribution of plants that grow by supporting themselves on others (epiphytes, climbers) is correlated with warm and wet climates, as well as the high diversity of woody trees and shrubs (phanerophytes). The distribution of therophytes (annuals), on the other hand, is strongly related to aridity and temperate climates, reflecting the ability of this life-form to withstand adverse environmental conditions as found in deserts or mountain tops. Further, we find plant life-form to be significantly constrained by phylogeny followed by contemporary climatic conditions, highlighting the need to incorporate the phylogenetic history of plant species to better predict species distributions in response to global climate change. This research provides important new insights into the evolutionary pressures surrounding plant life-form and associated plant traits and serves as a baseline classification of plant communities worldwide, allowing for standardized comparisons of floras among regions.

00674

## Global trait space of native and endemic island plants

Oral

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### Abstract

Most island biogeographical models such as the Equilibrium Theory of Island Biogeography and the General Dynamic Model consider species as ecologically equivalent and do not consider variation in functional traits across species. Consequently, little is known about patterns and drivers of functional traits on islands. Species traits can strongly influence dispersal, establishment and persistence, helping us understand the assembly of island biota. However, few studies have tested the importance of traits for the assembly processes specifically in an island context and so far, findings are mixed. Here, we use nine oceanic archipelagos (Canary Islands, Cook Islands, Galapagos, Hawaii, Madeira, Marquesas, Mascarenes, New Zealand and San Juan Fernandez) with a total of 3343 vascular plant species to investigate the contribution of species with different biogeographical status to the global trait space of islands, by distinguishing between natives, non-endemic natives, archipelago endemics and single-island endemics. We also investigate how functional and taxonomical diversity varies along gradients of island age, area, isolation, and environment. We find that global island trait space has two main hotspots, one hotspot is concentrated around long-distance dispersed (native non-endemic) herbs while the other is dominated by endemic species, composed mainly by trees. We also find that while taxonomic diversity follows General Dynamic Model predictions across all species groups, functional diversity seems to diverge from it when only endemic species are being considered. Our results demonstrate the importance of including functional traits when studying complex biogeographical patterns, as those could not be unveiled when only investigating overall species richness.

**00021**

**Can invasive species teach us how natives can cope with climate change?**

Oral

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Abstract

Climate change is blurring the lines of what native distributions are, with range shifts expected, and even desired, in order to preserve valuable species and communities. The interaction of climate change-induced range-shifts and invasive spread and integration into new communities is surely going to be a fertile research ground. Invasive species are ideal study model systems providing with important clues of the mechanisms available to the generality of plants to cope with climate change. Invasives are known to rapidly adapt to the new climates and habitats that they colonize, so much so that anecdotal evidence of incipient reproductive isolation between native and non-native ranges of some invasives indicates that at some point we will witness invasive speciation into neo-natives. For instance, research into the role of rapid adaptation of invasives along environmental clines wcan shed light on the contrasting role of isolation that preserves locally adapted traits against homogenizing gene flow, or admixture among populations that can spread advantageous traits across populations but can also result in the dilution of local adaptations. Data suggests that invasives might benefit from both admixture and isolation at different stages and under different circumstances, and that local adaptation along environmental gradients can help to hedge against the threats of climate change both for invasives and natives alike.

00046

## Success of native and alien species varies with trait-environment relationship

Oral

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### Abstract

Nutrient inputs affect the relative dominance of plant species which might cause a functional shift in grassland community composition. Traits of native and alien species are associated with ecosystem processes and thus different environmental conditions or nutrient addition might shift trait expression. Changes in nutrient availability may result in native-alien functional (dis-) similarity, as natives may have adaptations that allow them to boost nutrient extraction in the low-resource environment and consequently, have an advantage over alien species. In addition to resource availability, climatic factors, such as temperature and precipitation create an additional complexity layer of studying the trait-environment relationship and species success. The main goal of our study is to explain native and alien plant species abundance with species traits, environment (climate and nutrient treatments) and origin, using data from a worldwide grassland project NutNet. We hypothesize that there will be no difference in native and alien species success with respect to the trait-climatic relationship. However, we expect the difference in native and alien success regarding traits with nutrient additions (functional traits might respond differently according to their origin with different nutrient availability). Further, we investigate if native and alien success and traits differ between biogeographic regions. Climatic and nutrient conditions may have an antagonistic or synergistic effect on species success and their traits (e.g. nutrient availability may be significantly impacted by the change in precipitation). Therefore, studying the relationship between environment and functional traits may portray grasslands' dynamics better than focusing exclusively on species richness.

00180

## A call for mixed surveillance strategies for containing the invasion of the Japanese Beetle in Europe

Oral

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### Abstract

The Japanese beetle (*Popillia japonica*) is a polyphagous pest that spreads rapidly and is estimated to cost more than 460 M\$/year in damages and control in the USA alone. Thus, it is listed as a priority pest according to the phytosanitary legislation of the European Union. This study's goal was to build risk maps to inform surveillance strategies in continental Europe following the beetle's introduction and successive spread in the last decade. We developed a species distribution model (SDM) using a machine-learning algorithm, considering factors relevant to the beetle's biology, climate, land cover and human-related variables. This analysis was carried out at a fine spatial resolution (4x4 km); using presence-only data from native and invaded ranges (Japan, North America, Azores archipelago - Portugal). We gathered more than 30 000 presence data from citizen science platforms and standardized surveys. In order to balance presence-only data, we generated pseudo-absences using the target-group method (*Coleoptera*) to account for the sampling bias that is inherently associated with citizen-science data. Then we structured these data into environmental blocks and randomly sampled pseudo-absences within blocks using environmental distance to presence sites. Model training and performance evaluation have been performed with cross-validation using these environmental blocks. Our results show that climate, in particular seasonal trends, and human-related variables such as population and roads densities, are major drivers of the Japanese beetle distribution at the global scale. Risk maps show that Central Europe can be considered as suitable, whereas Southern and Northern European countries seem to be at lower risk. Furthermore, the currently occupied region in northern Italy and southern Switzerland is amongst the most suitable according to model predictions and represents less than 1% of the highly suitable area in Europe, which, overall, covers more than 182 thousand km<sup>2</sup>. A major cluster of high suitability areas is located near the currently infested zone, whereas others are scattered across the continent. This highlights the importance of designing hybrid surveillance strategies considering both active insect dispersal and the possibility of hitchhiking to reach distant areas.



00235

## Do invasive earthworms affect the functional traits of native plants?

Oral

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### Abstract

Invasive earthworms are one of the main drivers of plant community changes in North American forests previously devoid of earthworms. One explanation for these community changes is the effects of earthworms on the reproduction, recruitment, and development of plant species. However, few studies have investigated functional trait responses of native plants to earthworm invasion to explain the mechanisms underlying community changes.

In a mesocosm experiment, we set up a plant community composed of two herb and two grass species commonly found in northern North American forests under two earthworm treatments (presence vs. absence). After 3 months of experiment, we measured earthworm effects on above- and belowground plant biomass and functional traits.

Our results showed that although earthworm presence did not significantly affect plant community biomass and cover, it affected four out of the fifteen above- and belowground traits measured. While some traits, such as the production of ramets, the nutrient content of leaves, responded similarly between and within functional groups in the presence or absence of earthworms, we observed opposite responses for other traits, such as height, specific leaf area, and root length within some functional groups in the presence of earthworms. Plant trait responses were thus species-specific, although the two grass species showed a more pronounced response to earthworm presence with changes in their leaf traits than herb species. Overall, earthworms affected some functional traits related to resource uptake abilities of plants and thus could change plant competition outcomes over time, which could be an explanation of plant community changes observed in invaded ecosystems.

00283

## Body size and trophic position of invading species modulate its effects on simple food webs under global change

Oral

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Abstract

Environmental filters and species traits underpin invasion success of new species and their effects on local communities. Invasion frequency will likely increase with global change, yet we lack predictions on how species invasions interplay with food web responses to global change. We use biomass-based models of community dynamics parameterized with empirically derived values to investigate how body size and trophic position of the invading species modulate the impact of invasion on the structure, biodiversity and stability regimes of local communities across gradients of habitat productivity, warming, and size structure. Here we focus on food web modules consisting of two resident species and an invader, i.e. exploitative and apparent competition, trophic chain and intraguild predation. We show that body size and trophic position of the invader jointly determine the fate of the invasion and the response of the resident community along environmental gradients. We link our results to empirical evidence and predict that smaller invaders are favoured under competitive interactions, while larger invaders are favoured under predatory interactions. Notably, our results also show that invasions can sometimes increase community resilience or act synergistically with nutrient enrichment to cause community collapses. This variety of outcomes is explained by the complex interplay between the effects of abiotic drivers on individual species and the relative strengths of trophic interactions linking the resident and invading species.

**00505**

## **Is preadaptation to disturbance key to agroecosystems invasions? Empirical evidence, discussion, and future research routes**

Oral

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### Abstract

Past, human-induced evolutionary processes can have great influence on current plant distribution and invasion success. The Neolithic Plant Invasion Hypothesis proposes that Eurasian plants are particularly disturbance-adapted, which makes them successful invaders of disturbed agroecosystems. This assumption is based on the long history of agropastoral development in Eurasia compared to other continents. To test whether geographical origin and the assumed exposure time to agropastoralism affect early-life response of invasive plants to disturbance, we performed a multi-species experiment with 30 invasive species. We divided the species into three groups of exposure time: exposure long, native to Western Asia; exposure medium, native to Central Europe; exposure short, native to America. We created monospecific experimental units (n = 900), each containing 50 seeds, to which we applied three soil disturbance treatments (control/compaction/tilling) combined with two space occupancy levels (available/occupied). Contrary to our expectation of Eurasian species benefitting more from disturbance in terms of germination and seedling performance, all species groups profited equally from disturbance. For some traits, there were differences among the groups, regardless of the disturbance treatment. These results suggest that non-Eurasian species can cope just as well as Eurasian species with the disturbances associated with agropastoralism. In fact, the NPIH relies on a Eurocentric perspective that does not fully consider that several other cultures around the world independently developed agropastoralism through history, which challenges this hypothesized superior adaptation of Eurasian species.

In the second part of my talk, I will discuss assumptions of the Neolithic Plant Invasion Hypothesis that might be hardly verifiable, give an outlook on some of the valuable points, and discuss more in general whether preadaptation to disturbance is indeed key to the invasion of agroecosystems. I will report on some of the recent efforts that have been made to test this hypothesis and some new research routes that could be followed. Bridging the disciplines of ecology and archaeobotany is a promising attempt to disentangle pre- from post-introduction adaptation. One such approach could include comparing remains of invasive from different regions or points of time and therefore gain insight on the timing of past evolutionary processes.

00611

## The beginning makes the difference – invasive and native populations of *Jacobaea vulgaris* exhibit similar performance but different strategies support initial establishment

Oral

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### Abstract

Both genetic diversity and competitive ability are factors extensively addressed in experiments aimed at understanding the invasion success in plants. However, their interactive effects are so far understudied, especially on the population level.

Making use of a next-generation sequencing method (ddRADseq) we determined the pairwise genetic distances among 22 invasive (Pacific Northwest) and among 24 native (Central Europe) populations of *Jacobaea vulgaris* GAERTN., a biennial Asteraceae. Based on this information, we created 15 seed mixtures representing a gradient of increasing levels of genetic diversity per region of origin. All mixtures were additionally subjected to three levels of microsite availability by adding either 0, 5 or 10 individuals of *Festuca rubra* as a matrix organism.

We expected high genetic diversity to promote population performance particularly under unfavorable conditions due to sampling and complementarity effects. Furthermore, as invasive populations often exhibit a reduced genetic diversity in general, we expected invasive mixtures to benefit more from this effect than native.

We monitored performance of the sown mixtures continuously throughout two growing seasons to study the interaction between population origin, microsite availability and genetic diversity, while simultaneously observing whether the relative importance of the studied factors differs between vegetative and generative growth phases of the biennial model species.

The continuous monitoring revealed different patterns depending on life stages, especially during initial population establishment. Native mixtures significantly benefitted from the higher genetic diversity early in the experiment with decreasing importance over time. Invasive mixtures meanwhile exhibited a significantly higher establishment success that was completely independent of the genetic diversity. While ultimately, population performance at the end of the experiment was mostly decoupled from the experimentally manipulated factors in our common garden experiment, long-term population dynamics might still be impacted.

Invasive genotypes seem to have undergone selection leading to a different mechanism guaranteeing successful population establishment. Furthermore, our result clearly highlight that population dynamics differ between life-stages, a fact that is especially relevant in biennial species. The continuous monitoring revealed how important the timing of observation is in this species in particular and how this might impact the conclusions drawn on the role of genetic diversity.

00621

## Ultramafic soils select plant-pollinator interactions in New Caledonia

Oral

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### Abstract

Edaphic conditions are one major environmental filter driving plant assemblages and community structures. Soils derived from ultramafic outcrops (i.e. ultramafic substrates) are characterised by high concentrations of heavy metals and nutrient deficiencies and thus present very particular and restrictive edaphic conditions. Due to coupled effects of edaphic conditions and climate, tropical ultramafic substrates may harbour a very particular flora. In New Caledonia, these substrates contribute greatly to the high floristic diversity with a remarkably high rate of endemism. Thus, New Caledonia counts ca. 3400 plant species of which 74% are endemic. While the flora of New Caledonian ultramafic substrates is now quite well-known, its interaction with the fauna, notably insect pollinators, remains to be described. We combined two datasets to describe bee communities and plant-pollinator networks in ultramafic vs non-ultramafic substrates in New Caledonia. We showed that ultramafic substrates seem to act as reservoir for native bees and could be an abiotic barrier to the establishment of alien bees. Conversely, non-ultramafic substrates, likely due to a higher proportion of alien plants, tend to promote the establishment and the activity of alien bees. Finally, the non-ultramafic plant-pollinator network seemed to be more robust (robustness), likely due to a higher level of generalism linked to the presence of alien plants and pollinators. To our knowledge, our study is the first one to describe plant-pollinator networks in ultramafic vs non-ultramafic substrates. Our results extend the conservative value of ultramafic substrates to native bee species. Nevertheless, further studies are needed to monitor range expansion of recently introduced bees. Those alien bee species could in some cases enter and establish in ultramafic substrates. If so, they may have negative effects on native bees' presence and activity and disrupt native plant pollination and reproductive success.

**00298**

## **Towards an open, zoomable atlas for invasion science and beyond**

Oral

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Abstract

Non-native and invasive species are on the rise, and so are their global impacts on ecosystems, economies and human health. Invasion science is critical to mitigate invader impacts, yet due to the strong increase of data and information in this area, it has become difficult to acquire and maintain an overview of the field. Additionally, relevant information is often hidden behind paywalls. As a result, existing evidence is often not found, knowledge is too rarely transferred to practice, and research is sometimes conducted in pursuit of dead ends. We aim to address these challenges by developing an interactive atlas of invasion science that can be extended to other disciplines in the future. This online portal will be an evolving knowledge resource: users will be able to get an overview of the major research questions and hypotheses in invasion science, to “zoom in” and discover refined versions of these research questions and hypotheses as well as relevant studies connected to them. The online portal will apply cutting-edge visualization techniques, artificial intelligence and novel methods for knowledge synthesis. In the presentation, we will introduce our approach and discuss ideas for a complementary initiative in other fields of ecology.

00075

## Plant chemistry drives aphid preference

Oral

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### Abstract

Many plants show intraspecific diversity in the profiles of their secondary metabolites. Secondary metabolites, such as terpenoids, are known to affect plant-insect interactions. A typical example with high variation in secondary chemistry is common tansy (*Tanacetum vulgare*). Previous studies have shown that tansy chemotypes differ in their associated insect communities in the field. However, whether patterns in the field are driven by aphid preference (bottom-up) for chemotypes or rather by predator preferences (top-down regulations) is not fully understood. We tested aphid preference for tansy chemotypes using two different specialist aphids (*Macrosiphoniella tanacetaria* and *Uroleucon tanacetii*). Therefore, we identified different 'chemotypes' with biologically replicated 'daughters'. Chemotypes were grouped based on their chemical profile covering 54 different terpenoid compounds. We setup two-choice assays with tansy chemotypes, to investigate whether aphids would prefer certain chemotypes. In petri dishes with one leaf to the right and the left side each, we tested five chemotypes and their daughters against each other in all combinations and recorded aphid choice after two and five hours. Our choice-assays show preferences in both species. Specifically, we found that *M. tanacetaria* preferred chemotypes with eucalyptol & o-cymene or chrysanthenylacetate as dominant compounds, while avoiding the chemotype with camphor and camphene. *U. tanacetii* showed no clear preference towards chemotypes, but preferred specific daughters Cam7\_21, Cam7\_23 (camphene, borneol) and Schienen3\_11 (beta-thujone). With our experiment, we could confirm that plant chemical composition affects aphid choice, which may lead to bottom-up aphid colony-structuring effects at the plant level. Such effects of plant chemical composition on insect preference provide an important direction for future research on metacommunity ecology.

00161

## The role of chemodiversity in flower-insect interactions of *Tanacetum vulgare*

Oral

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### Abstract

Chemodiversity refers to the diversity of chemical compounds, particularly specialized metabolites, in living organisms. Plants utilize this diversity to interact with a broad range of herbivores and mutualists. The importance of chemodiversity in flower-insect interactions is under-studied, including its role in interactions with pollinators and floral herbivores or 'florivores'. Chemodiversity may exist at the level of the individual or the collective (i.e. population). The Asteraceae *Tanacetum vulgare* L., the common tansy, has been reported to have many different chemotypes, which can co-occur even within the same geographical site. These chemotypes differ in their terpenoid richness and composition but the mechanism(s) by which they are maintained in nature is unclear. Pollination mediates an exchange of genetic material across tansy individuals and chemotypes, but florivores may disturb this process through excessive consumption of pollen and flowerhead damage. Within a field common garden, we investigated the impact of tansy chemotypes on visitation rates of florivores and pollinators, and how these groups relate to each other in natural settings. Plants from five different chemotypes were grown in 60 groups (= plots) of five plants each. Homogeneous plots contained plants of a single chemotype while heterogeneous plots had plants of all five chemotypes. Using these plots set up in an equidistant, semi-balanced design, we also determined how plot level diversity influences pollinator and florivore visitation. At the end of the flowering season, seeds were harvested from all plants and germination rates determined in the laboratory as a measure of plant fitness. Chemodiversity on the plot level was found to be important for pollinator visitation but not florivore visitation. Certain chemotypes showed interactive effects with plot type, exerting a stronger influence on pollinator visitors when growing in homogeneous plots. Moreover, pollinators and florivores had negative effects on each other. Germination assay data was used to determine how these patterns affect reproductive outcomes of plants belonging to a chemotype and a plot type. Generally, these results show that chemodiversity at both the plant and plot level is important towards floral visitors.



00210

## Combined effects of food quality and pesticides on bumblebee health

Oral

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### Abstract

In the cultural landscape, bees are exposed to various different stressors with those having a close relationship to agricultural management and practice seemingly playing key roles here. Especially intensified land-use was shown to reduce the diversity and abundance of floral resources in grasslands, which are the main food source of pollinators. Furthermore, the quest for always higher yields entails the massive use of pesticides. In the present study, we aimed to assess the effects of food quality and a pesticide on health of *Bombus terrestris* in a full-factorial lab experiment. Bees were treated with either (1) a field realistic dose of the neonicotinoid acetamiprid, which is still broadly used in the EU after the expiration of approval of many neonicotinoids, (2) low quality food (polyfloral honeybee collected pollen with pollen exines/sporopollenin in a ratio of 70:30) or (3) a combination of both. As proxies for bumblebee health, we focussed on the cuticular chemical surface profile of workers, which plays an important role in communication and colony maintenance in social insects. Additionally, we assessed body size and ovarian activation as well as the individual encapsulation response, which is a general insect immune response that leads to a formation of a melanized haemocyte capsule around various antigens. Our results show that both, food quality and insecticide had an effect on bee health in our study. Food quality as well as insecticide treatment and their combination significantly changed the cuticular chemical surface profile of *B. terrestris* and decreased the total amount of scent. Poor-quality food and acetamiprid also significantly decreased body size, while the ovarian activation in worker bumblebees was significantly affected by food quality alone. Analysing the encapsulation response, we showed that the insecticide and an interaction of food quality and insecticide decreased the degree of melanisation and thus the immune response. We conclude that pesticides and food quality, both closely related to land-use intensity, affect bee health in different negative ways. Since we found combined effects, it is possible that there are also additive or synergistic effects that influence bees in cultural landscapes.

00339

## Plant diversity and soil legacy independently affect the plant metabolome and induced responses following herbivory

Oral

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### Abstract

Plant and soil biodiversity can have significant effects on herbivore resistance mediated by plant metabolites. Plant metabolites, together called the plant metabolome, are dynamic and respond to interactions with other organisms. Here, we disentangled the independent effects of plant diversity and soil legacy on constitutive and herbivore-induced plant metabolomes of three plant species in two complementary microcosm experiments.

In a controlled greenhouse experiment, we first grew plants in sterile soil with three different plant diversity levels. Second, single plant species were grown on soil with different plant diversity-induced soil legacies. In addition, we infested a subset of all plants with *Spodoptera exigua* larvae, a generalist leaf-chewing herbivore, and assessed foliar and root metabolomes prior and post seven days of herbivory.

Neither plant diversity nor soil legacy had significant effects on overall foliar, root, or herbivore-induced metabolome composition. Herbivore-induced metabolomes, however, differed from those of control plants. We also detected 139 significantly regulated metabolites by comparing plants grown in monocultures with conspecifics growing in plant or soil legacy mixtures. Moreover, plant-plant and plant-soil interactions regulated 141 metabolites in herbivore-induced plants.

Taken together, plant diversity and soil legacy independently alter the concentration and induction of plant metabolites, thus affecting the plant's defensive capability. This is a first step towards disentangling plant and soil biodiversity effects on herbivore resistance, thereby improving our understanding of the mechanisms that govern ecosystem functioning.

00359

## Plant and Plot-level Diversity of Chemical Profiles in a Tansy Plant Field Population Influences Aphid Occurrence and Seasonal Aphid Abundance Patterns

Oral

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### Abstract

Relationships between plants and insects are tightly mediated by plant chemistry. However, little is known about the role of plant chemical profiles in host plant discrimination by specialist and generalist aphids nor on temporal population dynamics of interacting phytophagous insects. Tansy plants (*Tanacetum vulgare*) are well-known for being highly diverse in the blend and individual abundance of a group of secondary metabolites called terpenoids. We defined six chemotypes by their terpenoid profiles, which were clonally propagated and planted in plots with different plot-level chemotypic diversity in Jena, Germany. We recorded aphid colonization and recolonization events as well as abundances every week on each plant over the 2021 summer season. Overall, we observed distinct chemotype effects on the occurrence of different specialist aphid species. For instance, *Uroleucon tanacetii* aphid numbers were lower on chemotypes whose dominant compounds were Chrysantenyl. We also observed that while individual chemotypes might not influence plant occupancy in the case of *Metopeurum fuscoviride*, plot-level chemical diversity could determine occupancy and abundance temporal patterns in both species. We show that intraspecific phytochemical variation structures ecological communities, as different aphid species respond differently to plant chemotypes, and that temporal population dynamics of the specialists *U. tanacetii* and *M. fuscoviride* seems to be shaped by *T. vulgare* plot-level chemotypic diversity.

**00655**

## **Chemistry matters: Pollen nutritional niches of wild bees**

Oral

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### Abstract

Bees, one of the most important pollinator groups, are unique in that they fully depend on floral resources, i.e. pollen and nectar, to obtain all required micro- and macro-nutrients. Pollen is particularly important for the development and survival of their offspring. From the perspective of flowers, however, pollen mainly serves a reproductive purpose and should thus be effectively transferred between flowers. Pollen is therefore under multiple selection pressures. It needs to (i) fulfill the reproductive requirements of plants, (ii) prevent consumption by non-beneficial herbivores and (iii) occasionally also offer a nutritionally valuable reward for beneficial pollinators. These requirements are also reflected in the chemistry of pollen which comprises a species-specific mixture of nutritional and non-nutritional compounds. Pollen chemistry likely also explains why bees are much more selective when it comes to pollen compared to nectar foraging. We nevertheless know surprisingly little about the pollen nutritional requirements of bees, in particular wild bees, and how they relate to their pollen foraging choices. Our group is interested in the role of pollen chemistry in mediating bee foraging choices and health. We therefore integrate several methodological approaches, including pollen and DNA metabarcoding, analytical chemistry and network analyses, to link floral landscapes to the pollen choices and nutritional niches of different bee species. Our research indicates species-specific nutritional niches and intriguing correlations between pollen chemistry and bee pollen choices, which do not necessarily reflect observed flower visitation patterns.

00615

## Elevational differentiation of warming and drought stress resistance in the world's highest elevation tree species

Oral

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Abstract

Global change continues to alter the stress matrix. How plant species respond to such change on contemporary and evolutionary time scales will dictate the likelihood of their persistence and the degree to which their natural distribution ranges may shift. Plant multi-stress resistance, i.e., the ability to maintain fitness in stressful environments, plays a central role in these dynamics. Quantifying heritable variation in multi-stress resistance (HVR) can have significant implications for the fate and management of plant populations facing rapidly changing environments, since it is proportional to a species' evolutionary potential and it may comprise pre-adapted (epi-)genotypes, which may be utilized in assisted gene flow and migration.

We studied HVR across an elevational gradient associated with decreasing temperatures and increasing precipitation in *Polylepis tarapacana*, an endemic tree species forming the world's highest elevation woodlands in the South American Altiplano. We exposed saplings originating from the species' lower (~4000m) and upper (~5000m) elevational distribution limit to individual and combined warming and drought stress. Control conditions reflected regional past climates, whereas stress conditions based on predictions of global circulation models with proper hindcasting performance for the Altiplano. We assessed growth, photosynthesis, root and leaf functional traits, and currently analyse the leaf metabolome via FT-ICR-MS and NMR spectroscopy.

Plant survival and photosynthesis were reduced by stress, whereby the effect magnitudes were significantly lower in low elevation populations supporting that they possess higher warming and drought stress resistance. The analyses of the metabolome in a smaller sub-sample identified stress-induced metabolic pathways such as ascorbate, catechine, cutin, suberin, cyanogenic glycoside and phenylpropanoid biosynthesis. These responses are known to actively mediate stress resistance in other plant species, and the magnitude of their induction was higher in populations from lower elevations.

Our results indicate that the steep environmental gradients of the Andean slopes may have fostered (epi-)genetic differentiation in *Polylepis*, despite efficient gene-flow. We carefully discuss the implications of our findings for seed sourcing in currently running conservation programs and give outlook into the planned continuation of this project.

00008

## Behavioral adjustments of Barbary macaques (*Macaca sylvanus*) inhabiting an agricultural landscape

Oral

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Abstract

Transition zones between natural and anthropized spaces are eroding in all terrestrial ecosystems. The persistence of animals in shared landscapes depends on their behavioral flexibility, which may involve being able to exploit human agricultural production. Crop-foraging by wild animals is an increasing phenomenon that exacerbates human/wildlife conflict, potentially resulting in injuries or death of animals. As a forest-dependent species, the Barbary macaque (*Macaca sylvanus*) is affected by the erosion of transition zones. Indeed, pastures close to forest edges are being progressively converted into crops. In this study, we explore how Barbary macaques adjust their behavior in response to this recent agricultural settlement by comparing a group living in an oak forest in the proximity of crops with another group inhabiting the core of an undisturbed oak forest. The first group was clearly a commensal one, whom all age-sex categories, including mothers with infants, used crops extensively despite risks of injury due to aggression from farmers and domestic dogs. The second group had no access to agricultural production. During crop production, especially walnuts, the commensal group spent more time resting, and less time foraging than the non-commensal group, and had shorter daily travels and a seasonal home range seven times as small. Our study reveals that Barbary macaques are able of great behavioral flexibility to adapt to anthropogenic landscapes. The use of crops by the commensal group resulted in improved foraging efficiency, limiting energy costs, the benefits of which may outweigh the potential costs on survival induced by harassment by humans. Nevertheless, this forest-dependent macaque, reluctant to cross open areas, gets facilitated access to human agricultural production when crop fields are settled close to forest edges. We, therefore, emphasize that the matrix/forest configuration is a critical parameter to be considered, along with behavioral features of the species, to mitigate human/wildlife conflicts.

00070

## Relationships between plant community structure and forage quantity and nutritive quality in semi-natural grasslands

Oral

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Abstract

Identifying synergies between biodiversity and forage production is of the utmost importance for grassland conservation as both of these grassland aspects play an important role in determining the maintenance of agricultural use and, subsequently, habitat conservation value. Considering forage nutritive quality in the evaluation of forage production may lead to the observation of positive relationships between production and conservation goals. This study investigates the relationships between plant community structure, in terms of diversity and functional characteristics, and forage biomass production and nutritive quality in semi-natural grasslands.

The study was carried out across a wide range of Natura 2000 permanent grasslands. Species and functional diversity indices, community-weighted means (CWM) of plant functional traits, and plant functional types were used to describe plant communities. The forage descriptors used in the study were standing biomass, digestibility, crude protein content, and average mineral content.

We found that forage standing biomass decreased with increasing forb (non-legume) cover. Increasing legume and forb cover was positively correlated with forage nutritive quality, and legume cover had no significant relationship with standing biomass. Forage nutritive quality increased with increasing specific leaf area CWM and decreasing leaf dry matter content CWM. Forage standing biomass was negatively correlated with species diversity. On the other hand, forage nutritive quality increased with increasing species evenness. Forage digestibility and average mineral content also increased with increasing PFT evenness.

High-quality forage can be obtained in species-rich grasslands if we consider forage nutritive quality in the evaluation of forage production. This is evident from the positive relationship observed between forage nutritive value and species evenness, and nutritive value and PFT evenness. These results provide a basis for management tools adjustments to accommodate both forage production and grassland conservation.

**00101**

## **Identification of key foraging resources to support diverse pollinator communities in habitat plantings**

Oral

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### Abstract

Current native bee declines have, among other factors, clearly been attributed to habitat loss. Mitigation approaches are trying to establish or enhance habitat by plantings of wildflowers, which are often done by seed mix applications. Within seed mixes, certain plant species have been found to dominate, establish, and perform above average or not be competitive at all. Whereas assessment of plant performance in a variety of restoration efforts has been done so far, there is a lack of evaluating plant performance in pollinator seed mixes alongside with function in supporting pollinators. I am presenting results from two different experiments that assess the performance of a set of native Californian wildflowers in seed mix applications and pollinator visitation. Based on multiple criteria I am identifying key pollinator resources and show how they can contribute to support a stable plant-pollinator network that eventually results in a diverse pollinator community. Not all species highly attractive to pollinators are competitive in seed mixes which argues to prioritize those of high performance. Plant-pollinator networks can be useful approaches to identify key species in an interaction perspective and can also facilitate the support of a diverse visitor community by selecting species of central importance and those of potential to support specialized interactions. The results are of interest for future plant choices for habitat restorations and seed mix design.



00133

## The White-backed Woodpecker as an umbrella species for threatened saproxylic beetles in Central Europe.

Oral

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Abstract

The umbrella species concept postulates that conservation schemes targeting a key species, although often locally restricted, will simultaneously benefit additional organisms of conservation concern. The White-backed Woodpecker is an old-growth deciduous forest specialist and has been proposed as an umbrella species for saproxylic beetles in Scandinavia and Eastern Europe. Yet, whether this link holds in Central Europe remains unclear. By combining White-backed Woodpecker telemetry data with light interception traps for insects, we compared saproxylic beetle communities at sites with no, low and high activity of the target bird species during its breeding season. We found that species richness of threatened saproxylic beetles paralleled the activity density of the woodpecker, with the highest richness found in high activity sites. Further, a multivariate analysis of community revealed that sites occupied by White-backed Woodpeckers harbored a consistent subset of the threatened saproxylic beetle community. This finding was corroborated by an indicator species analysis, showing that several threatened saproxylic beetles were associated to the woodpecker habitat. Overall, our results imply that the White-backed Woodpecker is a suitable umbrella species for the conservation of saproxylic beetles in beech dominated forests of Central Europe, supporting geographic transferability of the umbrella species concept in this study system.

00137

## Identifying suitable habitats for Nigeria-Cameroon chimpanzees in Kom-Wum Forest Reserve, Cameroon

Oral

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Abstract

Great apes lose suitable habitats required for their reproduction and survival due to human activities across their distribution range in Africa. Little is known about habitat suitability and status for the Nigeria–Cameroon chimpanzee (*Pan troglodytes ellioti* (Matschie, 1914)), particularly for populations inhabiting forest reserves in North-West Cameroon. To address this knowledge gap, we employed a common species distribution model (MaxEnt) to map and predict suitable habitats for chimpanzees in Kom-Wum Forest Reserve, North-West Cameroon based on environmental factors that potentially affect habitat suitability. We related these environmental factors to a dataset of chimpanzee occurrence points (nests, dung, footprints, direct observations, feeding locations, tool use sites and tracks) recorded during line transect and reconnaissance (recce) surveys in the forest reserve and surrounding unprotected forests. Up to 92% of the study area is unsuitable as habitat for chimpanzees. Suitable habitats only represented 8% of the study area, with a high proportion of very suitable habitats located in unprotected areas outside the forest reserve. Elevation, land cover with secondary forest and distance to villages and primary forests were the most important predictors of habitat suitability for the Nigeria–Cameroon chimpanzee. The probability of chimpanzee occurrence increased with elevation, density of secondary forest, distance from villages and density of primary forest. Our study provides evidence that suitable chimpanzee habitats in the reserve are already lost, suggesting that efforts to maintain these protected areas for chimpanzee conservation are insufficient. The reserve management plan needs to be adopted to conserve the remaining suitable habitat inside and adjacent to the protected areas and to avoid local extinction of this critically endangered chimpanzee subspecies.

**00188**

## **Using environmental DNA to study the critically endangered angelshark (*Squatina squatina*) distribution in Corsica by**

Poster

**N. Faure <sup>1</sup>, S. Manel <sup>1</sup>, B. Macé <sup>1</sup>, V. Arnal <sup>1</sup>, F. Pichot <sup>2</sup>, F. Holon <sup>3</sup>, A. Barroil <sup>2</sup>, D. Mouillot <sup>2</sup>, J. Deter <sup>2</sup>**

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Abstract

Environmental DNA (eDNA) barcoding is increasingly used to study marine species as it can rapidly assess species occurrence. Many recent aquatic eDNA studies have used quantitative PCR (qPCR) to target a single rare species as this method of DNA amplification is more sensitive to low DNA concentrations. However, no eDNA barcoding studies have been conducted on the angelshark (*Squatina squatina*) in the Mediterranean, which is listed as Critically Endangered by the IUCN Red List. In this study, we have developed a probe-based qPCR assay to target a 173 base-pair sequence of the cytochrome c oxidase subunit I (COI) region within the mitochondrial genome of *S. squatina*. It has been used to detect the angelshark in field samples collected along the northwest and east coasts of Corsica (France). Target DNA was found in 7 of the 76 field samples, revealing the presence of *S. squatina* in the Agriates and confirming its existence on the eastern coast of Corsica. These promising results highlight the sensitivity and efficiency of the eDNA-qPCR method for the detection of rare DNA molecules in eDNA samples. They provide an initial overview of the distribution of *S. squatina* in its last refuge in French waters, which is an important first step in understanding the ecology of this rare benthic species. This non-invasive technique opens promising perspectives for the management of other imperiled sharks that highly depend on effective monitoring methods.

**00242**

## **Hunting for sustainability? Impacts and trends of the trophy hunting business in Tanzania**

Oral

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### Abstract

Trophy hunting has been practiced globally over centuries, and is used in 50% of African countries. Currently, the trophy hunting industry is receiving strong criticism concerning its ethical practicality and its efficacy in wildlife conservation and community development. In Tanzania, trophy hunting is practiced in 80% of Tanzania's protected land area, highlighting its potentially socio-economic and ecological importance. Over the past years, almost half of the hunting blocks have been abandoned and returned to the government, mainly because of increasing illegal livestock intrusions into the protected areas reserved for hunting. We quantified the socio-economic benefits of hunting in the Moyowosi-Kiogosi Reserve of southern Tanzania and identified areas of livestock-wildlife overlap over the last 30 years. At these sites, we assessed vegetation and soils under different grazing pressure. Further, we conducted interviews with local villagers to understand timings and reasons for illegal livestock intrusions. We found that livestock intrusions were initially situated at the boundaries of the reserve but encroached into the core over time. Livestock grazing strongly reduced grass biomass and soil infiltration within the reserve. Livestock intrusions happened particularly during the rainy season when most areas outside of the reserve were cultivated, limiting grazing space for livestock. Our results show that trophy hunting contributes directly to wildlife habitat preservation by deploying constant surveillance and preventing illegal grazing. We propose maintaining trophy hunting as an essential socio-economic and ecological factor in wildlife conservation.

**00238**

## **Modulating effects of succession on flying insect biomass along an elevational gradient**

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.  
insects; climate change

Oral

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### Abstract

The globally observed decline in insect biomass is predictive for losses in insect diversity and poses challenges to ecosystem functioning. Most authors explain insect declines with both land-use and climate change. However, the relative importance of direct (physiology) and indirect (resource-availability) climate change effects on insect biomass remains largely unknown. Few studies have looked into insect biomass across different climates and biomes simultaneously, although the microclimate and available resources used by flying insects vary strongly in the course of natural succession. To improve our understanding of the relative effects of macroclimate and habitat on insect biomass under climate change, we are here investigating modulating habitat effects on insect biomass along a macroclimatic gradient in a space-for-time approach.

We collected flying insects using Malaise traps on 213 research sites spanning both an elevational (600-2250 metres a.s.l.) and a successional (9 development stages from grasslands to old-growth forest) gradient. We tested the effects of elevation (as proxy for macroclimate) and habitat development stage on aggregated and daily insect biomass.

Flying insect biomass was between 26.6 and 967.1 grams in total (0.3 to 27.2 grams per trap-day). Overall aggregated biomass peaked at intermediate elevations, while overall daily biomass increased steadily with elevation. However, these trends varied strongly between biomes. Both aggregated biomass and biomass per trap-day peaked at mountain pastures and open forest-stages, which also featured the highest cover of herb layer plants.

Our results suggest that insect biomass along a macroclimatic gradient is more strongly driven by habitat-specific variables than temperature. Flying insect biomass coincided strongly with the vegetation cover in the herb layer, indicating a filtering effect of resource availability. Our study shows that understanding the relative role of climate, habitat structure, and resource availability will help improve predictions on insect biomass.

00255

## Exploring a strategy of avoidance for key functional biodiversity areas in land-use planning

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.  
Conservation planning

Oral

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Abstract

Land-use change is a major source of biodiversity erosion through artificialization and habitat fragmentation. The Strategic Environmental Assessment (SEA) of land-use planning based on the mitigation hierarchy (i.e. avoidance, reduction and offsetting of impacts) is a fundamental and worldwide tool to limit these impacts with a large scale approach. However, SEA and Environmental Impact Assessment (EIA, environmental assessment at the project level) focuses only on rare and emblematic species and habitats, without assessing impacts on common species. Decision-makers also often lack objective information on the ecological functioning of their territory that is necessary to adopt a global vision of biodiversity issues. The aim of our study is to integrate the "avoidance" step in the mitigation hierarchy into SEA land-use planning for biodiversity conservation in order to develop a decision support tool. To do so we build a hierarchy of priorities with a functional approach to biodiversity using only open access databases to integrate the constraints of land-use planners. We applied our study to three territories in the North, West and South of France that have contrasting socio-ecological contexts. We constructed functional groups of species based on traits that affect population dynamics, distributions and displacements (e.g. reproductive success, diet and dispersal mode). We then developed spatial distribution and connectivity models to assess key biodiversity areas for each functional group. Finally, we perform spatial optimization analysis to prioritize areas of functional biodiversity in a participative framework with local land-use planners and their land-use planning objectives. The resulting functional biodiversity maps offer a novel conservation approach to improve land-use planning and policy for biodiversity conservation on a territorial scale and at the very early stage of decision making.

**00303**

## **Bee Goodies – key plant species for wild bees to improve flower strips**

Oral

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Abstract

Pollinators are mainly declining due to a lack of floral food resources. To increase the flower availability, flower strips are established in agricultural landscapes. The plant species composition of the seed mixtures often depends on logistics, e.g. the availability and costs of plant species seeds and advice from experts, but rarely includes information on actual bee visitation frequencies. In our study, we explored which flowering herbaceous plants host the largest wild bee species richness and explore differences between generalists, specialists and rare bee species. We analyzed data sets of the BienABest project and the Wildbienen-Kataster on flower visitations by wild bees in Germany across seasons and combined these data with literature data on pollen collection by bees. Our comprehensive dataset included 100,000 bee-flower interactions involving 460 bee species. We identified 34 key plant species that were highly attractive for wild bees independently of plant abundance and across locations. For example, *Echium vulgare* can serve as key species for flower strips. The key species change between seasons, e.g. early and late summer. The identified key plants attracted up to 40% of oligolectic or red-listed bees in our datasets. We also demonstrated that these plants are important pollen sources, which is the key function of host flowers for bees. However, only a part of these favourite plant species are regularly included in seed mixtures. We suggest that the identified attractive plant species can provide a core of plant species for seed mixtures or can be an attractive addition or substitute to existing seed mixtures in order to create flower strips intended to support as many bee species as possible.

00362

## Biodiversity on old conventionally restored grassland is driven by small-scale management and habitat connectivity

Oral

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### Abstract

Biodiversity of grassland ecosystems is declining at alarming rates. Central European grassland ecosystems decreased not only in its extent, but also suffered from degradation by shifting from an equilibrium of yield and biodiversity towards highly productive grass species characterised by a low species richness. Here, we evaluate a 30-year old grassland restoration effort and give evidence about the effects of management and landscape parameters across a long period of re-colonisation potential. Former arable sites were sown by a conventionally low diversity grassland mixture and were managed at different intensities over 30 years.

We surveyed vascular plant and butterfly species on 28 study sites with 14 sites being restored and 14 sites being continuous grassland. We selected study sites differing in management intensity (ranging from 0 to 150 kg N ha<sup>-1</sup> year<sup>-1</sup> and 1.5 to 3.5 cuts year<sup>-1</sup>) and landscape composition (ranging from 15 to 95% grassland cover, 0 to 60% arable land and 2 to 80% forested land cover) to cover the whole connectivity gradient in the study region. We measured restoration success by species richness and specialist species richness of vascular plants and butterflies.

Preliminary results show that restoration success is higher with lower management intensities and lower distance to surrounding continuous grassland habitats. Furthermore, landscape composition positively affected species richness of vascular plants and butterflies. However, species richness of restored grassland was generally higher than continuous grassland. Regarding specialist species patterns will be important to discuss restoration success in a next model analysis.

Overall, we show that species diversity was increasing over a long time period regarding target species of *Molinio-Arrhenatheretea* after sowing a low diversity conventional plant species mixture. Our study revealed limitations and effectiveness regarding species' colonisation after conventional grassland establishment as it is still farming practice today.



**00398**

## **Are existing Marine Protected Areas of the Southern Ocean representative of marine phylodiversity ?**

Oral

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### Abstract

Marine protected areas (MPAs) have been recognized worldwide as an effective tool for ocean biodiversity conservation. The Commission for the Conservation of Antarctic Marine Living Resources committed to elaborate a representative network of MPAs in the Southern Ocean (SO). MPAs planning in the SO tend to be representative of areas of pelagic and benthic biodiversity, however it has been based on taxonomic diversity and habitat structure, overlooking other biodiversity facets. Yet, it has been increasingly argued that instead of species richness, phylodiversity is a more conservation-relevant metric for biodiversity. Indeed, phylodiversity integrates species shared evolutionary history drawing inferences about evolutionary processes and environmental factors that shape current biodiversity distribution. This study is the very first assessment of phylodiversity distribution patterns for various marine fauna taxa at the global scale of the SO. We used species occurrences from public data repositories (GBIF and OBIS) and time-calibrated trees to investigate 1) whether currently existing MPA network of the SO adequately represent species phylodiversity (alpha diversity); 2) what is the current phylogenetic species turnover (beta diversity) across the Southern Ocean by defining phyloregions and 3) how environmental variables could explain phylodiversity distribution. As first results, we found that current network of MPAs of the SO is not representative of phylodiversity and its hotspots remain uncovered. Moreover, phyloregions delimited with beta phylodiversity (phylogenetic similarity between study grid cells) reflected environmental conditions distribution (e.g. bathymetry). We strongly support the combined use of phylogenetic alpha and beta diversities determining areas of evolutionary importance for priority.

00451

## Priorities for area-based conservation of the global diversity of butterflies

Oral

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### Abstract

Evolutionarily unique and narrow-range species are important conservation targets both because of their importance for protecting evolutionary history and their vulnerability to environmental change. Recently documented insect declines stress the need for strategic conservation actions that improve the protection of this ecologically important biodiversity. However, particularly in insects, large-scale conservation efforts are hampered by a lack of distributional and phylogenetic data on species. Here, we present a workflow of data validation and integration that facilitates closing this knowledge gap based on the strengths of various types of distribution data, including country-level occurrences, occurrence points, expert range maps and species distribution models. By combining species' ranges with a comprehensive genus-level phylogeny for 12,276 (67%) butterfly species and 84% of the butterfly genera, we conduct the first global analyses of species richness, rarity, and phylogenetic diversity for an entire insect taxon. We assess the extent to which these measures are congruent, identify diversity hotspots and evaluate the spatial coverage of hotspots by the global network of terrestrial protected areas. Our results show that whereas species richness and rarity are largely congruent ( $\rho = 0.77$ ), the pattern of phylogenetic diversity is essentially independent from species richness and endemism ( $\rho = 0.08$  and  $0.06$ ). With a modelling strategy that reduces the impact of geographical sampling bias in the data and balances hotspots among biogeographical regions, we identify hotspots of the butterfly diversity with main clusters in northern Mesoamerica, southeast Himalayas, central Africa, and the highlands of New Guinea. Many of these hotspots underline priorities recognized for plants and vertebrates, but 39% highlight novel priorities for global-scale conservation of insects. Hotspot coverage by established protected areas was only slightly higher than by chance alone. Based on aggregations we conclude that improved conservation of the hottest ecoregions, which cover 5% of the land mass, could protect at least 47% of all butterfly species and a high proportion of the phylogenetic diversity and endemism of this taxon. Our study provides unique insights into the biogeographical patterns of insect diversity and its current protection as well as informs about important new conservation priorities for insects.

00459

## Integrating niche models and demography for conservation.

Oral

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Abstract

The increase in population size is often used as a proxy for the recovery of a species, making abundance monitoring a major demographic criterion. However, population dynamic is complex, and beyond management practices, spatiotemporal variation of abundance might result from heterogeneity in environmental conditions. Also, measuring the abundance and monitoring its dynamics over time can be challenging. Thus, Species Distribution Models (SDM), based on occurrences only, are increasingly used as a tool in conservation to infer spatiotemporal variation in species abundances. Predictions assume a positive relationship between abundance and environmental quality gradients derives from SDM (Habitat Suitability Index, HSI). However, the meaning of the HSI in relation to independent data, as well as the relevance of SDMs in applied conservation remains to be questioned.

Here, we investigated different aspects of the relationship between abundance and HSI through 10-years population monitoring of a reinforced Houbara bustard (*Chlamydotis undulata undulata*) population, using two large independent data sets. Beyond the tests of linear effects, we explored the relationship between HSI and abundance indices with linear and non-linear regressions, and with quantile regressions to characterize more complex relationships. Indeed, we explored a triangular relationship: with sites of low HSI associated with low abundances, while sites of high HSI correspond to various levels of abundances.

We showed that sites with high HSI were associated with higher mean and maximum abundances. We also found a triangular relationship between mean and maximum local abundance and habitat suitability, highlighting the complex relationship between demographic processes and environmental quality gradients. By studying the temporal dynamics of this relationship, we found significant effects of habitat suitability on temporal variation in local abundance, suggesting that sites of both low and high suitability were associated with lower variation in local abundances than sites of intermediate quality.

Our study highlights the relevance of SDM in conservation for inferring maximum potential local abundances (carrying capacity) and their ability to make predictions at large spatial scales. SDMs can be valuable tools in conservation translocation by identifying high potential habitats and estimating local carrying capacity.

**00461**

## **Joint spatial modelling of wildlife casualties along major roads of Brittany, France.**

Oral

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Abstract

Roads are key vectors of the social and economic dynamism of a territory, but also represent a threat for wildlife, being semi-permeable barriers that trigger mortality through vehicle collisions. Wildlife roadkills may cause serious safety issues for users and inflate mortality rates in animal populations. For both reasons, predicting the spatial distribution of roadkills along road networks has become a major concern for the ecological component of infrastructure developments in spatial territory planning. Ultimately, a predictive model of roadkills patterns can be envisioned as a risk analysis in which exposure is modelled through the predictors of a species' geographic distribution and effect through predictors of observed casualties along a road network, accounting for sampling uncertainty. We evaluated the predictive performance of this framework by modelling jointly the spatial point patterns of living animal presences and wildlife roadkills in an Integrated Nested Laplace Approximation - Stochastic Partial Differential Equation framework, informed by landscape-level predictors related with habitat composition, configuration, and road characteristics. We fitted our models with opportunistic geolocated records of living animals gathered by local naturalists and semi-protocolled records of roadkills performed daily by road patrols in Brittany, France. We demonstrate the structure and results of the model for 27 common bird and mammal species, and report its ability for projections in both space and time. We then discuss the methodological challenges and opportunities associated with an operational use of this modelling approach to assist the planification of wildlife roadkills reduction over regional scales.

**00049  
Ecological dynamic regimes: Identification,  
characterization, and comparison**

Oral

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Abstract

Understanding ecological dynamics has been a central topic in ecology since its origins. Yet, identifying dynamic regimes remains a research frontier for modern ecology. The concept of ecological dynamic regimes emerged to stress the dynamic property of steady states in nature, referring to the fluctuations of ecosystems around some trend or average. Despite methodological developments in theoretical ecology, the implementation of this concept in empirical science is still challenging given the high dimensionality and stochasticity of ecological data and the large volume of data required to distinguish between stochastic and general, predictable dynamics. The era of big data and the investment in long-term monitoring networks bring new opportunities to study dynamic regimes in empirical ecology. In our work, we propose a novel methodological framework to describe ecological dynamic regimes from a set of ecological trajectories defined in a multidimensional state space. Our framework includes a formal definition of ecological dynamic regimes, their identification from empirical data, and several analyses and metrics to characterize and compare different dynamic regimes. We used artificial data to illustrate the different elements of our framework, and we applied our analyses to real data, using permanent sampling plots of boreal forests in Quebec (Canada) as an example.

Our results highlight the value of our framework to describe ecological dynamic regimes from large volumes of data compiled in long-term permanent plots. In our study case, we showed that the proposed framework enables identifying, characterizing, and comparing ecological dynamic regimes quantitatively, even when the available trajectories are asynchronous and incomplete. Our framework allows addressing multiple research questions, including the study of succession in long-lived ecosystems –where it can be used as a robust alternative to traditional space-for-time substitution approaches –, the variability of ecological properties over time, and the responses of populations, communities, and ecosystems to the threats associated with global change.

**00074**

# **An operational framework for unifying the study and the implementation of resilience in ecological systems**

Oral

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Abstract

Resilience is a concept commonly used in the study of ecosystem dynamics, and in environmental management. However, different conceptual approaches coexist, from system and disturbance theories to socio-economy and sustainability, making difficult a unified way to measure and apply resilience. Here we present a framework aiming to provide (i) a unified terminology and a common procedure to be used under different perspectives and disciplines, and (ii) an operational way to assess resilience in ecological studies and environmental management in front of disturbances or stressors. The resilience operational framework is based on a "what to what" approach, meaning that the performance of the system through time is described by quantitative variables of the ecological system, changing in response to disturbances or stressors. This approach is consistent with vulnerability assessments based on exposition to hazards, sensitivity and adaption ability. The operational resilience framework consists of a set of concepts, a rationale describing the relationship between them, and a sequence of steps to be applied. The framework is implemented by: (1) identification and quantification of system variable(s) and a reference state, (2) description of the disturbance regimes and stressors and the temporal and spatial scales at which they operate, (3) measurement of system resilience by different metrics comparing the system variable(s) to the reference state when confronting disturbance(s) or stressor(s), (4) selection of resilience predictors and co-drivers, and (5) assessment to combine resilience predictors according to trade-offs and synergies between them and between system variables. We checked the applicability of this operational framework by searching in the literature studying forest-related systems, including natural resource or landscape management. We screened 524 papers for identifying the use of the abovementioned concepts of the resilience operational framework. All papers incorporated some of the concepts, and most of them identified resilience predictors, a key concept to plan and develop actions to promote resilience. Overall, the proposed framework provides a common procedure to address resilience studies in ecological systems allowing comparability, identification of key factors that determine resilience and establishment of targets for decision-making and management.

00193

## The European 2018/2019 drought impacted earthworms but not soil microbes in intensive farmlands - implications for resilience of soil communities

Oral

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### Abstract

A key challenge of the 21st century is the deterioration and loss of soils in farmlands. In addition to the long-term pressure of land-use intensification, arable soils must buffer extra stressors such as droughts, whose frequency will increase due to global warming. Resilient arable soils exhibit a high resistance to stresses and/or a quick recovery to a pre-disturbed state after perturbation. Soil organisms allow studying the soil's resilience, as they are the agents of organic matter cycling.

Thorough observational investigations on the interactive effect of drought and intensive management on soil biota are lacking. In a four-year study, we investigated earthworms and soil microbes in four intensively managed Northern German farmlands, measuring biomass, abundance, and activity before, during and after the exceptional 2018/19 Central European drought. To disentangle the effect of drought and intensive management, soils of arable fields were compared to soils of adjacent permanent, grassy field margins.

Key findings are that the drought reduced earthworm biomass and abundances in both field and margins. In margins, earthworms recovered quickly after the drought, however in fields they did not recover. The drought reduced microbial biomass and activity in margins, but not in the fields. In fields, microbial biomass and activity were overall lower, but stayed at a constant level during and after the drought.

Our findings suggest that intensive farming reduces the resilience of earthworms to cope with additional stress as a drought, whereas it does not in the case of soil microbes. Soil microbes appeared to show a resilience to drought as they were unaffected. We conclude that different soil biota show group- and species-specific responses to the joint impact of intensive management and drought.

**00228**

# **A theory of pulse dynamics and disturbance in ecology**

Oral

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## Abstract

For a theory of pulse dynamics and disturbance in ecology we propose four postulates as the minimum set of logical propositions:

1) 'Resource Dynamics' characterizes the magnitude, rate, and duration of resource change caused by pulse events, including the continuing changes in resources that are the result of abiotic and biotic processes; 2) 'Energy Flux' characterizes the energy flow that controls the variation in the rates of resource assimilation across ecosystems; 3) 'Patch Dynamics' characterizes the distribution of resource patches over space and time, and the resulting patterns of biotic diversity, ecosystem structure, and cross-scale feedbacks of pulses processes; and 4) 'Biotic Trait Diversity' characterizes the evolutionary responses to pulse dynamics and, in turn, the way trait diversity affects ecosystem dynamics during and after pulse events.

We apply the four postulates to an important class of pulse events, biomass-altering disturbances, and derive seven generalizations that predict disturbance magnitude, resource trajectory, rate of resource change, disturbance probability, biotic trait diversification at evolutionary scales, biotic diversity at ecological scales, and functional resilience. Ultimately, theory can identify the variable combinations that result in dynamic stability, comprising resistance, recovery, and adaptation, or in change.

Let's discuss and be inspired!

Jentsch A, White PS (2019): A theory of pulse dynamics and disturbance in ecology. *Ecology* 100(7). e02734.



00369

## Wildfire and post-fire management modulate arthropod diversity and community dynamics in pine forests (*Pinus sylvestris*) in Germany

Oral

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### Abstract

In the light of global changes, understanding and identifying the processes driving community assembly is crucial to face and adapt to future environmental change and build resilient conservation strategies. Forests are a substantial carbon sink worldwide and support biodiversity and ecosystem functions and services, which are seriously compromised by climate change and its consequences (e.g. wildfires). In this study we aimed to understand the effect of wildfires and post-fire strategies on both soil-emerging and surface-active arthropod communities and their dynamics. The study area is located in the state of Brandenburg, Germany with 13 sites with different post-fire management and two unburned control areas which were sampled continuously for a period of 12 months (2021-2022) using paired emergence tents and pitfall traps.

Our results indicate a negative effect of wildfire on both the abundance and taxonomic diversity of arthropods, but wildfire also altered the community composition independently of the post-fire management. Local patterns in emergence of soil-developing arthropods differ significantly from communities of surface-active arthropods. Post-fire management in terms of tree establishment and dead wood removal were the most important factors determining community structure.

The high abundance and diversity of arthropods in unburned sites can be explained by the fact that the present litter layer increases soil fertility, the availability of food resources and by the resulting trophic cascades that attract and increase the abundance and diversity of arthropod predators. Not all arthropod taxa were negatively affected by fire and post-fire management as very mobile taxa showed more resistances to fire and even dependent on fire to fulfil their life cycle. Although wildfire generally reduces arthropod abundance, it does not equally affect arthropod diversity, for which effects also depend on fire severity and frequency. In fact, the diversity of habitats created by fire including intact patches and large amounts of dead wood, resulting from low severity fire, increase the diversity of arthropod communities. Identifying the current processes driving community assembly is crucial in understanding biodiversity dynamic and its response to future wildfires and post-fire management.

**00504**

## **Can the functional resilience of microbial communities exposed to multiple disturbances of the same nature be predicted?**

Oral

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### Abstract

Predicting the stability of ecosystems exposed to disturbances is a central topic in community ecology and global change biology. Given the crucial role of microorganisms in ecosystem functioning, many studies focused on understanding and predicting the responses of microbial communities to single and multiple disturbances. While simultaneous multiple disturbances received much attention, sequential disturbances have been far less studied. When organisms are exposed to successive disturbances, the outcome can be predicted under two opposite assumptions: acquired stress resistance and additive / synergistic response. In the first scenario, the individual response to each disturbance decreases with repetitions and in the second scenario it either remains the same or increases. The aim of the present study was to assess what properties of the disturbance sequences (nature, time interval between disturbances, disturbance intensity) would favour one scenario. We expected that (1) the outcome depends on the nature of the disturbance and that (2) when the time interval between two disturbances increases, disturbance events become more independent and an 'additive' scenario is more likely. To test these hypotheses, we exposed artificial phototrophic biofilms (composed of 5 diatom species) to 1 to 8 repetitions of 2 hour-long stress events separated by 30 minutes, 3 hours or 22 hours. Gross photosynthesis was measured 24 hours after the end of the sequence, and the resilience was estimated by comparison with an unstressed control. Three natures of stressors were considered, with 5 levels of intensity for each: thermal stress (37-41°C), chemical stress (2-20 mg/L CuSO<sub>5</sub>) and salt stress (5-25 g/L NaCl). We observed very few effects of the time interval and mainly additive effects for the chemical stress sequence, while the resilience increased with the time interval for thermal and salt stress sequences, thus confirming our first hypothesis. The individual effects of each thermal and salt stress repetition decreased with the number of repetitions at the longest time interval in accordance with the acquired stress resistance scenario, thus rejecting our second hypothesis.

00619

## Cork oaks adapt root water uptake if invaded by *Cistus* shrubs

Oral

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Abstract

Coexisting plant species compete for available resources aboveground and belowground. Here we examine the competition for water between cork oak trees (*Quercus suber* L.) and cistus shrubs (*Cistus ladanifer* L.). We use a precipitation exclusion and shrub invasion experiment in a Mediterranean cork oak ecosystem with different treatments in single-species cork oak plots and in mixed-species cork oak with cistus plots. We implemented into the process-based ecosystem model MuSICA a variety of different root water uptake strategies as well as soil water-limitation processes of canopy fluxes, which can be found in the literature. We fitted and transferred model parameters between single-species and mixed-species plots. We show that different formulations of root water uptake and soil water limitation of canopy processes can be fitted to reproduce observed sap flow and soil moisture measurements in both, the single-species cork oak plots as well as the mixed-species cork oak with cistus plots. We use sparse measurements of leaf water potentials for model evaluation. We further show that it is not possible with any of the model structures to transfer parameters between single-species and mixed-species plots, and *vice versa*, if we keep root structure the same in all plots. Transfer of model parameters between single-species and mixed-species plots is, however, possible if we have different root distributions for cork oaks in single-species plots and for mixed-species plots, with different distributions taken from the literature. In this case, formulations of root water uptake that are proportional to root length density, i.e. there is no compensation from deeper and wetter soil layers, can well reproduce water flow in single-species cork oak plots and in mixed-species cork oak-cistus plots during a wet and an exceptionally dry year.

00043

## Invasive species modulate the structure and stability of a multilayer plant-pollinator-seed dispersal network

Oral

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Abstract

Invasive species alter ecological networks by initiating cascading effects within and between trophic groups. However, field-based studies evaluating multitrophic cascades triggered by invasive species are rare. We explored whether invasive ungulates influence the structure and stability of pollination-plant-seed dispersal mutualisms. We have previously shown that ungulates disrupt a hummingbird-mistletoe-seed disperser marsupial keystone interaction, affecting its ability to maintain community complexity in the temperate forest of Patagonia. Non-native ungulates alter the tight interactions among the partners of this keystone interaction by consuming the main host of the mistletoe and changing the vegetation structure, leading to extinction of the seed disperser marsupial. We took advantage of an ongoing invasion scenario and compared invaded and non-invaded sites with historical records of this interaction. For each site (non-invaded vs. invaded), we built a multilayer network with pollination and seed dispersal interactions represented as two layers. We calculated the connectivity between interaction types, modularity and the role of species in connecting within and between modules. We further tested the effect of structure on stability in two ways. First, we used a stochastic coextinction model of disturbance propagation to evaluate the tolerance of the network to a single random removal of species. Second, we removed species sequentially according to their structural role (robustness). The non-invaded sites had a higher number of plant species connecting both interaction types, a greater number and proportion of indirect interactions between pollinators and seed dispersers, and a higher modularity. Species changed their structural role, evaluated as connectivity within and between modules, after the invasion of non-native ungulates. These differences in the community structure led to alteration of stability. The propagation of disturbances was greater in invaded sites. Moreover, robustness was lower in invaded sites when less connected species were removed first. Our results demonstrate that the disruption of a keystone interaction by invasive species triggers changes to the structure of a multilayer mutualistic network, producing multitrophic extinction cascades. This highlights the importance of considering multitrophic structures when studying the effects of invasive species on stability.

00048

## Landscape type and floral resources modify plant-pollinator network structure and stability: implications for pathogen exchange

Oral

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Abstract

Pollinators face multiple, potentially interacting threats from human activities. The Biodiversa VOODOO project (<https://voodoo-project.eu/>) seeks to understand how land-use, through its impact on floral resources, affects plant-pollinator communities and the transmission of viruses between pollinator species.

Land-use can modify plant-pollinator network structure (e.g. connectance, nestedness, modularity) in ways that modulate the vulnerability of communities to co-extinctions propagated through losses of interspecific links between mutualist partners.

Using a Stochastic Co-extinction Model (SCM) we correlated plant-pollinator co-extinction cascades with network structure in agricultural, rural or urban landscapes, explicitly correcting for network size and intrinsic dependence on mutualism among species. Differences in network architecture between the landscapes influenced the propensity for co-extinction cascades and species losses. Such shifts in plant-pollinator networks also have implications for pollinator-pathogen interactions and we present initial results highlighting how network structure can affect interspecific viral transfer among bee species.

**00087**

## **Ecological consequences of temperature-induced body size shifts on aquatic ecosystem**

Oral

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### Abstract

Decreasing body size with increasing temperature has been proposed as the third universal response to global warming, but the ecological consequences of these size changes remain relatively unknown. This study aims to understand whether and how reduced body size modulates the effects of temperature on trophic interactions and community size structure through an experimental approach in mesocosms, where we manipulated temperature and predator size. We studied the effects of these variables on the intercept and slope of the community size spectra (linear size-abundance relationship on a log-log scale) of zooplankton, phytoplankton and benthic invertebrates. We expected that the effects of temperature on the size spectra coefficients would depend on the presence/absence of fish and that the strength of the effects would depend on the size and/or thermal origin of fish. Our preliminary results indicate that warming increased the slope of community size spectra, indicating an increase in the abundance of small individuals in heated mesocosms, especially for the phytoplankton compartment. Furthermore, temperature effects were dependent on fish presence/absence, indicating that warming has a strong impact on trophic cascades. Finally, fish size and/or thermal origin did not appear to modulate temperature effects or alter the size structure of biological communities.

00109

## Isotopic niches and diets of ground-active arthropod predators differ between a post-mining and a natural lakeshore

Oral

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Abstract

The post-mining lakes in the Lower Lusatian district, Germany are young aquatic ecosystems with characteristic primary succession due to the high levels of acidification. The limited availability of nutrients and plant-based resources and simplified aquatic food webs at these lakeshores may affect the matter fluxes from these highly disturbed ecosystems towards food webs in the surrounding terrestrial habitats. To understand the impact of a post-mining lake on terrestrial food webs and the associated arthropod communities we compared emerging and active arthropods between lakeshores at a post-mining and a natural lake. We established aquatic and terrestrial emergence tents to sample potential prey that locally emerged (Collembola and Diptera) and used pitfall traps to sample ground-active terrestrial arthropod predators (Carabidae and Araneae). Community composition and stable isotopic analyses on  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  were performed to compare communities and isotopic niches of riparian arthropods. In total 5571 collembolans, 779 aquatic emerging dipteran, 1682 terrestrial emerging dipteran, 176 carabids and 1096 spiders were analyzed. As expected, the species composition of predator communities differed significantly between lakes. The  $\delta^{15}\text{N}$  values of terrestrial and aquatic emerging Dipterans differed dramatically between both lakes, with values for terrestrial Diptera being 8  $\delta^{15}\text{N}$  units higher than for aquatic Diptera at the post-mining lake, but showing the exact opposite pattern at the natural lake. Predator species from the natural lakeshore generally had larger isotopic niche sizes than the same species at the post-mining lakeshore suggesting a more diverse diet. Carabid species at the natural lake had extremely clustered isotopic niches, suggesting a utilization of identical prey resources. The trophic position of spider species was comparable between lakes, but spanned about 6  $\delta^{15}\text{N}$  units between *Tenuiphantes flavipes* (lowest at both lakes) and *Euryopis flavomaculata* (highest at both lakes). Our results indicate that apart from obvious community differences between natural and post-mining lakeshores, diets of predaceous arthropod species that occurred at both lakes and their potential prey may still differ substantially. These first results comparing isotopic niches for predators on lakeshores including a post-mining lake should caution future researchers to avoid over simplistic assumptions about isotopic values of aquatic and terrestrial prey.

00120

## Temperature variation is the main environmental driver of lake food web structure

Oral

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Abstract

Food web structure is a major determinant of biodiversity stability, persistence and resistance to perturbations. While many efforts have been devoted to understanding variations in food web structure among terrestrial and aquatic ecosystems, the environmental factors influencing food web structure within a single ecosystem type remain largely unexplored. Here, we compiled biodiversity inventories to infer food webs of 67 French lakes using an allometric niche-based model. We then characterized food web structures using 21 food web metrics and identified two distinct complementary and independent structural descriptors of these food webs. The first is related to the overall trophic diversity, whereas the second is related to the vertical structure. Generalized additive models highlighted that the trophic diversity descriptor exhibits concave and convex relationships with a water thermal variation metric (isothermality) and productivity (phosphorus) respectively and has a positive relationship with habitat size (lake area). Alternatively, food web vertical structure descriptor is positively correlated to water thermal seasonality and annual mean temperature as well three habitat metrics (lake depth, lake area and littoral complexity). Overall, although this is a set of environmental variables that collectively shape lake food web structure, we found that water temperature, and particularly its temporal variability, is the main driver of food web structure variations. Our findings therefore highlight the importance of focusing more on temperature variation especially in the context of climate change, as significant structural changes of aquatic food webs can be expected under increased temperature variations.



00125

## The structure of plant-pollinator networks is affected by crop type in a highly dynamic agricultural landscape

Oral

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### Abstract

In agricultural landscapes, bipartite networks formed by pollinators and the flowers they forage are characterized by the presence of species managed by humans, whether honeybees (*Apis mellifera*) or crop plants such as oilseed rape and sunflower. Crop plants differ both in the quantity and temporal period of their flowering. For instance, oilseed rape and sunflower produce a large amount of flowers during a short period, while wild flowers are present on a longer period but at a fewer density in grassland. This can affect the network structural properties between crop types, e.g. number of species or links between species that can lead to more complex properties distortion. This is why we asked how the structure of plant-pollinator networks is affected by the dynamic of agricultural landscapes. We used six years of long-term monitoring data conducting on the LTSER Zone Atelier Plaine & Val de Sèvre (West of France), and studied the six main crop types in this region, with interaction sampling by net along transects in an average of 160 fields per year. To describe networks, we used six metrics: connectance, nodes number, modularity, specialization, and two nestedness measures. We found that the structure of the interactions between pollinators (social bees, solitary bees, hoverflies and butterflies) and plants (crop plants and weeds) varies according to the network property considered in each crop, especially between oilseed rape and sunflower crops. Although the number of nodes and connectance remain similar between both mass-flowering crops whatever the sampling effort, a huge difference was observed in nestedness and specialization: oilseed rape crops have their networks much more nested and much less specialized than sunflower crops, and even meadows are far less specialized than sunflower crops. Indeed, our results show that the link between honeybees and mass flowering crop flowers is not equivalent among mass-flowering crops. Honeybee is twice more specialized in sunflower than in oilseed rape, and sunflower plant is three times more specialized than oilseed rape plant. Thus, honeybee and sunflower plants appear as specialist species in sunflower crops, interacting strongly and almost entirely with each other, whereas they are not usually specialists.

00170

## Mycorrhizal associations shape orchid distributions across an oceanic archipelago

Oral

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Abstract

Associations with mycorrhizal fungi help plants to thrive on islands by making them more competitive, although prior colonisation by the fungal partners is generally required for them to establish. This is especially relevant for obligatory mycorrhizal plants, such as orchids, but how their partners availability limits their distribution remains unclear. Here, we sampled 430 individuals from four orchid species commonly occurring across the Canarian archipelago to investigate their mycorrhizal communities. In addition, we took soil samples at sites with and without orchids to tease apart the biotic and abiotic factors influencing orchid distributions on islands. The results show that fungal communities of orchids vary both in composition and specificity. Widespread, generalist orchids associated with the highest number of mycorrhizal fungi, while endemic species associated with a narrower range of generalist fungi that were absent from sites without orchids. We conclude that free-living mycorrhizal communities do not constrain the distribution of widespread and generalist orchid species, but might limit the abundance of species with specialist interactions. This highlights the importance of mycorrhizal availability for specialist orchids and emphasises the relevance of including fungal interactions in conservation programs.

00174

### Could trait-matching predict litter consumption rate by detritivores?

Oral

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#### Abstract

**Context:** The trait-matching framework posits that intensity of trophic interaction depends on whether foraging abilities of consumers confer advantages in exploiting vulnerability traits of eaten species. In other words, the feasibility domain and strength of interactions could not be simply inferred from additive models based on consumer and resource traits. Trait matching rules have been identified in bipartite networks known to display rather high levels of resource trait diversity and foraging specialization (i.e. predator-prey, herbivore-plant, frugivore-fruit interactions). Here we focused on interaction strength between detritivores and plant litter in detrital food webs wherein generalism and homogeneous resources are believed to prevail.

**Question:** We addressed the question whether trait-matching can explain consumption of litters by detritivores.

**Methodology:** We set up a laboratory feeding experiment with functionally-divergent species of macro-detritivores and leaf litter. There were 9 species of detritivores from forest soils and streams, and 8 leaf litter species which were exposed to either leaching or microbial decomposition prior to being offered to detritivores. Detritivore (e.g. Isopods, Diplopods, Insect larvae) species were chosen to represent diverse life forms. Leaf litter were taken from tree species chosen to capture a broad range of litter quality (chemical and physical). Litter consumption rate was estimated in laboratory microcosms for the 144 possible pairwise interactions. We also determined consumer and resource traits selected based on priori trait-matching hypotheses relating to bioenergetic, biomechanic and stoichiometric constraints on trophic interactions. For instance, we expected a biomechanical match between mandible ability of detritivores and toughness of the leaf litter.

**Results:** Our findings highlight large variation in litter consumption rate owing to litter conditioning by microbial decomposers and identity of detritivore and leaf litter. These variations are best described by models accounting for statistical interactions between detritivore and litter traits, which supports the view that trait-matching rules influence the structure and dynamics of detrital food webs.

00226

## Insect herbivore - plant interactions: nonlinear specialization along a climatic gradient

Oral

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### Abstract

The 'altitude niche-breadth hypothesis' predicts a prevalence of generalist herbivores in cold high-elevation habitats compared to warm low-elevation sites due to enhanced environmental and population size variability, as well as predator and plant defence release. However, current empirical evidence is mixed and lacks accounting for the phylogeny and frequency of interaction partners. The role of microbial associates in insect's feeding specialization, nutrition, or health status is still inconclusive and could be affected by climatic gradients, phylogeny, and feeding niche. Hence, we aimed to test whether the specialisation of herbivores in insect-plant interaction networks decreases with temperature and how the respective microbial communities react.

We recorded dietary interactions between Orthoptera species as a major polyphagous insect herbivore taxon and their resource plants along a broad temperature gradient in southern Germany. Therefore, we assessed the vegetation composition and surveyed orthopteran assemblages on 41 calcareous grassland sites. To calculate herbivore specialization, we used direct field feeding observations and a non-invasive standardized DNA-metabarcoding approach (ITS2, 16S) of pooled faecal pellets from > 3,000 individuals of 54 species.

Species richness and abundance of herbivores increased with temperature, while plant richness peaked at intermediate temperatures. Interaction networks were most specialised at warm sites. However, considering the abundance and phylogeny of resources unravelled a nonlinear pattern of herbivore specialization, peaking at intermediate temperatures, where the insects mainly fed on a narrow range of phylogenetically clustered resources. The resource specialisation also affected microbial communities, since they were jointly shaped by feeding habits and consumed plants, but also changed along the temperature gradient.

Our results provide empirical evidence of resource specialization of insect herbivores, suggesting interactive effects of resource phylogeny, availability, and temperature on the composition and specialization of herbivore assemblages. Both, compositional and intraspecific changes were linked with increasing generalist feeding at both extremes of the climatic gradient. The non-linear variation of herbivore specialization underlines the currently limited understanding of how plant-herbivore interactions will rewire or change under future climatic conditions.

00265

## Spatial turnover of soil food webs along environmental gradients

Oral

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### Abstract

While soil food webs are key drivers of ecosystem functioning and associated services, we largely ignore how they change along large environmental gradients. Given their inherent complexity, responses of organisms may occur at different resolutions: broad trophic classes would respond if they were selected by different environments, and refined trophic groups would respond in addition if they were functionally complementary (and not redundant) within classes. Thus, looking at different resolutions when studying soil food webs may reveal different patterns of assembly. Here, we aimed at quantifying and investigating the spatial variation of soil food webs along the sharp environmental gradients of the whole French Alps. Using network dissimilarity metrics applied over 451 local soil food webs along 24 elevational transects, we (1) quantified soil food web turnover at two resolutions, and (2) deciphered the importance of geographic distance and environmental factors to explain spatial soil food web turnover. We found spatial variability of trophic groups and trophic interactions at both resolutions, but turnover between trophic classes was much weaker than between refined trophic groups. This confirmed the existence of a backbone of soil food webs (i.e. trophic classes that are always present). Environment variation explained much more of the soil food web turnover between sites than spatial distance. Soil C/N ratio and NDVI were the most important variables at both resolutions, while plant taxonomic turnover only influenced food web structure at the finer trophic group resolution. Our results illuminate the spatial structure of soil food webs at a large spatial scale, and their nested structure with a strong turnover of trophic groups determined by environmental filtering (i.e. trophic group sorting) ultimately constrained by a universal backbone of soil trophic interactions.

**00315**

## **The effect of earthworm ecological groups on plant-plant interaction**

Oral

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### Abstract

The plant-plant interactions are crucial in mediating the ecosystem process. Earthworms are the keystone organisms in the soil ecosystem, playing an important role in nutrient cycling and plant growth, yet, little is known about how earthworm ecological groups influence plant-plant interaction. In present study, we established a mesocosm experiment with three earthworm ecological groups (epigeic, anecic and endogeic) and three plant community {*Trifolium pratense* (legume), *Lolium perenne* (grass), and their mixtures} to test the role of earthworm ecological groups in the intra-and inter-specific interaction between legume and grass.

In comparison with monoculture plant, the mixture treatment had a strong facilitative effect on the plant productivity of both legume and grass. The mixture increased the quality (C/N) of grass, while slightly decreased the quality of legume. However, earthworm ecological groups did not affect plant growth. Earthworm species only affected the  $\delta^{13}\text{C}$  of grass, but not the  $\delta^{13}\text{C}$  of legume. Compared to grass monoculture, grass  $\delta^{13}\text{C}$  value in the mixture was decreased by endogeic *A. rosea* and epigeic *E. fetida*, indicating higher photosynthesis and water use efficiency.

We concluded that the mixture of legume and grass facilitate the growth of both plant functional types, but earthworm ecological groups did not directly affect the plant-plant interaction. Earthworm species alter the resource acquisition efficiency differentially for plant functional groups, hinting the distinct plant strategies for coexistence.

00320

## Individual phenology and spatial heterogeneity shape plant reproduction through plant-pollinator interactions

Oral

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Abstract

Plant-pollinator interactions condition the seed set of insect-pollinated plants. Pollination competition and facilitation amongst co-flowering plants produce unequally distributed reproductive outcomes amongst plant species and individuals. Moreover, spatio-temporal heterogeneity in floral resources and plant traits (e.g. phenology) can modulate the plant-pollinator interactions, at different ecological scales, that a plant individual is exposed to during its flowering period, with implications for pollination and seed set.

Using a field experiment, we tested how multi-scale plant-pollinator interactions, modulated by flowering phenology and spatio-temporal floral heterogeneity (arising from agroecological infrastructure) combined to affect the seed set of individual wild plant species. We transplanted replicates of insect-pollinated plant species contrasting in flowering phenology, *Cyanus segetum* and *Centaurea jacea* (Asteraceae), into sown wildflower or legume-grass field borders across a farm-scale agroecological experiment. We recorded the flowering period of each individual plant, the corresponding plant-pollinator interactions at individual, local community and agroecosystem-scales, and the subsequent seed production.

Our phenologically constrained models of *C. segetum*/*C. jacea* seed set revealed that the individual plant attractiveness (integrating floral display and visitation rate), the local plant-insect community composition (richness or density) and the size and architecture of the agroecosystem-scale plant-pollinator network combined in specific ways for each focal species to influence seed set. For *C. segetum*, competition and facilitation between the focal individuals and other plant species co-existed at the local floral community scale, with the net balance conditioned by the position of *C. segetum* in the agro-ecosystem scale interaction network. For *C. jacea*, facilitation of seed set dominated at the community scale through the combination of individual attractiveness and the community floral density. Individual plant seed set was thus shaped by patterns in diversity and network structure that imply a co-occurrence of pollinator-mediated facilitative and competitive interactions operating within and between ecological scales.

00352

## Exploitative plant strategy: an unexpected link between initial abundance of denitrifying soil community and biological denitrification inhibition (BDI)

Oral

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Abstract

Plant growth strategies have been a long-standing interest topic in plant ecology. Plant growth strategies have strong impacts on the plant performance, dynamics and cascading effects on ecosystem functioning. Interactions between plant strategies and ecosystem functioning are commonly approached by functional traits. Trait-based approaches have proved to be useful to explain plant distribution along resource gradients from exploitative (also called acquisitive or competitive) to conservative strategies. These primary axes of ecological specialization define a gradient of strategies related to plant growth, reproduction, and survival, which links above- and below-ground traits to plant resource uptakes, growth rates and can influence N cycling. Recent studies suggest that plants developed control strategies to acquire nitrogen by shaping and recruiting N-related microorganisms, either directly with trophic competition or indirectly with non-trophic interactions. In this context, some plants are able to control soil denitrifying communities through the production of secondary metabolites (procyanidins). This phenomenon is referred to as the biological denitrification inhibition (BDI) strategy and has been firstly demonstrated in the *Fallopia* sp. complex. Our study compares the *Fallopia japonica*, known to develop a BDI strategy, to another exploitative plant (*Dactylis glomerata*) known to be a non-BDI plant. This comparison is done on a large panel of soils in order to investigate biotic and abiotic soil factors influence. Therefore, a mesocosm experiment was conducted using nine soils with contrasting biotic (i.e. abundances of soil microbial communities) and abiotic (i.e. soil physico-chemical factors) characteristics. Our study demonstrates for the first time that BDI strategy varied along a gradient of biotic and abiotic soil parameters. In addition, we found an unexpected link between initial soil denitrifying community and the BDI strategy. These results may suggest that the plant is able to detect the presence of the initial microbial communities during plant installation. This work opens up new perspectives on plant-microorganism interactions in the context of nutrient competition.



**00423**

## **Interactions between wild bees and flowers regarding floral traits and seed set**

Oral

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### Abstract

The interactions between pollinators and their host plants are essential, as pollination efficiency has a direct effect on crops and therefore mankind. Wild bees play a key role as pollinators of wild and agricultural plants. Yet this important ecosystem service is prone to pollinator decline. For wild bees, one of the main reasons for the decline is the lack of suitable food sources. Hence, implementing flower strips within agricultural landscapes is a common used countermeasure to promote wild bees. However, many bee-plant interactions are highly specialised as many bee species rely on specific plant species as a pollen resource. Therefore, it is crucial to adjust the plant composition of wild flower strips in order to promote a high variety of bee species. In this project, we investigated two important factors regarding the effect of such plantings: on one hand we investigated various floral traits of species-rich flower strips that were established within the BienABest project ([www.bienabest.de](http://www.bienabest.de)) in order to get a better understanding of the ongoing interactions between the wild bee community and their host plants. We analysed a variety of floral traits regarding morphology, floral cues and floral reward. As we reconciled the plant data with bee monitoring data of the BienABest project, we could identify possible clusters and keys for bees' plant choice. On the other hand, we investigated the dependency between wild bee abundance and diversity, and pollination efficiency of selected wild plant species. We performed pollination experiments with potted plants of four different plant species that also occurred in the flower strips. Again, we used the monitoring data to match seed production data with bee species composition and abundance. Our seed data reveal differences in quality and quantity of seeds depending on the wild bee diversity. The results of this project can play an important role in not only implementing but also improving wild flower plantings and thereby optimizing pollination efficiency in agricultural landscapes.

00425

## Plants forming phytotelmata: a model system for discovering new strategies used by plants to tailor a nitrogen-fixing microbiota

Oral

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Abstract

The phytotelmata, defined as water bodies held and enclosed by living plants, are small ecosystems that are ideally suited for holistic investigations of microbiome diversity and identification of novel biotic interactions. These discrete habitats are quite frequent in nature and include the cup-shaped structures at the base of opposite leaves in the common teasel (*Dipsacus*) and the flasks of bromeliads.

We found that anoxygenic phototrophic bacteria (APB) are widespread and abundant in the tanks of bromeliads[1]. Using gene profiling, we discovered co-phylogenetic relationships between APB and the bromeliad species suggesting that APB are a trait forming part of the extended phenotype of the host plant2. Our genomic analyses demonstrated that up to 80% of the APB microbiota possess the nitrogenase genes (*nifH*), suggesting that these specific microbes may be benefit for the plant nitrogen nutrition2.

Recently, we explored the microenvironment of the l cups of *D. fullonum* and the associated microbiome. Congruent with our previous observations, we found very high levels of bacteriochlorophyll a, the photosynthetic pigment of APB. Moreover, both acetylene reduction and quantitative PCR assays for nitrogenase activity and abundance, respectively, demonstrated the significance of nitrogen fixation in the cup assemblages since up to 45% of the overall community are N<sub>2</sub>-fixers. In addition, microscopic observations showed that a high bacterial density preferentially occur around glandular trichomes located in the tanks. These observations coupled with the identification of terpenes in the secretion products of these glands, known to structure the rhizosphere microbiota, led us to postulate that glandular trichomes may be key players in the nitrogen fixation process.

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00243

## Spatio-temporal effects of landscape heterogeneity on plant-pollinator interactions

Oral

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Abstract

Wild pollinators play an essential role for crop production by increasing pollination services in natural and agricultural landscapes. However, they are facing major threats, which can mostly be attributed to habitat loss, land-use intensification (e.g. pesticide exposure), and climate change.

While a more diverse landscape composition (i.e. proportion of land-use types) can generally promote the diversity of pollinators, few studies have investigated the effects of landscape configuration (spatial arrangement of land-use patches) on pollinator communities. Agroecosystems are dynamically changing landscapes where resource availability (e.g., floral resources and crop diversity) and pesticide applications can substantially vary throughout the flowering season. Therefore, pollinators and plants need to match both spatially and temporally to ensure successful interactions and effective pollination services.

This study aims to test the spatio-temporal effects of landscape heterogeneity (composition and configuration) on the structure of pollinator-plant networks. We used a landscape ecology approach to examine the effects of spatial configuration, temporal land use regimes, and floral resources turn over on pollinator-plant network characteristics.

We will show how landscape composition and configuration affect the structure of pollinator plant networks along a gradient of land-use intensity and across time in Central Germany. More specifically, we will present how temporal variation of resource availability throughout flowering seasons can reflect changes in the topology of plant-pollinator networks, by influencing nestedness as well as connectance. Integrating a temporal component in the spatial analysis of species interactions may help to better understand how wild pollinators respond to landscape heterogeneity, and will facilitate improved recommendations for the management of pollinator populations in agroecosystems.

**00464**

### **Biodiversity of food webs in response to warming across ecosystem types**

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.  
food webs, temperature

Oral

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Abstract

Global warming is undoubtedly contributing to biodiversity erosion. However, the mechanisms by which ecosystems respond to rising temperatures remain unclear and prevent the formalisation of a predictive framework able to a priori identify more sensitive communities. To develop a community-sensitivity framework, we assess how different ecosystem types and food-web structures determine the response of species persistence to warming using a dynamic model on a dataset of 219 empirical food webs. We observed that community response to warming differs between ecosystem types, with stream ecosystems being more fragile than marine, lake or terrestrial ecosystems. We also reveal that two categories of food-web structures are key in supporting species coexistence. First, structures facilitating the circulation of energy across species have a protective effect against temperature increase. Second, structures related to the trophic similarity of species – while associated with stronger competition and expected to have a detrimental impact – enhance community resistance to warming. This effect probably occurs because the associated insurance effect offsets the negative impact of competition. However, the set of descriptors associated with these two types of structural characteristics was not able to explain the variation across ecosystem types. It indicates that (1) the mechanisms associated with the descriptors considered here are universal, applying to all food webs irrespective of ecosystem type and (2) the response of communities to temperature is driven by these universal mechanisms as well as some that are ecosystem specific, both interacting to determine the future of ecosystems in a warming world.

**00479**

## **Assessing the performance of statistical methods to infer animal interactions from movement data**

Oral

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### Abstract

Animals often do not move independently of each other but under influence of con- and heterospecifics, such as competitors and predators. Three main types of interactions among such moving individuals can be distinguished: avoidance, attraction and neutrality. The 'big data' era together with a rapid improvement of tracking technologies has led to collecting the data at increasingly fine resolution for multiple individuals moving simultaneously. In response to the availability of such big data, several methods have been developed to infer interactions among moving animals. These methods, however, differ in their assumptions, the type of data required, and specific research questions they can address, which makes it challenging to choose the most appropriate method for a particular situation. Here, we assess the performance of two commonly used methods: WildlifeDI, and a method for inferring interactions by Schlägel et al. 2019. We simulate three types of interactions between one predator and several preys, who move according to the biased correlated random walk. We test how methods' performance is affected by the proportion of tracked prey individuals, the temporal resolution and the perceptual range of the predator. Our preliminary results for two investigated indices in WildlifeDI (Correlation coefficient and Dynamic interaction index) show, that with an increase in the proportion of the 'tracked' preys, the ability to correctly infer interactions increases. Further, we demonstrate that with an increase in the perceptual range of the predator, the accuracy of all investigated methods also increases. The performance of one method, the Correlation coefficient, was biased by temporal resolution. Interestingly an increase in the temporal resolution increased the accuracy of the method. Whereas the accuracy of two other methods were not affected by the resolution. We identified the thresholds in the proportion of tracked prey and temporal resolution, above which all the methods deliver satisfactory estimates. These thresholds will help guide the design of the telemetry data collection in the future.

00510

## Daily temporal dynamics of plant-pollinator networks

Oral

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### Abstract

Temporal dynamics of ecological networks are increasingly recognized, acknowledging that static network depictions allow limited understanding of interactions and their functional consequences. Most of such studies describe dynamics over the course of a season or over multiple years, but diel dynamics (changes within a single day) may also be important. Here, we show that diel dynamics matter in plant-pollinator networks in meadows of Southern Germany. First, we compare diel dynamics to seasonal dynamics, highlighting that both are important and have similarities such as hump-shaped patterns of flower visitation activity, with little interaction among the two temporal scales. Second, we present an experimental test of network dynamics. Diel dynamics are particularly strong when plants of different Asteraceae groups are dominant in a network, including Cichorieae that close their flower heads early in the day. By experimentally preventing such early flower closure in the field, we show that the temporal availability of open flowers, rather than intrinsic timing of pollinators, is the main driver of the strong daily temporal dynamics, which are limiting the network dominance by generalized Cichorieae. Evidence for temporal partitioning of pollination niches among plants cautions against ignoring the temporal dimension of plant-pollinator interactions when interpreting network indices and when designing field sampling campaigns.

00535

## Can co-occurrence matrices predict trophic matches between plant resources and butterfly consumers?

Oral

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### Abstract

Agricultural intensification affects biodiversity and homogenizes biotic communities by imposing environmental filters on plant communities and thereby modifying biotic interactions between plants and higher trophic levels. Biotic interactions between plant resources and insect consumers affect the species composition of local plant communities, and these interactions might be inferred from spatial occurrence patterns. By comparing the co-occurrence matrices of resource and consumer species to trophic linkage matrices in agricultural grasslands of two regions in the DFG biodiversity exploratories, we aim to test if species co-occurrence analyses can reflect well-documented trophic interactions between butterflies and plants. We further aim to understand if certain pairs of resource-consumer species co-occur due to strong trophic relationship or due to shared environmental preferences. To test this, we collected occurrence data for plant and day-active butterfly species from field observations at 100 grasslands in two regions in Germany and compared them with documented trophic interaction data from the literature for those regions. We calculated co-occurrences on a pairwise approach by using the Relative Interaction Intensity index and the probabilistic model. Additionally, we collected data on flower availability and flower visitation records for data validation. We hypothesise that trophic interactions can be inferred from spatial co-occurrence data. We also expect to find pairs with joint strong co-occurrence and strong trophic link in extensively managed grasslands, but not in intensively managed grasslands where consumer-resource associations might be decoupled. Furthermore, we identified 61 pairs with strong joint co-occurrence and strong trophic linkage in the south-western region (AEG) and 17 pairs in the north-eastern region (SEG). Those pairs included about 20% of the plant species and 6% of the butterfly species present in the AEG region, but only 14% and 5% respectively in the SEG region. Our analyses suggest that the co-occurrence analysis only detects a rather low proportion of the consumer-resources matches described in the literature, and this was further confirmed by correlation analyses. Further steps will characterize the effect of land use intensity on the pairs with joint trophic interactions and co-occurrences to identify matched pairs of consumers and resources that may be candidates for future conservation effort.

00558

## Feeding in the frequency domain: The effects of nutritional heterogeneity grain size on consumer performance

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.

Nutritional ecology

Oral

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Abstract

During their lifetime, most consumers need to deal with fluctuations in food quality. They have to combine dietary compounds acquired separately from nutritionally complementary food resources that often might not co-occur in space and time. Accumulating evidence shows that such nutritional fluctuations could be at least as important as the average experienced food quality and may have far-reaching implications such as the control of herbivorous pest populations in agroecosystems through spatial crop heterogeneity. Yet, the effects of the grain-size, i.e. the characteristic spatio-temporal scale, of nutritional heterogeneity on consumers remains poorly understood. At the scale of the individual consumer, different grain-sizes translate to the time domain and yield different quality fluctuation frequencies. Here, we combine a mathematical model and growth experiments with the model organism *Daphnia* to test how a gradient from high to low frequencies (reflecting fine- to coarse-grained environments) modulates the effect of resource variance, supply peak timing (i.e. early or later in life) and covariance (i.e. degree of complementary foods' co-occurrence in space/time). We show that the ability to store resource when in excess can buffer growth at high frequencies, but yields a sensitivity of growth to resource peak timing at lower ones. When two resources covary, negative covariance causes stronger growth depression at low frequencies. However, negative covariance might be beneficial at intermediate frequencies, an effect that can be explained by digestive acclimation. Our study provides a mechanistic basis for understanding how alterations of the environmental grain size affect consumers experiencing variable nutritional quality in nature.



**00570**

## **Predator effects on herbivore host switch: an eco-evolutionary experiment**

Oral

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### Abstract

The population dynamics of herbivorous insects is importantly determined by the equilibrium between natural enemy pressure and plant nutritional quality. Insect herbivores maximise fitness by exploiting plants where they are at low risk of enemy attack, and which have high nutritional value. This question has been particularly explored in the frame of the enemy-free hypothesis whereby herbivores are selected to exploit suboptimal plant resources if feeding on them reduces natural enemy pressure. A little explored question is whether herbivores may switch to plants of suboptimal quality because they provide a niche with low levels of intraspecific competition. To test this idea, we study the dynamics over several generations of an experimental community composed of two plants, three herbivores (one of them an inferior competitor), and two natural enemies each specialised on each of the two superior competitors. We hypothesise that in the absence of natural enemies, the superior competitors will capitalise plant resources, but in their presence the inferior competitor will thrive. In agreement with this, we found that the inferior competitor switched between plants depending on the natural enemy present, even when the plant available had a poor nutritional value. Further experiments revealed that host plant switch led to the evolution of particular traits that may allow development on a suboptimal nutritional source. This experiment is an example of an eco-evolutionary dynamics triggered by indirect effects of natural enemies.

00031

## Forecasting in the face of ecological complexity: number and strength of species interactions determine forecast skill in ecological communities

Oral

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Abstract

The potential for forecasting the dynamics of ecological systems is currently unclear, with contrasting opinions regarding its feasibility due to ecological complexity. Increasing ecological complexity is often assumed to worsen forecasts, yet recent results both support and contradict this hypothesis. To investigate forecast skill as a function of complexity within and across systems, we monitored a microbial system exposed to either constant or fluctuating temperatures in a five months long laboratory experiment. We tested how the forecasting of the abundance of a species depended on the number and strength of interactions of the species and on the model size (i.e. the number of predictors used). We also tested whether these relations are affected by a greater system complexity caused by the fluctuating temperatures. We found that the more a species interacted (i.e. the more connected it was in the system), the weaker these interactions were and the better its abundance was predicted. Greater system complexity decreased forecast skill for three out of eight species and forecast skill increased with model size. We show that the relation between forecast skill and complexity can be both species-specific and of different sign within and across systems. These insights into how the prediction of species abundances depends on the embedding of the species within the system and on overall system complexity could improve species forecasting and monitoring. Based on our results, to achieve forecasts of equal skill more data is likely required for a species with few but strong interactions than for a species with many but weak interactions.

00648

## Evidence of an animal-mediated fertilization in red algae.

Oral

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Abstract

Plants-insects relationship have a long co-evolution history that has been going on for at least 140 millions of years. Insect-pollination is the most widely distributed mode of fertilization in flowering plants. While it has been extensively studied on land, animal-pollination was only demonstrated recently in the marine environment, in a seagrass where the role of invertebrates species in pollen transport was highlighted. This finding contradicts the paradigm that animal mediated pollination is absent in the sea, opening up new avenues of inquiry in other phylums of the tree of life. This is particularly relevant in Rhodophyta since male gametes are non-motile and fertilization takes place onto a remote female organ. The non-flagellated sperms cannot swim to reach the receptive area of the female reproductive organ and depend entirely on passive transport in the water column, unless an additional active mechanism is involved in sperm transfer. Here, we studied biotic interactions between the red alga *Gracilaria gracilis* and the isopod *Idotea balthica*, often found in association in nature. Our results reveal that algal fertilization success was twenty times higher in the presence of idoteas in experimental conditions, when compared with a control without idoteas. Moreover, confocal microscopy analysis shows that idoteas transported spermatia that adhere to their bodies. Thus, idoteas significantly increase the reproductive success of algae by facilitating the diffusion of spermatia, indirectly via water movement due to swimming activity and gill respiration, but also by direct transport from males to females. The discovery of animal mediated fertilization in seaweed brings a new vision on how the mating system evolves in algae, in which the role of animal interactions has never been questioned. These unprecedented results change our view of the evolutionary history of plant-animal relationships. They suggest that the role of animals in plant fertilization in the marine environment may have evolved either in parallel or well before the colonization of the terrestrial environment.

## Ecology, functioning and evolution of urban and anthropized systems (1/2) - Verlaine B 22/11 ; 16:15-18:15

00077

### Interactions of Functional Traits With Native Status and Ecosystem Novelty Explain the Establishment of Plant Species Within Urban Ecosystems: Evidence From Berlin, Germany

Oral

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Abstract

A key challenge in urban biodiversity conservation is to understand the drivers that govern the population establishment of different groups of species in different urban ecosystems. Here, we ask whether and to what extent vascular plant species establishment (i.e., the ability to establish self-sustaining populations within a certain time span) is driven by interactions of species functional traits, native status, and the type of ecosystem species occur in, with types of ecosystems distinguished by their degree of ecosystem novelty. To answer this question, we use a dataset of 1,178 vascular plant species occurring in Berlin, Germany that originally had been compiled to substantiate the Berlin Red List of endangered plant species. This dataset classifies native and non-native species into casual and established species based on a minimum of 25 years of expert observation. Whether a species is established or casual is distinguished among four broad types of ecosystems: natural remnant, hybrid, novel immature, and novel mature ecosystems. Moreover, we classify species into those native to Berlin and non-native species (split into archaeophytes and neophytes), and link species to selected functional traits and indicator values. By applying ordinal regression within a Bayesian framework, we show that traits are key drivers of these establishment processes and that the traits that drive species establishment differ across types of ecosystems. While across traits, more established species are present in natural remnants, low canopy height, annual life span, and late end of flowering specifically promote establishment in novel immature ecosystems. In hybrid ecosystems, low canopy height and reproduction by seeds are beneficial traits, with the latter promoting establishment in novel mature ecosystems, too. Traits were less important in predicting species establishment in native as compared to non-native species. All types of ecosystems add to urban biodiversity, and trait analyses refine our knowledge on how they can be supported in doing so on the long term. This can help in sharpening conservation measures.

**00080**

## **Restoring urban ecosystem for nature and people**

Oral

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### Abstract

The ecology of urban greenspace has gained considerable attention because of its relevance to sustainable development, wildlife conservation, human welfare, and climate change adaptation. The loss of biodiversity and the degradation of ecosystems require new approaches and concepts for ecological restoration in urban environments, aiming at ecosystem services, biodiversity conservation and climate change mitigation.

Apart from natural and semi-natural ecosystems, cities harbour a wide range of so-called hybrid and novel ecosystems with strongly altered abiotic conditions, species composition and biotic interactions. A consequence of this ecological novelty is the lack of classical reference systems for defining restoration measures and targets, potentially hampering the implementation of ecological restoration in cities.

In consideration of these challenges and by formulating restoration targets for several urban habitat types of different levels of ecological novelty, we developed a new conceptual framework to provide guidance and support for urban ecological restoration initiatives. Highlighting the value of strongly altered, but yet “well-functioning” urban ecosystems, as compared to degraded ecosystems, can further stimulate urban ecological restoration that produces meaningful outcomes for both nature and people. Still, more approaches to ecologically improve urban ecosystem in a changing climate are needed. Re-shaping and re-thinking of urban greenspace together with citizens and other stakeholders will be crucial to make greenspace more sustainable. Next steps are to discuss and spread such restoration approaches across different countries and convince city administrations across Europe to invest in urban ecological restoration – for a sustainable and biodiverse future of our cities.

00128

# New insights into wasteland ecosystems of the glass industry

Oral

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## Abstract

Over the past two centuries, large amounts of waste have been released into ecosystems from glass manufacturing operations. Nowadays, an increasing number of abandoned slag heaps results from the cessation of these activities and may be contaminated with metallic trace elements (MTE) formerly used in glass and crystal products. However, recent findings emphasized that derelict lands should also be recognized as a resource delivering a wide range of ecosystem services. Therefore, the major purpose of this research was to provide new insights into wasteland ecosystems of the glass industry; while assessing the relative influence of edaphic factors on biotic communities, which is still poorly understood although closely related to the potential re-use of these sites. To that end, we investigated (i) Orthoptera, diurnal Lepidoptera, plant communities, and (ii) abiotic parameters in the topsoils.

Multivariate analysis revealed strong correlations between potentially phytoavailable and pseudo-total lead (Pb), cadmium (Cd) and zinc (Zn). Arsenic (As) also co-varied significantly with DTPA-extractable Pb. Despite the severe Pb contamination reported in the topsoils, wastelands of the glass industry were able to support a substantially higher than expected biodiversity with orthopteran assemblages similar to grasslands and a diurnal Lepidoptera diversity comparable to urban parks. We also noted a positive influence of plant richness on the diurnal Lepidoptera community structure. Hence, Pb contamination does not appear to be a primary limiting factor for the establishment of these communities regarding the low mobility of Pb due to the high amount of organic matter recorded in the topsoils under subalkaline conditions. We assumed that wasteland ecosystems of the glass industry were more affected by soil fertility or land management practices. To conclude, these sites are able to provide biodiversity ecosystem services, acting as wildlife sanctuaries for Orthoptera and diurnal Lepidoptera, and strategic metals by phytoextraction in a circular economy model.

00136

## Urbanisation as a neutral filter or urban areas as a habitat? A test at the continental scale focused on bird communities.

Oral

A. Monchy<sup>1</sup>, V. Cazalis<sup>2</sup>, A.S.L. Rodrigues<sup>1</sup>

<sup>1</sup>Cefe - Montpellier (France), <sup>2</sup>Sdiv - Leipzig (Germany)

### Abstract

Anthropic activities are modifying ecosystems worldwide. Urbanization is one of the most dramatic forms of ecosystem transformation, associated with major changes in the physical environment and thus potentially highly modified animal communities. Two mechanisms can take place in the assemblage of urban communities. On one hand, the urban environment may act as a neutral filter that selects a subset of species out of the local surrounding community. On another hand, the urban environment may behave more like a proper habitat in itself, offering common living conditions across different biomes. In the first case, the composition of urban communities should be highly influenced by that of the surrounding areas, whereas in the second it should be composed of properly urban species, independently of the regional pool of species.

Here we have investigated the relative effects of these two mechanisms, using eBird data to contrast the composition of urban versus non-urban bird communities in nearly 70 ecoregions across the American continent.

We found that across ecoregions, species richness is nearly always lower in urban than in non-urban communities (average 73%, range 39-116%). The large majority of urban species (average 75%, range 49-93%) are common to non-urban communities, and the species richness of urban communities varies positively ( $R^2 = 0.43$ ) with that of the non-urban communities. Furthermore, when pairs of ecoregions are contrasted, the dissimilarity in the composition of their urban communities follows very closely the dissimilarity between the respective non-urban communities (slope = 0.96; even if there is ample variation,  $R^2 = 0.57$ ). These results indicate that within each ecoregion, the urban community is highly determined by (and mainly a subset of) the non-urban community, pointing to the neutral filter mechanism.

Nonetheless, we also found that in all ecoregions a non-negligible fraction of the urban species (average 25%; range 7-51%) are not found in non-urban communities, pointing to the urban environment being a habitat in its own right. This continental perspective sheds light on the mechanisms underpinning the assemblage of urban communities, to better anticipate future biodiversity changes in the context of growing urbanization.

00149

## ECOPOLIS project: The transformation of a contaminated industrial wasteland into a living-lab based on a phytomanagement approach

Oral

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Abstract

The main goal of the ECOPOLIS project is the restoration by phytomanagement of the industrial wasteland of Vieux-Charmont (Doubs, France), located in an urban area and contaminated by metallic trace elements (MTE) and hydrocarbons. With the collaboration of different public and private partners, a living-lab will be implemented on the area for research activities and communication with the public. This implementation is based on three specific objectives, (1) to characterize spatially and quantitatively the contamination, mobility and health and environmental impacts due to contaminants on the site. This will be done by monitoring biodiversity on the site and measuring contaminants transfers into ground and surface water, vegetation and animals, (2) To test different management scenarios for the contaminants based on phytoremediation methods in accordance with the principles of the National Methodology for the Management of Polluted Sites and Soils and its associated standard (NF X31-620) and, (3) To assess the potential reproducibility of the methods on similar industrial wasteland through the territory.

The presentation will first highlight the overall project and living-lab implementation based on a short (3 min) video. The second part of the presentation will focus on the data sets obtained within the period 2021-2022. The first set of data showed that 3 MTE are dominant on the site, Zn, Pb and Cd, that have been shown to have potential toxic effect on human health, based on the exposure scenarios and bioaccessibility tests. A botanical survey led to the identification of some native plants that can accumulate Zn (> 2000 mg/kg DW) and Cd (> 15 mg/kg DW) in aerial parts. Some of these plants are further being studied for their phytoextraction potential, with the final aim to develop tools to reduce the available contents of these elements in the soil and their toxicity.



**00153**

## **Living in the city: responses of cavity-nesting bees and wasps and their natural enemies across European cities**

Oral

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### Abstract

Here, we present the first study focused on cavity-nesting bees and wasps and their natural enemies, set along 5 European cities (Antwerp, Paris, Poznan, Tartu and Zürich) that differ in terms of size and density and summarise the spectrum of European cities. Specifically, we have studied CNBW and their natural enemies in focal patches located along urbanization gradients with variable amount of available habitat. We aimed to (1) measure the amount of available habitat in terms of quantity, quality, diversity and connectivity using a set of proxies and metrics; (2) study the effects of the amount of available on CNBW and their natural enemies from the individual to the community level; and (3) contrast the patterns found across the 5 European cities. We have been sampled our taxa using trap-nests in 80 sites (32 in Zürich and 12 in each of the remaining cities), distributed in each city according to a gradient of patch size and isolation. Analytically, we have used a combination of individual to community responses (including species richness, trait metrics, mortality rate, sex ratios) together with food web metrics. Furthermore, we characterised the amount of available habitat by combining field data on resources together with remote sensing tools and landscape metrics. The results of this study should lead to a better understanding of the ecology of urban environments applicable to improve city design and planning.

00311

## The BISES project: Toward a better understanding of urban soil biodiversity

Oral

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Abstract

In order to remediate the negative impacts of urbanisation, development policies are moving towards sustainable and productive cities based on the development of nature in the city. To achieve this, a leap in the knowledge of urban socio-ecosystem ecology is essential and critical.

The BISES project (Biodiversity of urban soils and sustainable cities: state of the art, interactions between productive and non-productive systems and importance for the provision of ecosystem services) aims to understand the ecology of urban soil communities. This biodiversity remains poorly known despite its main role in the provision of ecosystem services essential to our societies. The project uses two complementary methodological fields based on academic collaborative and participative research.

For the academic collaborative part, our aim is to compare soil organisms between productive (allotments, urban farms) and non-productive (parks, roadside linear and roundabouts) vegetated areas and their indirect flows using spatially explicit methods. We selected ca. 200 sites located in 4 different French cities located under contrasted climates (Montpellier, Nantes, Nancy and Paris) based on their use and location along the urbanisation gradient. First results on nematods and earthworms showed a contrasted response to urbanisation features.

For the participative science component, we developed a new citizen science programme entitled QUBS ([www.qubs.fr](http://www.qubs.fr)). QUBS seeks to encourage curious city dwellers to set up, in their garden or those of the community, simple and rigorous protocols to monitor macro-biodiversity (i.e. earthworms, ants, spiders) and organic matter decomposition.

This four and a half-year project (January 2020 - July 2024) is fully funded by the French ANR and brings together 9 scientific partners (à citer) and an association (Plante & Cité). In addition to major advances in terms of fundamental research, the project will make it possible to validate a dashboard of indicators of the ecological quality of urban soils, enabling sustainable management of city soils.

00168

## Punching above their weight, the role of small green spaces for biodiversity in cities

Oral

K.A. Vega <sup>1,2</sup>, A. Taucher <sup>1,3</sup>, J. Six <sup>1,2</sup>, C. Kueffer <sup>1,4</sup>

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### Abstract

Cities are dynamic living ecosystems in which human actions directly intertwine with natural processes—mutating, promoting or impeding them. The plants that occur within cities often seem to exist only at our will: we plant and sow, mow and trim the greenery of our urban spaces. However, in reality many species are succeeding in making urban green spaces their own. For these species, seed dispersal, pollination, colonization, and competition are still major drivers of diversity, evolution, and biogeography in cities. We believe that with the right design, species selection, and promotion, we can work with rather than against these ‘wild’ natural processes to help make cities sites of biodiversity conservation. Our work explores this interplay between human action and biologically driven patterns in urban wildflowers and pollinators in Zurich. We conducted a vegetation survey across 7km<sup>2</sup> of the city, identifying both sown and spontaneous wildflower species in public green spaces. We identified the ecological patterns associated with isolation and patch size in determining the biodiversity of even tiny green “islands” spread throughout a sea of concrete. We identified the major role small green spaces play in increasing urban beta-diversity, the minimum-benefit distances between small green spaces, and those whose ability to self-disperse make them ideal candidates for further promotion. While cities represent a system in constant flux due to rapid human actions, they also present an opportunity to directly engage with and influence the system’s key shapers and drivers. Working with a local citizen science network, we have run two projects: 1) Wo Samen fallen which highlighted the self-dispersing flower species which emerge in our gardens/balconies of their own volition, and 2) B3 Bienen Bienen, Baumscheiben und Bestäubung which revealed the importance of the distribution of small green spaces for supporting wild pollinators. In doing so, we brought volunteers into dialogue about wildflowers in cities, their pollination, the role of design in ecological connectivity, and the perception of wilderness in a city.

# Ecology, functioning and evolution of urban and anthropized systems (2/2) - Verlaine B 23/11 ; 10:00-11:45

**00647**

## **Beltway for biodiversity – bats and birds along the Ringgleis in Braunschweig, Germany**

Oral

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Abstract

Maintaining and facilitating wildlife within cities is the goal of many local, national and transnational biodiversity strategies. Building on island biogeography, most conservation efforts focus on habitat islands within the urban matrix, for example, large remnants forests, large parks and novel urban nature like industrial brownfields. The urban matrix is less often the focus of conservation efforts, because ownership and management is dispersed and small-scale. Nevertheless, the urban matrix represents a large proportion of the city and can provide nesting and foraging resources and function as connector for wildlife. Here we present data from bird and bat surveys from the so-called “Ringgleis” in Braunschweig, Germany. The “Ringgleis” is a decommissioned railway line that has been transformed into a bike-path. It encircles the city and while it is adjacent to some large greenspace patches, it mainly cuts through the urban matrix. We discuss similarities and differences in biodiversity patterns along 13 km of the “Ringgleis” between the two species groups and outline how the urban matrix around the “Ringgleis” could be preserved and improved for facilitating the two species groups.

**00348**

# **The effect of design features on biodiversity in urban squares**

Oral

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## Abstract

Cities can harbour high biodiversity and offer important habitats for a variety of wildlife taxa. Consequently, research increasingly emphasizes the importance of cities for conservation. However, most urban biodiversity studies focus on green spaces (e.g., parks, gardens, remnant forest fragments, etc.). While maintaining and increasing urban green space is generally agreed to improve biodiversity, it remains unclear which features shape urban biodiversity and species composition in the built-up areas of cities. Here we analyse features driving urban biodiversity and species composition in public urban squares in the city of Munich, Germany, to investigate which properties of these urban spaces, including their grey and green infrastructures and human activity, have the strongest effects on the abundance, activity, or diversity of a range of urban wildlife taxa (pollinators, mosses, arthropods, birds, bats, vegetation, and small mammals). We selected 103 squares as a representative sample of all squares in Munich, which span gradients in size, distance to the city centre, and greenness on and surrounding the squares. Using linear models, we found that diversity, abundance, and activity of all groups increase (except for bats and small mammal pests) with the proportion of green on a square. Using random forests, we determined which features were most important for each taxonomic group. We found variation in the importance of features for each group. For example, the richness and abundance of flowers on a square were most important for pollinators; for arthropods, the proportion of grass coverage was the most important. Birds showed a dependence on several features, with richness depending greatly on the tree density, tree richness and the volume of shrubs on a square. Thus, we show that while the amount of green on a square is important, the features that make up the greenness greatly influence the diversity, abundance, and activities of different taxonomic groups. As urbanization continues to increase and remnant green spaces experience higher pressures, the protection of biodiversity in human-centred spaces becomes more important. We recommend when designing new urban public spaces that planning considers different facets of green to support the demands of different taxa, enabling coexistence and increasing urban biodiversity.

00363

## Multivariate effects of urbanisation on an anthropophilic land snail, *Cornu aspersum*

Oral

M. Dahirel <sup>1</sup>, K. De Wolf <sup>1</sup>, Y. De Tombeur <sup>2</sup>, A. Ansart <sup>2</sup>, C. Gérard <sup>2</sup>, D. Bonte <sup>1</sup>

<sup>1</sup>Ghent University - Gent (Belgium), <sup>2</sup>Université Rennes 1 - Rennes (France)

### Abstract

Urbanisation is an all-encompassing human-induced land use change, combining habitat fragmentation, pollution, temperature changes... in a cocktail of environmental pressures never experienced before in organisms' evolutionary histories. To fully understand how some species manage to survive and sometimes thrive in such a context, it is important to go beyond single trait approaches and study how organisms are affected by urbanisation across multiple trait dimensions, including morphology, behaviour, fecundity, metabolism... We studied the effects of urbanisation on the brown garden snail *Cornu aspersum*, a very common species that can be found both outside and deep inside cities. We will present phenotypic data from two experiments, using field-collected snails sampled in Belgium (Flanders and Brussels regions) and France (city of Rennes), respectively. Preliminary results show that urban and non-urban snails differ in a variety of phenotypic traits, with some level of congruence between the two study sites separated by 500 km. For instance, snails are consistently smaller in cities in both sites, which may be linked to lower resource availability, or the interplay of the Urban Heat Island and the temperature-size rule. By contrast, urban snails do not seem to have adjusted their movement speed, which may contribute to dispersal costs given the higher fragmentation in cities. Our results confirm that urbanisation can impose consistent constraints across regions, and that even seeming "winners" of urbanisation can be negatively affected by it. We will also discuss the possible implications of urbanisation for parasite transmission, whether between snails, between snails and their predators, or to a lesser extent to humans and pets. We will conclude by highlighting ongoing and future studies aiming to disentangle the contributions of plasticity and evolution to snails' phenotypic responses to city life.

00384

## Quantitative assessment of nutrient inputs from angling baits in small lake fisheries

Oral

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### Abstract

The importance of trophic subsidies for consumers and recipient ecosystems has been widely demonstrated and human activities have been reported to disrupt these natural subsidies through habitat alteration and biological invasions. Interestingly, human activities (e.g. agriculture, industry, domestic activities) can also represent a novel form of subsidies to freshwater ecosystems. Recreational fishing, through groundbaiting, provides potentially important artificial subsidies to freshwater ecosystems, but its ecological importance is still underappreciated. The aim of our study was to evaluate the quantity and temporal dynamic of nutrient entrance through groundbaiting in different lake fisheries. We first quantified the C:N:P composition of the four principal angling baits, namely seeds, groundbaits, boilies and pellets. Second, we interviewed 110 anglers for three fishery types to determine the type of bait used and the quantity released in recipient ecosystems. Third, a two-year survey of angling activity was conducted in 11 small lake fisheries to determine the number of anglers and its seasonal variability. We first found that the elemental composition strongly varied between angling bait types with N content varying by a factor of three and P content varying by a factor of five. In comparison with natural subsidies, most P-enriched baits were more than ten times P-richer than tree leaves, the most common natural subsidies in small lakes. Using results from anglers' interviews and angling activity survey, we found that angling bait inputs strongly differ quantitatively, qualitatively and temporally between fisheries. The yearly amount of phosphorus from angling activities entering each lake fishery with groundbaiting averaged 1.5 kg/ha and varies from 0.5 to 3.5 kg/ha for the most fished lake, exceeding by far the phosphorous inputs from natural subsidies. Altogether, these findings demonstrated that angling baits is an important, variable but poorly known trophic subsidies in some lakes with potential implications on ecosystem functioning that remains to be quantified.

00481

## The secret life of social wasps in urban community gardens

Oral

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<sup>1</sup>Technical University Of Munich - Freising (Germany), <sup>2</sup>Museum for Natural History - Berlin (Germany)

### Abstract

Wasps and hornets hunt other arthropods to feed their larvae with protein, and also visit flowers for nectar, thereby collecting pollen. Thus, they make an important contribution to the control of agricultural pests, and also as pollinators of a diverse set of agricultural plants. In small-scale agriculture, such as urban gardening, it is likely that wasps and hornets also make a significant contribution to pest control and pollination, and their presence has a beneficial effect on gardeners' yields. Yet, compared to pollinating insects such as honey bees and wild bees, or natural predators like ladybugs, native social wasps have hardly been the subject of scientific research and are often disregarded by urban gardeners for their role in the various ecosystem services that they can provide. In this study, we use social wasps as a model organism to investigate perceptions of relatively 'uncharismatic' wildlife and associated ecosystem services, as well as social drivers around the acceptance of wildlife in gardens. We asked: (1) what perceptions, attitudes and emotions are associated with social wasps and their ecosystem services in urban gardens? (2) How do these perceptions, attitudes and emotions compare to other insect groups? We surveyed urban gardeners in 30 community gardens in Berlin and Munich, Germany. We found that gardeners often associated negative attitudes and emotions e.g., fear, anger and disgust with wasps. Furthermore, people were less likely to share their garden spaces with or create new habitat for social wasps compared to other insects. Here we argue that these animals also deserve space in our urban landscapes and should be considered as components of healthy functioning ecosystems. Overcoming fear and anxiety to make room for such less charismatic wildlife, to share our gardens and urban green spaces with them, is key to maintain and support ecosystem services across urban landscapes.



**00572**

## **Field evaluation of the cotton-strip assay for quantifying organic matter decomposition rates on extensive green roofs**

Oral

D. Techer <sup>1</sup>, D. Aran <sup>2</sup>, M. De Silva <sup>2</sup>, R. Claverie <sup>1</sup>, M. Erbrech <sup>3</sup>, C. Bojic <sup>2</sup>, V. Goncalves <sup>2</sup>, F. Maunoury-Danger <sup>2</sup>

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Abstract

Green roofs are increasingly popular “nature-based solutions” which may help mitigating stormwater runoff and urban heat island phenomenon in a global change context. Shallow substrate depths (below 150 mm) characterize extensive green roofs that are especially designed to be low weight and maintenance infrastructures. Moreover, they are usually less expensive than intensive green roofs that are thicker. Thus, they may offer unique opportunities to expand the greening of cities meanwhile providing numerous other ecological and social co-benefits. However, green roof multifunctionality and potentialities to maintain several ecosystem services strongly depend on their technical components including substrate physicochemical characteristics, as well as on their ecological functioning to support healthy vegetation communities. Within this context, the organic matter decomposition rate, which directly influences the local nutrient recycling appears as a key ecological process for achieving long-term sustainability of these “man-made urban ecosystems”, with no additional maintenance requirement (e.g. fertilizer application, plant replacement). Nevertheless, to our knowledge, there is no published work to date that attempted to assess this crucial ecosystem function on these green infrastructures. Therefore, the primary aim of this study was to evaluate the convenience and sensitivity of a cheap and easy-to-use standardized method, the cotton-strip assay, to compare the organic matter decomposition rate on green roofs from various construction design. For this purpose, nine green roof plots were selected, contrasting in their initial specifications in terms of substrate composition, presence/absence of a water storage layer or vegetation palette. Three metrics (tensile strength loss, mass and surface) were compared for the assessment of cotton-strip decomposition rates following 34, 91 and 110 days of burying into substrates. Data also included those obtained from arable land and a gravel roof (serving as “positive” and “negative” control groups respectively). Results allowed validating the cotton-strip assay for green roof infrastructures while providing first insights into the influence of substrate composition on both water content and organic matter decomposition. Similarly to “natural soils”, decreased C:N favoured decomposition. Finally, broader green roof monitoring regarding organic matter decomposition rate could help to better understand their ecological functioning, potentially leading to improved media formulation for enhanced ecosystem multifunctionality.

**00633**

## **Reduced grassland multifunctionality as a result of lower precipitation due to climate change – a mesocosm experiment in climate chambers**

Oral

L.H. Teixeira <sup>1</sup>, S. Rojas-Botero <sup>1</sup>, J. Kollmann <sup>1</sup>

<sup>1</sup>Chair of Restoration Ecology, School of Life Sciences, Technical University of Munich - Freising (Germany)

### Abstract

Urban grasslands are key to support biodiversity and ecosystem services in cities, whereas little is known about their multifunctionality in response to climate change. Thus, we investigated the effects of simulated climate change, i.e. increased [CO<sub>2</sub>] and temperature, and reduced precipitation, on individual functions and overall multifunctionality of experimental grasslands sown with forbs and grasses in four different proportions. Climate change scenarios RCP 2.6 (control) and RCP 8.5 (worst-case) were simulated in walk-in climate chambers (ca. 7.7 m<sup>2</sup>), and watering was manipulated to test normal vs. reduced precipitation. We measured eight functions based on the characteristics of soil and plant communities. Higher [CO<sub>2</sub>] and temperature conditions resulted in increased vegetation cover, height and flower production of the experimental grasslands. Lower precipitation impacted carbon cycling by reducing biomass production and soil respiration. In turn, only precipitation affected water regulation in the experimental grasslands. Multifunctionality was affected by the three components of climate change manipulated as well as by the proportion of functional groups present in the communities. While increased temperature and [CO<sub>2</sub>] resulted in differential effects on grassland functioning, reduced precipitation showed consistent negative effects. We observed trade-offs among grassland functions performing better depending on the proportion of grasses and forbs composing each community. Grasslands with an even ratio of plant functional types were less affected by climate change. Hence, this can be a good option to support the functioning of urban grasslands. Here, we provide experimental evidence that ecological knowledge should be applied for the design of urban grasslands in order to foster climate change adaptation and the delivery of the benefits expected from such systems.

# Ecotoxicology and environmental pollution (1/2) - Verlaine B 22/11 ; 10:15-12:15

**00001**

## **Sublethal exposure to pollutants affects maternal care in an insect with facultative family life**

Oral

J. Meunier <sup>1</sup>, C. Lecureuil <sup>1</sup>

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### Abstract

The extensive use of chemical pollutants in agriculture and industry generally leads to lethal and sublethal exposure of target and non-target organisms in fields and their surroundings. While our current understanding of these sublethal effects generally focuses on reproductive and physiological parameters, recent work highlights that sublethal effects on behaviours such as maternal care may be of major importance in the maintenance and population dynamics of a large number of non-target species. Maternal care is indeed present in many insect species, it is the backbone of key insect societies such as in bees, and alterations in maternal care are generally detrimental to the development, survival, and reproductive success of the offspring. Nevertheless, the impacts of sublethal exposure to chemical pollutants on maternal care remain poorly explored in insects. In this talk, we will present the results of a series of experiments investigating whether and how exposure to sublethal doses of pesticides and heavy metals affects maternal care and reproduction in the European earwig, a subsocial insect in which mothers provide extensive forms of care to their eggs and juveniles. Our results first show that sublethal exposure to some pesticides - but not heavy metals - after egg production reduces the expression of maternal care towards the eggs, but that this alteration does not affect egg development and hatching success. In contrast, such exposure after egg hatching had only limited effects on maternal care of juveniles and, somewhat surprisingly, increased female investment in future reproduction. Overall, these results provide important information for our general understanding of the diversity of sublethal effects that can occur in insects and allow us to ask whether anthropogenic perturbations can alter the evolutionary trajectories of sociality in insects. They also highlight potential new markers of fitness reduction associated with pesticide exposure and open up new avenues of research to enable the safe and effective use of these compounds in crops and orchards.

00053

## Meta-transcriptomics reveals stress adaptation processes in microbial communities differing in exposure history

Oral

F. Larras <sup>1</sup>, E. Billoir <sup>2</sup>, S. Lips <sup>3</sup>, S. Schreiber <sup>3</sup>, P. Veber <sup>4</sup>, M.L. Delignette-Muller <sup>4</sup>, M. Schmitt-Jansen <sup>3</sup>

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Abstract

In a changing environment, communities have to adapt continuously to survive. When microbial communities are chronically exposed to stress, adaptive mechanisms render them more tolerant. Yet a mechanistic understanding of differential adaptation processes to stress at a molecular level is lacking. Transcriptomics is a relevant methodology to tackle this challenge because it provides comprehensive functional information at molecular level. However, it was rarely applied for discriminating adaptive processes in communities differing in their exposure history and leading to community tolerance acquisition.

Our study contributed to understanding acute stress responses of microbial communities differing in chronic pre-exposure to the photosynthesis inhibitor diuron, combining untargeted meta-transcriptomics (RNA-seq) and dose-response design. Freshwater microbial communities were incubated for 5-weeks in microcosms 1/ under constant exposure to 4µg/L diuron (stressed community) or 2/ without contamination (non-stressed community). Afterwards, both communities were exposed for 1 hour to a diuron concentration gradient to investigate differences in stress responses after chronic exposure. The meta-transcriptome analysis was handled by the DRomics R package, which provides a workflow dedicated to omics data obtained using a typical dose-response design, favoring a great number of tested doses (or concentrations) rather than a great number of replicates (no need of three replicates). This experimental design and the DRomics workflow enabled the determination of response trends as well as sensitivity thresholds for thousands of contigs and an accurate selection of responsive contigs within a dataset of more than three million contigs. Among the numerous responsive cellular processes, clear differences in gene expression and sensitivity were especially observed between both communities for photosynthesis-related processes. However, processes related to the carbon metabolism like fatty acid, lipid or glycolytic processes displayed impairment in both cases. In conclusion, meta-transcriptomics applied in a dose-response design provided key mechanistic insights for the understanding of adaptive processes and tolerance acquisition on environmental communities.

**00094**

## **Indirect effects of stream pollution on riparian food webs: activity and hunting behaviour of terrestrial insectivores**

Oral

M. Huszarik <sup>1</sup>, A.P. Roodt <sup>1</sup>, T. Wernicke <sup>1</sup>, A. Metz <sup>1</sup>, G. Osayi <sup>1</sup>, E. Lima-Fernandes <sup>1</sup>, M. Link <sup>1</sup>, R. Schulz <sup>1, 2</sup>, M.H. Entling <sup>1</sup>

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### Abstract

Flying insects emerging from streams are an important source of high-quality prey to terrestrial insectivores, including bats, ground beetles, and spiders. However, stressors such as chemical pollution from agricultural and wastewater inputs can negatively affect emergent aquatic insects in streams and alter the magnitude and composition of emergence. This can lead to indirect effects on terrestrial predators which depend on emergent insects as prey. However, such effects of stream pollution have yet to be thoroughly investigated. Thus, we conducted a 13-week field study at 16 forested streams in Rhineland-Palatinate, Germany, to evaluate how chemical pollution impacts riparian bats, spiders, and ground beetles. We measured insect emergence, nutrient concentrations, wastewater and pesticide pollution, and predator distribution and activity around streams. We also used DNA metabarcoding to compare the diet of spiders at different sites. We expected that higher pesticide toxicity and wastewater pollution in streams would be associated with lower insect emergence, and consequently, decreased predator presence, as well as a dietary shift toward terrestrial insects. Preliminary results show that the presence of bats, spiders, and ground beetles was concentrated around streams, highlighting the importance of this riparian ecosystem. While we did not observe an overall reduction in insect emergence associated with pollution, there was a change in emergence composition, with higher Diptera emergence at more polluted sites. In contrast to expectations, the activity of riparian bat species was also higher at more polluted streams. This alteration in emergence could be related to higher nutrient levels of polluted streams, which could increase overall biomass productivity within the range of streams studied. The analysis of bat hunting behaviour and spider diet is still underway, but is expected to more concretely describe the effects of stressors and altered emergence on riparian insectivores.

00116

## DRomics, a workflow to model and make sense of dose-response (multi-)omics data

Oral

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Abstract

DRomics is an R package we developed (Larras et al., 2018) to enable dose-response modeling from omics data. If dose-response modeling is now a classical approach in ecological risk assessment on apical endpoints, it is less classically used on omics data. Many tools were developed during the last decades to properly analyze omics data, taking into account both the specific nature of each data (e.g. counts data for RNAseq) and the large size of datasets. But those tools are usually dedicated for differential analysis, and their use on data collected through a dose-response design is far from being straightforward. Our aim by developing DRomics was to provide an efficient way to analyze omics data from dose-response designs and even in situ data (on which the exposure gradient is uncontrolled) for a risk assessment purpose.

The DRomics workflow selects items (e.g. contigs, metabolites) that significantly respond to the dose/concentration gradient, and for each of them characterizes its response using parametric modeling and estimates a sensitivity threshold as a benchmark dose (BMD). Recently we added in the package different functions to help interpreting the outputs of this workflow, in the light of their biological annotation obtained from databases such as KEGG or Gene Ontology (GO). Those functions were especially designed to help the comparison of dose-responses of the selected pathways obtained at different experimental levels: different measurement levels (e.g. multi-omics), different developmental stages of organisms, different exposure histories (e.g. PICT experiments – Pollution-Induced Community Tolerance), etc.

We propose to give an overall view of the methodological choices we made in DRomics to rationalize and optimize a strategy to analyze dose-response omics data and to illustrate the use of the new DRomics functions on different case studies. We will also present our further development perspectives and discuss the challenges and open questions we face while working on such problematics.

Larras F, Billoir E, Baillard V, Siberchicot A, Scholz S, Wubet T, Tarkka M, Schmitt-Jansen M and Delignette-Muller ML (2018). DRomics: a turnkey tool to support the use of the dose-response framework for omics data in ecological risk assessment. *Environmental Science & Technology*. <https://pubs.acs.org/doi/10.1021/acs.est.8b04752>.

00118

## MULTIPAT project: Effects of metal contaminants on fish-pathogen interactions and blood as a biomonitoring tool

Oral

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Abstract

Environmental pollution is one of the major anthropogenic changes affecting ecosystems as they potentially threaten the health of living organisms. In particular, metal contaminants from past mining activities are persistent (millennial-scale) in soil, biofilm and sediment, and can also accumulate in food chains with potential adverse effects on wildlife health even centuries after the cessation of mining activities. However, their effects on biotic interactions and parasitism are still relatively unexplored. Disease dynamics in wildlife is influenced by the environment, host and pathogen characteristics and there is thus a need to consider the impact of environmental contamination to better predict disease dynamics in wild populations. In riverine ecosystems, the use of fish as a monitoring tool of metal contamination is well established, but existing studies often focus on internal tissues such as liver and/or muscle tissues that require the sacrifice of organisms. Thus, the first objective of this project was to develop a reliable and non-lethal method for monitoring metal contamination in fish and other aquatic organisms. We explored blood as a potential non-lethal method to measure trace metal concentrations in brown trout (*Salmo trutta*). Results show that fish blood appear to be a promising and reliable tool that could reduce the impact of biomonitoring efforts on freshwater fish populations. Subsequently, the second objective is to assess the adverse effects of metal contamination on trout health and their resistance and tolerance to an emerging disease, *Tetracapsuloides bryosalmonae*, responsible for the deadly Proliferative Kidney Disease in e.g., the Pyrenees. Indeed, metal contamination could potentially impact fish health through direct effects on pathogens and/or through immunotoxic effects on fish physiology, thus altering pathogen infection. In an OneHealth perspective, it is crucial to consider the impacts of metal contaminants on host-pathogen interactions to better understand disease dynamics and anticipate contamination effects on wildlife health.

00261

## Current-use organic pesticides in freshwater ecosystems: effects propagating to terrestrial predators of emerging aquatic insects

Oral

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### Abstract

Contamination of freshwater ecosystems with pesticides can potentially impact adjacent terrestrial food webs by changing the availability of emerging aquatic insect subsidies or by direct dietary exposure of terrestrial predators to pesticides accumulated by these insects. Currently, there is a lack of information on the relevance of pesticide- and organism-specific parameters, such as pesticide class and sex-specific life history of emerging insects, as well as the extent of dietary exposure of terrestrial predators for many current-use pesticides. We performed microcosm experiments in which emerging insects were exposed to sublethal concentrations of single insecticides or a mixture of fungicides and herbicides during their aquatic development phase. We measured effects on larval development time, emergence success and emergent biomass as well as pesticide concentrations in the aquatic and terrestrial life stages. Furthermore, we sampled riparian spiders, their prey and the adjacent aquatic ecosystems from river sites along a gradient of agricultural land use to assess the trophic transport for many current-use pesticides. At the microcosm scale, exposure to insecticides negatively impacted insect development duration and emergence success. Exposure to a mixture of fungicides and herbicides resulted in the majority of pesticides being retained after emergence. Furthermore, we observed sex-specific differences for larval development duration and pesticide concentrations in the adult emerging insects over the full terrestrial life stage. Additionally, a broad range of current-use pesticides were found in riparian spiders. Exposure to current-use pesticides during aquatic insect development can therefore result in potential negative effects for terrestrial consumers.



00262

## Sex-specific responses to aquatic micropollutants affect the fatty acid transport via hemi- and holometabolous aquatic insects

Oral

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<sup>1</sup>ies Landau - Landau (Germany)

Abstract

Emergent aquatic insects serve as subsidy for many terrestrial consumers, providing physiologically vital nutrients such as long-chain polyunsaturated fatty acids (LC-PUFA). Aquatic micropollutants may affect the transport of these nutrients by interfering with the insect fatty acid (FA) metabolism or by impairing insect development and emergence. We examined effects of different aquatic micropollutants, including organic pesticides, metals and a biocontrol agent, on the emergence and the FA profile of adults of the holometabolous midge *Chironomus riparius* and the hemimetabolous mayfly *Cloeon dipterum*. All micropollutants reduced emergence, with declines being as high as ~95% in Cd-exposed *C. riparius*. We also found evidence that micropollutant exposure can directly affect the FA profile of emergent adults. Interestingly, effects may vary based on the micropollutant at hand and can even be positive as observed for Cd with increases in saturated fatty acids (SAFA) and omega-3 PUFA by ~35% in females and ~55% in males of *C. riparius*, respectively. Due to their negative effects on emergence, micropollutant exposure generally resulted in a (severe) reduction of FA transport. In addition, we found sex-specific differences in the FA profiles of adult insects. Females have a higher total FA content and are predominately associated with SAFA, while males are predominately associated with PUFA. Sex-specific differences in the sensitivity towards micropollutants may thus cause meaningful shifts in the FA transfer to terrestrial systems. Given the increasing occurrence of micropollutants in freshwaters, the decline in the transport of high quality LC-PUFA observed at laboratory scale can likely be extrapolated to larger scales with unknown consequences for the consumer fitness and ecosystem trophic cascades. To facilitate this mechanistic understanding, we are currently analysing spider samples of the genus *Tetragnatha*, which were fed with emerged aquatic insects previously cultured in the presence or absence of micropollutants.

## Ecotoxicology and environmental pollution (2/2) - Verlaine B 22/11 ; 13:45-15:45

00366

### Toxicokinetic modelling to understand the influence of exposure pathways on the distribution, toxicokinetic and fate of cadmium in the organs of *Gammarus fossarum*

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.

Toxicokinetic modelling

Oral

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Abstract

Most of the studies on metal bioaccumulation in freshwater crustaceans are focused on waterborne contamination. This work aims to improve the knowledge of metal bioaccumulation processes in the sentinel species *Gammarus fossarum* by considering separately two pathways of accumulation: dissolved and trophic. We assessed the organotropism, toxicokinetic (TK) and fate of cadmium (Cd) after exposure by either pathway. To implement a multi-compartment TK model with the trophic route data, accumulation efficiency (AE) was first estimated. For this, gammarids (n=12) were fed for 1h with alder (*Alnus glutinosa*) leaf discs previously radiolabeled with <sup>109</sup>Cd, to reach a concentration of 5.2 µg Cd.g leaves<sup>-1</sup>. Radioactivity was then monitored in each individual for a period of 14 days to assess Cd AE and retention time (biological half-life). In a second phase, gammarids were exposed to <sup>109</sup>Cd-contaminated leaf (0.59 µg Cd.g leaves<sup>-1</sup>) discs for 6 days: this accumulation phase was followed by an 11-day depuration phase during which the gammarids were fed with uncontaminated leaves. The ingestion rate (IR) during the accumulation phase was measured. At different times (days: 2, 4, 6, 8, 11, 14, 18) during the two phases, 20 gammarids were dissected and separated into four pools (n = 5) to measure radioactivity in five target organs (caeca, cephalon, gills, intestine, and remaining tissues). Considering AE and IR data, a multi-compartments TK model was developed, associated with an iterative inference process where sub-models were fitted to all data simultaneously, to describe the internal dynamics of accumulated Cd. In fine, the most parsimonious multi-compartments TK model was selected, allowing to describe metal exchanges between the different organs and thus leading to a realistic view of the physiological regulation of metals. These results were compared to previous ones obtained through dissolved Cd exposure, at an environmentally relevant concentration (i.e. 52 ng.L<sup>-1</sup>). This work highlights that Cd organotropism and management by organs depend on the exposure pathway. By dissolved pathway, accumulation occurs through both intestine and gills, while elimination occurs exclusively through intestine. By trophic pathway, only two organs seem to play an important role in Cd management: intestine and caeca.

00407

## Regime shifts in shallow aquatic systems caused by agricultural run-off and warming – Insights from micro- and mesocosms experiments

Oral

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Abstract

Shallow aquatic systems are highly abundant in productive lowland regions with intensive agriculture. Because of their high surface-to-volume ratio, they are prone to multiple stressors such as climate warming and agricultural run-off. Shallow aquatic systems typically occur in two alternative stable states, the desirable macrophyte-dominated state with clear water and a high biodiversity, or the degraded state with phytoplankton or blanketing algae dominance and loss of many ecosystem functions. While eutrophication and climate warming are known driving factors for regime shifts from the macrophyte- to the phytoplankton-dominated state, the role of pollutants such as pesticides and their combined effects with nutrients and warming are unknown. In the French-German project CLIMSHIFT, we investigated in different micro- and mesocosms experiments the role of agricultural run-off (ARO) composed of nitrate and a pesticide mixture (each one organic herbicide, insecticide and fungicide plus copper as ingredient of inorganic fungicides). The micro- and mesocosms contained pelagic and benthic organisms to reflect the tight benthic-pelagic coupling found in these systems. Some experiments were based only on primary producers (submerged macrophytes, phytoplankton and periphyton), while others contained also primary consumers (*Daphnia magna* or natural zooplankton, *Lymnaea stagnalis* and *Dreissena polymorpha*). We applied different exposure scenarios (dose-response, single-versus-pulsed, water or sediment exposures) and tested the full ARO or components of it. ARO always negatively affected the systems, through effects on competitive or trophic interactions, leading to shifts to phytoplankton, periphyton or blanketing algae development at the detriment of submerged macrophytes. Nitrate acted synergistically with pesticides (organic pesticides plus copper) by enhancing negative effects on submerged macrophytes. Warming enhanced macrophyte growth, but in combination with nitrate and pesticides reversed the effect resulting in macrophyte decline. Warming was found to lower the threshold of ARO for a shift to phytoplankton dominance. Our results show the utility of complex experimental set-ups in micro- and mesocosms in disentangling the effects of multiple stressors on shallow aquatic systems. We conclude that multiple stressors such as climate warming and exposure to agricultural run-off threaten the good ecological state of shallow aquatic systems, and that safety margins should be defined to counteract negative effects.

00469

## Variation in pesticide sensitivity of twenty-eight European spiders

Oral

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### Abstract

Spiders are among the most abundant and diverse predators in terrestrial ecosystems, also playing a key role in pest control in agro-ecosystems. However, their ecological function may be reduced by the exposure to pesticides. Pyrethroid insecticides, a widely used group partially substituting neonicotinoids, for example, can reduce spiders' survival, feeding behaviour and locomotor activity. Despite these unintended consequences for non-target species, arachnids have received comparatively little attention in the Environmental Risk Assessment of plant protection products in Europe, and scientific research has been mainly focused on a few typical species from agricultural habitats. Hence, how sensitive spiders are to insecticides like pyrethroids is largely unknown. We examined the chemical sensitivity of 28 European spiders and the relationship between sensitivity, spider traits and habitat characteristics. Pregnant female spiders were collected in the field from different climates, i.e. polar, boreal, cool and warm temperate, and habitats, i.e. forest, wetland and open land. Spiders were reared in the laboratory until hatching. Then, spiderlings were raised during one month, and used in single-species toxicity tests with the pyrethroid lambda-cyhalothrin. The median lethal concentration of 89% of species was below the recommended application rate of lambda-cyhalothrin, suggesting a high mortality risk to spiders under field conditions. Moreover, pesticide sensitivity varied between species by a factor of nearly 30. Spiders from boreal to polar climate were significantly more sensitive than spiders from cool and warm temperate climate. This indicates that habitat characteristics, such as temperature, may influence spiders' chemical sensitivity. Furthermore, free-hunters were generally more sensitive to the insecticide than web-builders. This may indicate that pesticide pollution negatively affects ecosystem functions such as biocontrol, where free hunting spiders play an important role.

**00476**

## **Environmental emergent problems: what's the influence of the reproduction cycle in a freshwater sentinel species submitted to climatic and chemical stressors?**

Oral

F. Louis <sup>1</sup>, L. Giamberini <sup>1</sup>, V. Felten <sup>1</sup>, S. Pain-Devin <sup>1</sup>, S. Devin <sup>1</sup>, L. Minguéz <sup>1</sup>

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### Abstract

Currently, the study of the fate and adverse effects of toxicants remains increasingly complicated in a global change context. Although no consensus was established between the occurrence of extreme events and global changes, the frequency and the magnitude of heat waves is still increasing. The basal metabolic activity of sessile aquatic organisms could be strongly affected, limiting thus their defence capacity facing to additional stresses. This study aimed to assess the combined effects of a multi-metallic stress and recurrent heat waves in a freshwater bivalve, *Dreissena polymorpha*, during contrasted reproduction cycle steps. Mussels were exposed to an environmental concentration of a nickel-chromium mix solution (20 µg.L<sup>-1</sup> and 5 µg.L<sup>-1</sup>, respectively) for 40 days. A gradual increase of the temperature (+15°C) was weekly performed in exposed media for 24 hours. The same experimental design has been set up in the reproduction (May-June) and the rest (November-December) periods. Key metabolism functions were targeted along the biological organisation levels through a panel of markers. Different physiological patterns of responses were highlighted between both sexes and reproduction cycle stages. An effect of recurrent heat waves was observed in females while males' one was only impacted by the multi-metallic stress. Mussels exposed to the combined stress showed a decrease of the global metabolic activity compared to organisms exposed to the simple stress conditions. This study pointed out the need to include global change issues and temporal variations for further ecotoxicological investigations. This study questioned about classical used approaches in ecotoxicology, which often do not consider confounding factors.

00485

## Anthropogenic noise surprisingly increases fitness of a freshwater zooplankton

Oral

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### Abstract

Sound emissions from shipping, recreational boating and industries are increasing in freshwaters, which harbour a disproportionate fraction of earth's biodiversity compared to terrestrial and marine habitats. Although the responses of top-chain predators to noise is well documented, effects on lower-trophic level species like plankton communities have been largely overlooked. There are rare works on zooplankton fitness and behavior exposed to acute sound. For instance, exposure to the impulsive and very loud sound emissions from air guns has been found to induce mortality in marine zooplankton, but no modification of *Daphnia magna* mobility with acute boat noise. However, the impacts of chronic exposure to moderate sounds, like boat noise, remain unknown.

We performed experiments on *Daphnia magna*, a widespread freshwater crustacean (Cladocera), exposed to three noise conditions: silence (control), intermittent motorboat noise and continuous broadband noise. Individuals were isolated in microcosm during all their live, allowing to measure survival, fecundity and swimming speed.

Boat noise did not alter *D. magna* fitness while surprisingly, continuous exposure to broadband noise resulted in higher survival and fecundity compared to silence. *D. magna* exposed to broadband noise also exhibited a reduced mobility. Thus, we suggest that the energy not allocated to mobility was re-allocated to survival and reproduction. Differences of results between both treatments could be due to differences in sound frequencies and temporal exposition (continuous versus intermittent noise). These questions are also asked for fish responses to noise without clear responses.

We show in our work that zooplankton could be affected by chronic exposition to artificial noise, with some surprising effects. Consequently, our study highlights the necessity to focus also on zooplankton to predict effects of acoustic pollution on aquatic communities.

00623

## A temporal perspective on aquatic subsidy: Bti affects the emergence of Chironomidae

Oral

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Abstract

Aquatic and adjacent riparian food webs are inter alia linked via the flux of energy and nutrients through emerging aquatic insects which provide high-quality subsidy to terrestrial predators. Thus, any disturbance of emergence processes may cascade to higher trophic levels and lead to effects across ecosystem boundaries. One stressor with potential impact on non-target aquatic insects, especially on non-biting midges (Diptera: Chironomidae), often constituting up to 90% of aquatic subsidy, is the widely used mosquito control agent *Bacillus thuringiensis* var. *israelensis* (Bti). In a semi-field experiment, we investigated insect communities from Bti-treated (3 times, maximum field rate:  $2.88 \times 10^9$  ITU/ha) and control floodplain pond mesocosms (FPMs) over 3.5 months for changes in the community composition, the diversity as well as emergence dynamics and the weight of emerged aquatic insects. Bti treatments altered community compositions over the entire study duration, an effect mainly attributed to a significantly earlier (~10 days) and reduced peak (~26%) in the emergence of Chironomidae, the dominant family (88% of collected individuals). A decrease in the larval density due to lethal effects of Bti on sensitive Chironomidae larvae causing less resource competition is the most reasonable explanation. This is supported by heavier Chironomidae emerging from treated FPMs (~21%) during Bti application (April – May). A temporal shift in the emergence dynamics of substantial aquatic subsidy can cause changes in the availability of prey in linked terrestrial ecosystems. Consequently, terrestrial predators depending on appropriate prey, especially during periods of high energy demands, e.g. reproduction in spring, may be affected leading to further consequences in higher and lower trophic levels and thus the whole terrestrial food web. Therefore, this study indicates the importance of a responsible and mindful use of Bti and additionally, it highlights the need to include a temporal perspective in evaluations of stressors in aquatic-terrestrial linkages.

00609

## Linking trait syndromes from diatoms, fishes and invertebrates to micropollutants in streams: a way for identifying relevant model species

Oral

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Abstract

Nowadays, world-wide streams can be impacted by cocktails of micropollutants, including pesticides. These impacts can be additive, especially when micropollutants exhibit similar modes of actions, i.e. when co-occurring micropollutants target similar cellular functions such as photosynthesis and biosynthesis of proteins and amino-acids. Using a novel and large dataset (2007 sampling events) compiling the results of large scale routine monitoring of benthic diatoms, benthic macroinvertebrates and fishes found in French streams, we investigated the existence of trait syndromes (i.e. combinations of co-occurring traits) driven by the joint toxicity of micropollutants, taking into account mineral micropollutants, pesticides, PAHs and other organic micropollutants.

Using clustering methods on correlation matrices between traits and water toxicity (expressed as toxic units), we have identified several trait syndromes: five for diatoms, and eight for both fishes and macroinvertebrates. These trait syndromes exhibited significant links, either positive or negative, with groups of modes of action. Among the traits composing these syndromes, we identified key traits that could be used to further highlight exposure by specific micropollutants. We also identified specific model species for each biological compartment and mode of action, by defining taxonomic paragons for each trait syndrome, i.e. theoretical taxa highly representative of the combination of traits found in each syndrome.

Our results have highlighted the direct and indirect potential of trait syndromes for identifying specific impacts of micropollutants in streams.



**00656**

## **Linking PPP load in blood to life history traits : the Grey Partridge as a bioindicator of agroecosystem health**

Oral

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<sup>3</sup>BIODIVAG - Angers (France), <sup>4</sup>Biogeoscience UMR CNRS 6282 - Dijon (France)

### Abstract

In order to maintain agricultural productivity, the use of pesticides has become necessary and common in worldwide agrosystems. However, by their lack of specificity and their persistence in the environment, pesticides can be found in all environmental compartments of agricultural landscapes and may cause unintentional effects on non-target organisms. These adverse effects of pesticides have been documented by a huge number of standardized toxicological studies but these experimental procedures do not assess the possible sources of pesticide exposition. In addition, sublethal effects (i.e. adverse effects on individual fitness) of pesticides is often overlooked. Studies involving free-living animals can provide a more complete view of how animals are exposed to pesticides in their natural environment and their impact on their health. In this study, we aimed at assessing the potential of the Grey Partridge, a famous farmland bird, as a bioindicator of agricultural ecosystem health by linking the pesticide diversity and concentration found in their blood to different proxy of their health. To reach our objectives, we used, for the first time, an original protocol to determine a large number of pesticides in the blood of partridges (94 compounds from all pesticide families) captured directly in organic or conventional fields. On the same individuals, indicators of their health were assessed (behaviour and physiological parameters). These individuals were then GPS-tracked in order to follow their movement and link their home range with their pesticide load (ongoing analyses). This study linking partridge's pesticides load to their home range and the consequences on their health status is a major advance in terms of biomonitoring, making the Grey Partridge an early warning indicator for agroecosystem health.

# Evolution approaches for understanding ecological features - Salle 1 23/11 ; 14:30-16:15

00014

## Links between ecology and evolution of different wound care strategies in ants: leg amputations and use of antimicrobial compounds

Oral

E.T. Frank <sup>1</sup>

<sup>1</sup>University Of Würzburg - Würzburg (Germany)

### Abstract

Animals developed different behavioural adaptations to combat pathogens. Ants often use the metapleural gland, but some ant genera lost this gland in their evolutionary history. Here we compare two different behavioural adaptations to combat an infected wound, one with the metapleural gland and one without. The ant *Megaponera analis* treats infected wounds with antimicrobial compounds secreted from the metapleural gland, thereby reducing mortality of infected ants by 90%. Further analyses of the metapleural gland secretions of *M. analis* revealed over 121 chemical compounds and 41 proteins, almost half of which could be attributed to have an antimicrobial effect. However, ants from the genus *Camponotus* do not have this gland at their disposal. Remarkably, we observed that workers amputated the infected leg by biting it off at its base. This behaviour halted the infection and guaranteed the survival of the injured ant. The large phylogenetic distance between *Megaponera* and *Camponotus* and their strikingly different natural history (*Megaponera* a group-hunting predator, *Camponotus* a solitary foraging generalist) also suggest that wound care behaviour could be much more widespread in social insects than previously thought. Overall, our study reveals a multifaceted care system, which not only allows to differentiate between sterile and infected wounds but also to treat them either with antimicrobial compounds or amputation of the infected leg. Thereby allowing *M. analis* and *Camponotus* to combat opportunistic pathogenic pressures present on their frequently inflicted wounds with two very different strategies.

00037

## Contemporary and historical hybridization between two endangered species

Oral

H. Dittberner <sup>1</sup>, A. Tellier <sup>2</sup>, J. De Meaux <sup>3</sup>

<sup>1</sup>Out Of Academia - Cologne (Germany), <sup>2</sup>Tum - Munich (Germany), <sup>3</sup>University Of Cologne - Cologne (Germany)

### Abstract

Contemporary gene flow, when resumed after a period of isolation, can have crucial consequences for endangered species, as it can both increase the supply of adaptive alleles and erode local adaptation. Determining the history of gene flow and thus the importance of contemporary hybridization, however, is notoriously difficult. Here, we focus on two endangered plant species, *Arabis nemorensis* and *A. sagittata*, which hybridize naturally in a sympatric population located on the banks of the Rhine. Using reduced genome sequencing, we determined the phylogeography of the two taxa but report only a unique sympatric population. Molecular variation in chloroplast DNA indicated that *A. sagittata* is the principal receiver of gene flow. Applying classical D-statistics and its derivatives to whole-genome data of 35 accessions, we detect gene flow not only in the sympatric population but also among allopatric populations. Using an Approximate Bayesian computation approach, we identify the model that best describes the history of gene flow between these taxa. This model shows that low levels of gene flow have persisted long after speciation, stopped 10 000 years ago, with gene flow now resuming at one unique hotspot. To understand the ecological consequences of gene flow, we quantified genetic differences between species and test whether QTLs underpinning these difference co-locate with inter-specific allelic introgressions.

**00069**

## **Genetic architecture of dispersal and local adaptation drives accelerating range expansions**

Oral

J. Deshpande <sup>1</sup>, E. Fronhofer <sup>1</sup>

<sup>1</sup>Isem, Cnrs - Montpellier (France)

### Abstract

Contemporary evolution has the potential to significantly alter biotic responses to global change, including range expansion dynamics and biological invasions. Models predicting range dynamics often make highly simplifying assumptions about the genetic architecture underlying relevant traits. However, genetic architecture defines evolvability and higher order evolutionary processes, which determine whether evolution will be able to keep up with environmental change or not. Therefore, we here study the impact of the genetic architecture of dispersal and local adaptation, two central traits of high relevance for range expansions, on the dynamics and predictability of invasion into an environmental gradient, such as temperature. In our theoretical model we assume that dispersal and local adaptation traits result from the products of two non-interacting gene-regulatory networks (GRNs). We compare our model to simpler quantitative genetics models and show that in the GRN model, range expansions are accelerating, and less predictable. We further find that accelerating dynamics in the GRN model are primarily driven by an increase in the rate of local adaptation to novel habitats which results from greater sensitivity to mutation (decreased robustness) and increased gene expression. Our results highlight how processes at microscopic scales, here, within genomes, can impact the predictions of large scale, macroscopic phenomena, such as range expansions, by modulating the rate of evolution.

00076

## Holobiont diversity in an heterogeneous and anthropized marine environment

Oral

D. Aurelle <sup>1</sup>, C. Desnues <sup>2</sup>, S. Samadi <sup>3</sup>, E. Rozis <sup>1</sup>, S. Sartoretto <sup>4</sup>, D. Guillemain <sup>1</sup>, S. Chenesseau <sup>2</sup>, S. Bouchard <sup>2</sup>, P. Pontarotti <sup>2</sup>, J.C. Poggiale <sup>1</sup>, L. Chaoui <sup>5</sup>, M.H. Kara <sup>5</sup>, N.E. Topçu <sup>6</sup>, M. Bally <sup>2</sup>

<sup>1</sup>Aix-Marseille Université - Marseille (France), <sup>2</sup>Cnrs - Marseille (France), <sup>3</sup>Mnhn - Paris (France), <sup>4</sup>Ifremer - La Seyne Sur Mer (France), <sup>5</sup>Université D'annaba - Annaba (Algeria), <sup>6</sup>Université D'istanbul - Istanbul (Turkey)

Abstract

Marine biodiversity is impacted by local and global anthropic pressures. In this context, it is crucial to better understand the adaptative abilities of ecologically key species facing heterogeneous and changing environments. We chose the yellow gorgonian, *Eunicella cavolini*, as a model species : this octocoral is an ecologically important species of benthic Mediterranean ecosystems which can be found in contrasted thermal conditions (different depths and regions) and can colonize sites near pollution sources in coastal areas. As other Mediterranean gorgonians, *Eunicella cavolini* is recurrently impacted by mass mortality events linked to marine heat waves. We studied the genetic variation of the gorgonian holobiont along depth (20-40 m) and pollution (a major sewage outfall) gradients, with two sampling seasons in each case. Our project took place at a local scale near the city of Marseille, in the area of the Calanques National Park. We considered different components of the holobiont to study their changes across diverse environmental conditions and the interactions between these components. Regarding microbial diversity we analysed the overall composition and structure of communities of viruses, bacteria and micro-eukaryotes associated with gorgonians from eight study sites. At the host level, we characterized the demographic structures of the studied population. We also analysed the genomic diversity of the gorgonian to precise species limits and to study the differentiation and connectivity among sites and environments. The findings will allow to address questions relating to holobiont structuring factors and to test for correlations between host diversity and environmental conditions or microbial diversity. We will present here the results obtained for the diversity of the host genome, inferred from RAD-sequencing, and of microbial communities, analysed with 16S metabarcoding.

00084

**"Born with a silver spoon in the mouth has bad sides too": experimentally increasing growth rate enhances individual quality but accelerates reproductive senescence in females of the mealworm beetle, *Tenebrio molitor***

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.  
Evolutionary ecology and entomology

Oral

A. Crosland <sup>1</sup>, T. Rigaud <sup>1</sup>, A. Balourdet <sup>1</sup>, Y. Moret <sup>1</sup>

<sup>1</sup>Umr Cnrs 6282 Biogeosciences, Equipe Ecologie Evolutive, Université De Bourgogne-Franche Comté - Dijon (France)

Abstract

Senescence occurs because of the decline of the strength of selection with age, allowing late-life reduced performances not being counter selected. From there, several phenomena may explain late-life reduced performances, such as the accumulation of deleterious mutations, the expression of pleiotropic genes or the existence of resource trade-offs between early and late performances. This latter phenomenon is at the core of the disposable soma theory of ageing, which predicts that growth and early-life reproduction have costs that increase reproductive and actuarial senescence. Whereas the impact of the cost of early reproduction on reproductive and actuarial senescence has been extensively studied, that of the cost of growth remains overlooked and often inconclusive, possibly because of confounding effects associated with the procedures used to manipulate growth rate.

Here, we investigated the cost of growth rate and its impact on reproductive senescence and longevity of females of the mealworm beetle, *Tenebrio molitor*. For this purpose, we generated insects with contrasted growth rates by raising groups of them in conditions below, above and optimal relative humidity (RH: 55%, 85% and 70%, respectively) during the larval stage. The resulting adult females then bred, under the same optimal RH conditions, early in life, then later in life and were followed there until death.

We found that larvae grown under the highest relative humidity exhibited the highest larval growth rate, thanks to both shorter growth duration and the achievement of heavier pupae mass. Adult females from this favorable growing condition lived longer, were more fecund early in life, but suffered from lower late-life reproductive investment. Our study shows that growth rate, which is highly dependent on the early-life environment, is an important factor modulating adult reproductive senescence, through the occurrence of early-late life trade-offs.

**00114**

## **Back to the past: rapid adaptation in *Viola arvensis* using resurrection ecology**

Oral

S. Acoca-Pidolle <sup>1</sup>, P.O. Cheptou <sup>1</sup>

<sup>1</sup>Cefe, Cnrs - Montpellier (France)

### Abstract

Insect pollinators decline has been reported in various parts of the world, thus inducing changes in selective pressures on entomogamous plants. As plants need pollinators for their reproduction, pollinator decline may impact plant reproductive system. We hypothesized that pollinator limitation may induce plant evolution towards less attractive flower and higher capability of selfing in self-compatible entomogamous. This set of traits is called the selfing syndrome. Using resurrection ecology, the aim of our work was to study the evolution of phenological, floral and fitness traits in a common annual weed. We thus studied four populations of the Field Pansy, *Viola arvensis*, from the Parisian basin (France), as four independent replicates. We grew up populations issued from seeds collected in 90'-2000 and their descendants collected in 2021 in common environment. Phenotypic traits were measured in 2021, the refreshing generation, and in 2022, the test generation. We also used population genetics tools to estimate realized selfing rates in natura. Microsatellites markers revealed an increased of realized selfing rates between 90's and 2021. Phenotypic measurements showed a shift of corolla traits, toward less conspicuous flowers in all the populations, consistent with the evolution of a selfing syndrome. Such evolution towards selfing syndrome raises questions about the future of plant-pollinators interactions and on a potential breakdown of this interaction.

**00355**

## **Maintenance of color polymorphism under balanced selection**

Oral

P. Lacoste <sup>1</sup>, M. Joron <sup>1</sup>, M. McClure <sup>2</sup>

<sup>1</sup>Cefe - Montpellier (France), <sup>2</sup>Leesa - Cayenne (France)

### Abstract

Studying colour polymorphism can be useful to understand the mechanisms explaining the maintenance of phenotypic diversity. We try and identify the selection pressures exerted on the variation of coloration in a neotropical butterfly in order to understand how different colour pattern forms are able to coexist within a population.

First, our predation data on artificial butterfly models suggest that there is no difference in predation rates between the different forms. We are currently analysing the mimetic community structure in order to determine the frequencies of each morph so as to better explain these results.

Secondly, our mate choice data suggests the existence of heterogamous mating preferences in only one of the two color forms. This type of mate choice can generate negative frequency-dependent selection, which could explain the maintenance of a certain level of diversity. We will combine these empirical results with a modeling approach to test if these preferences are sufficient to maintain polymorphism, and to ascertain other hypotheses that could later be tested empirically.



## Evolution approaches for understanding ecological features (2/3) - Salle 1 24/11 ; 10:00-11:45

00207

### Trophic morphology of goatfishes (Mullidae) from South-West Madagascar

Oral

L. Mittelheiser <sup>1</sup>, G. Lepoint <sup>2</sup>, A. Gillet <sup>1</sup>, B. Frederich <sup>1</sup>

<sup>1</sup>Laboratory Of Functional And Evolutionary Morphology - Liège (Belgium), <sup>2</sup>Laboratory Of Trophic And Isotopic Ecology - Liège (Belgium)

#### Abstract

Mullids, also called goatfishes, constitutes a main group of the reef ichthyofauna . They have a worldwide distribution in tropical and subtropical reefs with a few species in temperate areas such as the North-East Atlantic coast or the Mediterranean Sea. The Mullidae family belongs to the Syngnathiform order including seahorses (Syngnathidae) and trumpetfishes (Aulostomidae), and comprise 98 species grouped in 6 genera: Mullus, Upeneus, Upeneichthys, Mulloidichthys, Pseudupeneus and Parupeneus. The main morphological trait distinguishing Mullidae from other Syngnathiform families is the presence of a pair of hyoid barbels. It is often assumed that all goatfishes are mainly benthic carnivores, using barbels to extract small prey from the substrate (crustaceans, mollusks, worms).

Despite the role that goatfishes play in reef ecosystems, knowledge of their ecomorphological diversity remains scarce. Thus, we explore the ecomorphology of six species of goatfishes living in sympatry at Toliara Reef (South-West of Madagascar) by using a combination of morphometric and isotopic ( $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$  and  $\delta^{34}\text{S}$ ) data. The shape of cephalic region was quantified by landmark-based geometric morphometrics and linear measurements.

Morphometric analyses permitted to distinguish each genus and species according to head elongation, cheek size and pectoral fins insertions. Isotopic ratios, used as trophic niche proxy, allowed to highlight clear trophic niche segregation among species built on C and S isotopic ratios. This diversity is possibly linked to variation in selected prey type and feeding areas. Interspecific variation of these two ratios could also be linked to a cross-reef distribution with species living in the lagoon and outer-shelf dwellers. The absence of variation in  $\delta^{15}\text{N}$  values suggests that the six species share similar trophic position. Our phylogenetic comparative analyses revealed a significant relationship between isotopic and morphometric data. These results allowed the formulation of hypotheses regarding differences in goatfishes feeding strategies: "long head" species mainly search for preys in anfractuosités or deep in the substrate while "short head" species use their head to dig in superficial soft bottoms. We highlighted ecomorphological partitioning among sympatric goatfishes, satisfying the Hutchinsonian niche concept where sympatric species do not occupy the same ecological niches.

00260

## Effects of evolution on niche displacement and emergent population properties, a discussion on optimality

Oral

R.P. Rohr <sup>1, 2</sup>, N. Loeuille <sup>3, 4</sup>

<sup>1</sup>Department Of Biology - Fribourg (Switzerland), <sup>2</sup>University of Fribourg, <sup>3</sup>Institute Of Ecology And Environmental Sciences, less - Paris (France), <sup>4</sup>Sorbonne Université, UPEC, CNRS, IRD, INRA

### Abstract

Understanding the effects of evolution on emergent population properties such as intrinsic growth rate, species abundance, or dynamical resilience is not only a key theoretical question, but has major empirical implications for conservation, agroecology, invasion ecology among others. Evolution can also lead to the maintenance of polymorphism based on niche differentiation among different phenotypes. Specifically, we aim to answer the following three questions. Can we clarify the evolutionary scenarios allowing the optimization of population growth-rate and of total abundance ? Can we relate the eco-evolutionary emergence of polymorphism to the niche and fitness difference concepts sensu coexistence theory ? Can the population properties be optimized after a branching point due to niche-displacement. We revisit previous theoretical results, which state that eco-evolutionary dynamics optimize when the invasion fitness of a rare mutant morph is affected by the environment, set by the resident morph, in a uni-dimensional feedback loop and monotonically, using a classical Lotka-Volterra model describing ecological dynamics.

Depending on how the traits under selection affect species intrinsic growth rates or ecological interactions, we determine three scenarios, ranging from the optimization of all three population properties to no optimization. Furthermore, we provide a link between evolutionary dynamics and coexistence theory. We find, in general, that optimization is incompatible with niche differentiation sensu coexistence theory and, therefore, with the emergence of polymorphism. Niche displacement between resident and mutant phenotypes, and potentially polymorphism, only arise when we do not expect optimality to hold. Finally, we show how this approach can be generalized to coevolution and that optimization is unlikely to happen in such conditions. Along the three scenarios, we also propose biological scenarios and traits that may fall into them. Although it is possible to find traits for which optimality is expected, for the majority of the cases optimization arguments do not hold. Finally, we provide practical applications of our results in conservation, agroecology, harvesting, and invasion ecology.

**00267**

## **The necessity to quantify plant drought stress along the soil-plant-atmosphere continuum.**

Oral

B. Berauer <sup>1</sup>, A. Schweiger <sup>1</sup>

<sup>1</sup>University Of Hohenheim-Department Of Plant Ecology - Stuttgart (Germany)

### Abstract

With ongoing climate change both, frequency and severity of droughts will increase, threatening ecosystem functioning and fuelling the risk of food insecurity. Water is transported following a negative pressure gradient from soil, via plant to atmosphere, well known as the soil-plant-atmosphere continuum (SPAC). All three compartments are of high importance to recognize and understand drought especially in plants. Though, experimental plant drought studies often only quantify drought using one (if any) of the three compartments. This might be one reason for the missing generalizability of experimental plant drought stress studies. To better understand which edaphic (water supply) and atmospheric (water demand) conditions cause plant drought stress, we conducted an unreplicated crossed-gradient experiment to create a response surface across multiple organisational levels, from molecular to plant-soil system. Therefore, we grew wheat plants from five different Triticale varieties exposed to six equidistant atmospheric drought levels (controlled by vapor pressure deficit within climate chambers) and seven equidistant edaphic drought levels (controlled by gravimetric water content of the pots). After plants reached equilibrium we measured abscisic acid (molecular), stomatal conductance (cellular) leaf water potential (organ) and evapotranspiration (system) to quantify the wheat plants drought response surface. At both ends of the soil water gradient (field capacity and permanent wilting point) the influence of atmospheric drought is minimal. Yet, at intermediate soil water availability plants reveal higher drought stress with increasing atmospheric water demand. The variation within the drought response surface decreases from between species (one variety of each of the three species) to within species (three varieties of the same species). Our results highlight the importance of quantifying (and reporting) drought conditions along all three compartments of the SPAC, as especially under intermediate and mild edaphic drought the atmospheric water demand is crucial to induce drought stress in plants. The lack of reported information on drought conditions hamper the compatibility and synthesis of existing experimental plant drought stress studies. By showing the necessity to quantify plant drought stress along the SPAC, we hope to improve compatibility of future experimental plant drought studies and thereby contribute to face the pressing challenges of the upcoming century.

00301

## Genomic signatures of long-distance dispersal events mediated by megafrugivores in palms in Madagascar

Oral

L. Méndez <sup>1</sup>, C.D. Barratt <sup>1</sup>, W. Durka <sup>2</sup>, W.J. Baker <sup>3</sup>, W.D. Kissling <sup>4</sup>, W.L. Eiserhardt <sup>5</sup>, V. Randrianas <sup>6</sup>, A. Shapcott <sup>7</sup>, R.E. Onstein <sup>1</sup>

<sup>1</sup>German Centre Of Integrative Biodiversity Research (idiv) Halle-Jena-Leipzig, Germany - Leipzig (Germany), <sup>2</sup>Department Of Community Ecology (bzf), Helmholtz Centre For Environmental Research-Ufz, Halle, Germany - Halle (Germany), <sup>3</sup>Royal Botanic Gardens, Kew, Richmond, Surrey, Tw9 3ae, United Kingdom - London (United Kingdom), <sup>4</sup>Institute For Biodiversity And Ecosystem Dynamics (ibed), University Of Amsterdam, P.o. Box 94240, 1090 Ge Amsterdam, The Netherlands - Amsterdam (Netherlands), <sup>5</sup>Department Of Biology, Aarhus University, Ny Munkegade 116, 8000 Aarhus C, Denmark - Aarhus (Denmark), <sup>6</sup>Kew Madagascar Conservation Centre, Ivandry, Antananarivo, Madagascar - Antananarivo (Madagascar), <sup>7</sup>Genecology Research Centre, School Of Science And Engineering, University Of The Sunshine Coast, Maroochydore, Queensland, Australia - Queensland (Australia)

Abstract

Seed dispersal is a key process in the generation and maintenance of genetic diversity and genetic structure of plant populations in tropical ecosystems. In the last 2000 years, Madagascar has suffered biased extinctions of large-bodied animals such as giant lemurs and elephant birds that were potentially providing long-distance dispersal events of fleshy-fruited plants. This may have caused dispersal limitation in these plants, leading to low genetic diversity and high genetic structure between populations. Here, we assess this hypothesis in four animal-dispersed palm (Arecaceae) species from the dry-west of Madagascar which differ in fruit lengths from very large megafaunal fruits of up to 30 cm (*Borassus madagascariensis*), medium size 4-5 cm megafaunal fruits (*Hyphaene coriacea*, *Bismarckia nobilis*), to small 1.3 cm fruits (*Dyopsis madagascariensis*). We sampled 167 individuals from 25 populations across the four species, and used double-digest restriction-site-associated DNA (ddRAD) libraries to identify single nucleotide polymorphisms (SNPs). We integrated the genetic data with distribution ranges for both extant and extinct frugivore species, and climate, soil and human impact data. Using species distribution modelling, phylogenetic reconstruction, and linear mixed effect models, we identified overall increasing species-level genetic diversity with increasing fruit size, but population-level genetic diversity was primarily explained by precipitation seasonality and absence of roads. Genetic differentiation decreased with increasing shared past megafrugivore species between populations, which suggests that increased gene flow between palm populations due to past dispersal events by megafrugivores, thereby reducing genetic differentiation, are still detectable today. Overall, our study suggests that large-fruited Malagasy savanna palms do not (yet) show genomic signatures of population dysconnectivity due to the extinction of their past megafaunal seed-dispersing interaction partners. This may be explained by alternative dispersal strategies (e.g., human-mediated dispersal), too few generations to show the dispersal limitation effects (long lifespan), and other life-history characteristics of these palms.

**00308**

## **Sublethal effects of selective pressures and the measure of plant fitness**

Oral

M. Pauwels <sup>1</sup>, N. Faure <sup>1</sup>, D. Vile <sup>2</sup>, H. Frérot <sup>1</sup>

<sup>1</sup>University Of Lille - Villeneuve D'ascq (France), <sup>2</sup>Inrae - Montpellier (France)

### Abstract

Anthropogenic pollution is a major driver of global environmental change. To be properly addressed, the study of the impact of pollutants must consider both lethal effects and sublethal effects on individual fitness. However, measuring fitness remains challenging. In plants, the total number of seeds produced, i.e. the seed set, is traditionally considered, but is not readily accessible. Instead, performance traits related to survival, e.g., vegetative biomass and reproductive success, can be measured, but their correlation with seed set has rarely been investigated.

To develop accurate estimates of seed set, relationships among 15 vegetative and reproductive traits were analyzed. For this purpose, *Noccaea caerulescens* (Brassicaceae), a model plant to study local adaptation to metal-contaminated environments, was used. To investigate putative variation in trait relationships, sampling included several accessions cultivated in contrasting experimental conditions. To test their applicability, selected estimates were used in the first generation of a Laboratory Natural Selection (LNS) experiment exposing experimentally plants to zinc soil pollution.

Principal component analyses revealed statistical independence between vegetative and reproductive traits. Traits showing the strongest positive correlation with seed set were the number of non-aborted silicles, and the product of this number and mean silicle length. They thus appeared the most appropriate to document sublethal or fitness effects of environmental contaminants in plant ecotoxicological studies. The relevance of both estimates was confirmed by using them to assess the fitness of parental plants of the first generation of an LNS experiment: the same families consistently displayed the highest or the lowest performance values in two independent experimental metal-exposed populations. Thus, both these fitness estimates could be used to determine the expected number of offspring and the composition of successive generations in further LNS experiments investigating the impact of multi-generational exposure of a plant species to environmental pollution.

**00344**

**Eco-evolutionary dynamics in mutualistic metacommunities: Landscape connectivity and heterogeneity delay extinction of declining interaction partners**

Oral

M. Palmer <sup>1</sup>, A. Weinbach <sup>1</sup>, M. Alberti <sup>2</sup>, K.T. Allhoff <sup>3</sup>

<sup>1</sup>University Of Hohenheim - Stuttgart (Germany), <sup>2</sup>University Of Washington - Seattle (United States), <sup>3</sup>University Of Hohenheim - Stuttgart (Germany)

Abstract

The response of a given ecosystem to external disturbances strongly depends on eco-evolutionary dynamics at play within the system. For instance, declining pollinator abundances can trigger an adaptive re-adjustment of energy allocation within an interacting plant population. A decreased investment into the interaction (e.g. reduced flower or nectar production in favor of increased selfing or cloning) can then reinforce the initial partner decline, up to its potential extinction. We hypothesize that the strength of such self-reinforcing eco-evolutionary feedback depends on the characteristics of the spatial landscape in which the interacting partners are embedded. To test this idea, we use a mathematical model, combining concepts from the framework of adaptive dynamics with metacommunity theory. More precisely, we consider a set of patches, mimicking for example an urban landscape of habitat islands within a hostile matrix. Each of these patches contains a mutualistic 2-player system and is coupled to other patches via migration. We vary the connectivity between the patches, as well as the level of heterogeneity in patch quality. We find that both connectivity and heterogeneity have a positive impact on species persistence. This result is consistent with insights from previous, non-evolutionary metacommunities. However, the relative importance of connectivity and heterogeneity depends on whether or not the evolution of the undisturbed interaction partner is taken into account. Without evolution the relative effect of heterogeneity dominates over the effect of connectivity, while the opposite is true when evolution is switched on. Our results thus suggest that conservation measures should not only consider target species in their respective spatial landscapes but also the interplay between spatial dynamics and potential multi-species eco-evolutionary dynamics.

00350

# Evolution of parasite virulence in structured metapopulations

Oral

J.L. Lombard <sup>1</sup>, F.M. Massol <sup>2</sup>, S.L. Lion <sup>3</sup>

<sup>1</sup>Univ. Lille, Ciil, Umr 9017-Cgim - Lille (France), <sup>2</sup>Univ. Lille, Cnrs, Ciil, Umr 9017-Cgim - Lille (France), <sup>3</sup>Cefe, Cnrs, Univ Montpellier, Ephe, Ird, Univ Paul Valéry Montpellier 3 - Montpellier (France)

Abstract

## How epidemiology and evolutionary dynamics interact in a spatial context with limited dispersal ?

While most models in epidemiology and evolution assume well-mixed populations, the last decades have seen the rise of various studies suggesting that explicit spatial context would modulate selective pressures acting on host and pathogen evolution. In such a context, dispersal appears to be a key variable for the evolutionary dynamics, as it shapes both demographic and genetics flows.

We developed a modelling framework using an extension of the classical island model to account for local epidemiological dynamics with different patches states (*i.e.* disease-free or with an endemic pathogen). We use this first model to build an adaptive dynamics model in order to assess the evolution of the parasite virulence depending on the level of host dispersal. We compared the evolutionarily stable states predicted by the model with those expected from the non spatial case, supported by stochastic simulations. The robustness of the predictions to other simple spatial structures was tested, especially for lattice structured populations using pair approximation methods.

Our findings suggest that the evolutionarily stable level of virulence in a spatial context was generally much lower than that of the non spatial model. We also found that a moderate to high level of dispersal could lead to the evolutionary branching of parasite virulence, although a high restriction on dispersal led to continuously evolutionarily stable virulence levels. I will discuss the findings of the model and address particular considerations and perspectives relating to the importance of spatial structure in understanding the evolution of pathogen virulence during epidemics.

## Evolution approaches for understanding ecological features (3/3) - Salle 1 24/11 ; 10:00-11:45

00381

### Risk factors affecting honey bee thermoregulation as potential mechanisms underlying colony overwintering failure

Oral

E. Minaud <sup>1</sup>, F. Rebaudo <sup>1</sup>, E. Verrier <sup>1</sup>, G. Mainardi <sup>2</sup>, F. Vardakas <sup>3</sup>, I. Steffan-Dewenter <sup>2</sup>, F. Hatjina <sup>3</sup>, F. Requier <sup>1</sup>

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<sup>2</sup>University Of Würzburg-Department Of Animal Ecology And Tropical Biology - Würzburg (Germany), <sup>3</sup>Hellenic Agriculture Organisation Demeter, Institute Of Animal Science, Dep. Of Apiculture - Nea Moudania (Greece)

#### Abstract

In temperate regions, the lack of resources and low temperatures make winter a critical period for the survival of many species. Low temperatures are particularly impactful on ectothermic species such as insects, but some species have developed social strategies to survive. During winter, individual workers of the Western honey bee (*Apis mellifera*) group in the hive as a cluster and produce heat by thoracic contraction. The energy needed for producing heat is obtained by the consumption of the honey reserves accumulated during the summer season. Interestingly, although the high mortality rate of honey bee colonies is well documented since 30 years, the ecological mechanisms underlying the colony overwintering failure are still unclear. Surprisingly, very few is known on the effects of biotic and abiotic factors on winter colony thermoregulation. We will present an overview of the current knowledge linking risk factors, ecological mechanisms and the failure in honey bee colony overwintering. To do so, we carried out a systematic review considering 50 articles, for which we will present the main outcomes. Moreover, we will present preliminary results of an international field experiment developed in the frame of the European H2020 project BeeConnected. Given that opening beehives during the winter endangers the colony survival by disturbing its thermoregulation, collecting field data on winter colony dynamics is challenging. The BeeConnected project aims at lifting the veil on this knowledge gap using Information and Communication Technologies (ICT) as a tool for automatic monitoring of biological processes of honey bee colonies during winter, using on-board electronics and computing. We monitored the temperature of 135 connected beehives distributed over France, Germany and Greece, along gradients in climate and landscape composition. We will discuss the results on the potential combined effects of climate and landscape on the thermoregulation of honey bees in winter. The results will help understanding the risk factors and mechanisms involved in honey bee mortality towards management recommendations for anticipating or prevent colony overwintering failure.



00392

## Population genomics of *Diplolepis rosae* causing bedeguar galls in wild dog roses: insights into gall induction by insects

Oral

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### Abstract

Phytophagous insects have developed many strategies to exploit their host plant. Some have evolved the capacity of inducing the development of abnormal plant tissues called galls. The gall serves as a nutritional resource and a temporary shelter for gall inducers. The formation of galls represents a specific response driven by insects. Gall wasps (Hymenoptera: Cynipidae) are a group of insects comprising many gall-forming species. Little is known about the genes involved in the induction and development of galls triggered by Cynipidae despite being one of the largest groups of gall-forming insects. Our study tries to assess what genes have been recruited to induce galls using a combination of transcriptomics and population genomics in *Diplolepis rosae* that causes bedeguar galls in wild dog roses (*Rosa* sect. *Caninae*). Supposing the gall formation to be an adaptive trait we expected to detect traces of positive or balancing selection acting on the genes of interest. First, the genome of 18 *D. rosae* individuals sampled in the French territory was sequenced, with one individual sequenced in a long read for constructing the reference sequence. Population structure analysis showed that *D. rosae* is divided into two peripatric populations with no apparent geographic distribution. The best supported demographic scenario inferred *D. rosae* suffered a bottleneck in an ancestral population that was followed by exponential growth and then a split into the two populations. We, therefore, conducted a McDonald-Kreitman test that showed twelve genes to be under positive selection. Interestingly, certain genes detected under positive selection encode transposable elements being close to those of the Hessian fly (Diptera: Cecidomyiidae), the most studied insect galler. Transcriptome analysis of different life stages could reveal the potential role of those genes in gall formation.

00417

## An NGS-based approach to investigating the spatial and temporal evolution of myrmecophytism in Southeast Asian *Macaranga* (Euphorbiaceae) lineages

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.  
Molecular phylogenetics and evolutionary history of plant systems

Oral

N. Dixit<sup>1</sup>, D. Guicking<sup>1</sup>

<sup>1</sup>University Of Kassel - Kassel (Germany)

Abstract

### An NGS-based approach to investigating the spatial and temporal evolution of myrmecophytism in Southeast Asian *Macaranga* (Euphorbiaceae) lineages

Nadi Dixit<sup>1</sup>, Daniela Guicking<sup>1</sup>

<sup>1</sup>University of Kassel, Department of Botany, Heinrich-Plett-Straße 40, 34132 Kassel, Germany

Mutualisms and symbiotic associations are considered to be important drivers of biodiversity, especially in the tropics. Through our investigation of the evolution of myrmecophytism, a plant-ant mutualistic interaction, in the pioneer plant genus *Macaranga*, we hope to contribute to the understanding of the extraordinary biological diversity prevalent in Sundaland. Previous attempts aimed at resolving the evolutionary relationships among myrmecophytic *Macaranga* using ITS sequences were largely fruitless, revealing little to no variation among species. By exploiting the technological advancements offered by next-generation sequencing (NGS), specifically genotyping by sequencing (GBS), we have for the very first time a well-resolved phylogeny of the Southeast Asian *Macaranga* lineages in hand. This has made it possible for us to trace the evolutionary history of myrmecophytism in this genus and reliably infer its spatial and temporal origin. Our phylogenetic analysis based on genome-wide GBS-derived SNP data revealed myrmecophytic *Macaranga* to be a monophyletic clade within the genus, while also establishing clearly demarcated clade boundaries of the three myrmecophytic taxonomic sections of *Pachystemon*, *Pruinosae*, and *Winklerianae*. As hypothesized, results from our biogeographic analysis point to the island of Borneo as the region of origin of myrmecophytism in this genus, which is unsurprising given that this region has played a significant role in harboring and preserving rainforests through the cooler and drier conditions of the Pliocene. With these results in hand, we hope to fill in some gaps in the knowledge of the extensive biodiversity prevalent in the Southeast Asian tropics.

**00471**

## **The impact of life history, species ecology and humans on the population decline of extant megafauna**

Oral

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<sup>1</sup>Aarhus University - Aarhus (Denmark)

### Abstract

The late Quaternary extinction event, strongly supported by the fossil record, is characterized by selective extirpation of large-bodied animals at a global scale. While fossils provide valuable glimpses into histories of species, the fragmentary nature of such data limits precision of past population dynamics inferences. We therefore analysed genome sequence data of over 100 extant megafauna species using pairwise sequentially Markovian coalescent (PSMC) models to infer past changes in megafauna population sizes. We employed a Bayesian statistical framework to analyse population trajectory differences between species while taking into account differences in life history traits, ecological parameters, as well as paleoclimate and hominin impact. We find a global trend of megafauna decline towards present time during the Pleistocene, with larger species experiencing the strongest decline. Furthermore, we find that the rate of population decline intensified approximately 100,000 years ago, with species in temperate regions with a relatively long history of hominin activity experiencing the strongest decline. Additionally, the decline in population size was strongest for carnivores and mildest for generalist species. Finally, we developed predictive models based on temperature fluctuations and human population sizes to assess their relative impact on megafauna population dynamics. We find that the paleoclimate has limited explanatory power for recent shifts in megafauna population sizes, which largely coincide with human arrival times and expansion. Our results provide unique insight into factors governing population shifts in large animals and have important implications for the global restructuring of ecosystems.

**00475**

# **Eco-evolutionary dynamics in 2-species mutualistic systems: One-sided population decline triggers joint interaction disinvestment**

Oral

F. Weyerer <sup>1,2</sup>, A. Weinbach <sup>2</sup>, C. Zarfl <sup>1</sup>, K.T. Allhoff <sup>2</sup>

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Abstract

The interplay between ecological and evolutionary dynamics can create feedback loops that reinforce the impact of external disturbances and thus threaten species coexistence in a changing world. In the case of two mutualistic interaction partners, such as plants and their pollinators, a decreasing abundance of one interaction partner (such as insect decline) might force the other to invest more energy into being independent (e.g. via selfing or clonal reproduction) and less into the interaction (e.g. via reduced flower or nectar production). This disinvestment reduces waste of energy at the cost of accelerating the initial partner decline, up to its potential extinction. We ask under which conditions such self-reinforcing feedback occurs in mutualistic systems when considering one-sided population decline. We furthermore ask whether it can be counteracted by self-dampening feedback if co-evolution of both interaction partners is taken into account. We address these questions using a mathematical model, based on the framework of adaptive dynamics. In line with previous studies, we find that the described pattern of accelerated population decline occurs for a wide range of parameter values. In our model, this was due to a concave allocation trade-off between independent growth and interaction investment. When both partners are co-evolving, the undisturbed population disinvests first, which then forces the declining population to disinvest as well, in favor of other energy sources. A decelerated decline can occur if the adaptation of the undisturbed partner is too slow compared to the environmental change, reducing the speed of its disinvestment, or if the initial investment into the interaction was very high. Our results thus suggest that if actions are taken to save endangered populations, not only the evolution of the target species, but also of their interaction partner, as well as the type and strength of their interaction should be considered.

00635

## Genetic resources of the red alga *Palmaria palmata* exploited along Brittany coast and intertidal differentiation

Oral

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Abstract

The red seaweed *Palmaria palmata*, also known as dulse, is used for human food and for the cosmetics industry. Most of the biomass used today comes from manual harvesting of wild populations. The annual variations in the wild stock as well as the growing demand for biomass for this species in recent years, underline the need to manage the available resource and develop its aquaculture. Indeed, attempts to domesticate this species over the past twenty years have been unsuccessful, in particular due to the lack of knowledge of their genetic resource and its unusual life cycle. This species has haploid diploid life cycle, with alternation of diploid tetrasporophytes and male and female haploid gametophytes. It is characterized by a marked sexual dimorphism (the female is microscopic). In this study, we explored the genetic resources of wild populations of *P. palmata* across the intertidal gradient, along the coast of Brittany (France). This region stretching from the Atlantic to the English Channel is known to be one of the main harvesting areas for *P. palmata* in Europe. Nearly 900 individuals (diploids and haploids) were sampled in 17 sites distributed along the Brittany coast. After determining the level of ploidy using flow cytometer, the individuals were genotyped using 11 microsatellite genetic markers.

The results show that the frequencies of diploid individuals in populations were twice higher than the haploid ones. Moreover, the genetic analysis reveals that the wild populations of *P. palmata* were structured along the coast, and showed a clear separation between North and South Brittany and less pronounced but significant between the high and low levels of the shore.

This study allows, on the one hand, to have a better estimate of the genetic resources available in this precious species in Brittany and, on the other hand, contributes to improve the knowledge crucial for its forthcoming domestication.

00514

# Evolutionary assembly of ecological communities and its effects on coexistence mechanisms, community robustness, and productivity

Oral

V. Lepori <sup>1</sup>, N. Loeuille <sup>2</sup>, R. Rohr <sup>1</sup>

<sup>1</sup>University Of Fribourg - Fribourg (Switzerland), <sup>2</sup>Sorbonne Université, IEES - Paris (France)

Abstract

How many, and how, species can be arranged on a niche axis such that they coexist, is a long-standing question in ecology dating back to the works of Hutchinson and MacArthur. Since species interactions can drive evolutionary change, coevolved communities should differ substantially in this respect from non-evolutionary assemblages. More recently, both theoretical and empirical efforts have focused on how coevolution can affect species coexistence and community productivity. Here, we address these questions in a niche-based model, where species are defined by their niche position on a resource axis. We start with one phenotype and let biodiversity emerge through successive diversification events. We follow the evolution of niche positions and community properties between and following branching points, up to the formation of evolutionary stable communities (ESCs). We leverage the structural approach to coexistence to study feasibility in  $n$ -species systems. Finally, we compare evolutionary trajectories against Monte-Carlo randomized communities.

We find that between diversification events, both fitness and niche differences (*sensu* coexistence theory) increase along evolutionary trajectories. We introduce a new structural metric to show that the stabilizing effect prevails: evolution has a net positive effect on community robustness to extinction, provided that the system is undersaturated with respect to the maximum evolutionary niche packing – the ESC. When compared to randomized communities, niche evolution converges towards singular strategies (branching points and evolutionary stable communities) located on Pareto fronts which optimize the niche difference relative to the fitness difference. In other words, evolution finds the best compromise between maximizing the stabilizing effect of niche difference and minimizing the destabilizing effect of fitness difference. This confirms that evolutionary stable communities are highly non-random. Communities also evolve towards increasing net biomass production, as a result of greater complementarity in niche utilization. That being noted, we show that productivity indicators are not strictly maximized except for monomorphic systems. In higher dimensions, constraints on niche and fitness differences restrict access to more productive trait configurations.

00496

## Biogeographic rules of arthropod body-size across trees in a forest canopy

Oral

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### Abstract

Body size is arguably the single trait that integrates the largest amount of variation of life histories and physiologies across arthropod species. Biogeographic rules relate large body size in arthropods species to large-scale environmental gradients of decreasing temperature or increasing isolation, reflecting decreasing developmental speed and increasing need for resources to disperse. Temperature and isolation also vary at much smaller scale, such as among different tree individuals within a forest canopy, but we do not know whether larger arthropod species establish on cooler or more isolated trees. We studied true bugs, moths and spiders across oak individuals varying in thermal regime and in phylogenetic isolation from neighbouring trees. We found that in all three taxa the body size significantly relates to host-tree temperature, but strengths and even signs of the relationships shifted between taxa and within taxa between years. Shifts between years can be explained by the fact that in some years high temperature decreases host-plant quality and might thereby indirectly decrease rather than increase developmental speed. In all three taxa, body size increased with phylogenetic isolation at least in some years. In one case, phylogenetic isolation of host trees reinforced the decline of body size with temperature. Overall, body size of arthropods relates to temperature and isolation even across the micro-archipelago of tree crowns within a forest canopy. We suggest that small and large species are sorted across trees through a mosaic of dispersal limitations and heat, and reshuffled through shifts between direct and indirect impacts of heat, ultimately contributing to the emblematic species diversity of forest canopies.

# Forest ecology in a context of global change (1/3) - Salle 1 22/11 ; 10:15-12:15

00018

## The contribution of insects to global forest deadwood decomposition

Oral

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### Abstract

The amount of carbon stored in deadwood is equivalent to about 8% of global forest carbon stocks. Deadwood decomposition is largely governed by climate with decomposer groups, such as microbes and insects, contributing to variations in decomposition rates. At the global scale, the contribution of insects to deadwood decomposition and carbon release remains poorly understood. Here we present a field experiment of wood decomposition across 55 forest sites on six continents. We find that deadwood decomposition rates increase with temperature, with the strongest temperature effect at high precipitation levels. Precipitation affects decomposition rates negatively at low temperature and positively at high temperatures. As net effect, including direct consumption and indirect effects via interactions with microbes, insects accelerate decomposition in tropical forests (3.9% median mass loss per year). In temperate and boreal forests we find weak positive and negative effects with a median mass loss of 0.9% and -0.1% per year, respectively. Furthermore, we apply the experimentally derived decomposition function to a global map of deadwood carbon synthesised from empirical and remote sensing data. This allows for a first estimate of  $10.9 \pm 3.2$  Pg yr<sup>-1</sup> of carbon released from deadwood globally, with 93% originating from tropical forests. Globally, the net effect of insects accounts for a carbon flux of  $3.2 \pm 0.9$  Pg yr<sup>-1</sup> or 29% of the total carbon released from deadwood, which highlights the functional importance of insects for deadwood decomposition and the global carbon cycle.



00042

## Aboveground impacts of a belowground invader – earthworm invasion alters aboveground arthropod communities in a northern North American forest

Oral

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Abstract

Strengthening global-change drivers alter ecological communities across the globe. Despite a lot of research on the consequences of these alterations, our understanding of how changes above the ground impact communities below the ground, and vice versa, is very limited. Declining aboveground arthropod communities have recently gained a lot of attention, with climate and land-use change among the most-frequently discussed drivers. Here, we focus on a seemingly underrepresented driver of arthropod community decline, biological invasions, and thus focus on the aboveground consequences of a belowground invasion. For approximately 12 000 years, earthworms have been absent from wide parts of northern North America, but they have been re-introduced with dramatic consequences. Most studies investigating earthworm-invasion impacts focus on the belowground world, resulting in limited knowledge on aboveground-community changes. We present observational data on earthworm, plant, and aboveground-arthropod communities in 60 plots, distributed across areas with increasing invasion status (low, medium and high) in a Canadian forest. We analysed how earthworm-invasion status and biomass impact aboveground arthropod community abundance, biomass, and species richness. Additionally, we assessed how earthworm impacts cascade across trophic levels, from detritivores and plants up to herbivores, omnivores, predators, and parasitoids. We sampled approximately 13 000 arthropods, dominated by Hemiptera, Diptera, Araneae, Thysanoptera and Hymenoptera. Total arthropod abundance, biomass and species richness declined significantly from areas of low to those with high invasion status, with reductions of 61, 27 and 18%, respectively. Structural equation models suggest that earthworms directly and indirectly impact arthropods across trophic levels. Our results show that earthworm invasion can alter aboveground multitrophic arthropod communities and suggest that belowground invasions might be underappreciated drivers of aboveground arthropod decline. These findings are a powerful example of how global-change related alterations in one system can have knock-on effects in adjacent system – a subject that is still largely underrepresented.

**00064**

# **A silvicultural manipulation experiment on microclimate and regeneration in European beech forests**

Oral

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## Abstract

Regeneration determines future tree species composition and forest structure driving ecosystem services and providing habitat for numerous species. Increasing extreme weather events may endanger regeneration and alter development pathways. Canopy trees potentially buffer weather extremes, thus protecting regeneration. In 2015, three years before a drought episode hit Central Europe, we established a silvicultural manipulation experiment with a factorial block design in European beech (*Fagus sylvatica* [L.] dominated forests. Our objectives were (i) to analyze treatment effects on the forest microclimate, and (ii) to assess the drivers of regeneration density, species diversity, and structural diversity.

At five sites, we established two canopy removal patterns (aggregated and distributed canopy openings), four deadwood treatments (removed, downed, standing, downed+standing), and one untreated control plot. We recorded microclimatic conditions for the summers of 2016-2020, measured light availability above tree regeneration, and derived browsing condition, species, and height class for each sapling. We employed Bayesian multilevel models to analyze treatment effects on microclimate and to quantify regeneration drivers.

The buffering capacity of intact forest canopies was higher in warmer and drier years. An increase in understory light levels of 10 % relative to closed canopies elevated maximum temperature ( $T_{max}$ ) and maximum vapor pressure deficit ( $VPD_{max}$ ) by 0.42°C and 0.04 kPa, respectively. While tree regeneration was positively associated with understory light levels,  $VPD_{max}$  influenced tree regeneration negatively. Deadwood presence and type neither altered forest microclimate nor tree regeneration notably.

Our study indicates that microclimatic buffering under forest canopies can dampen extreme weather events. Gap sizes typical for individual-tree or group-selection cuts did not strongly impair regeneration success of European beech during drought as our experimental plots maintained a sufficient microclimate. However, negative effects of  $VPD_{max}$  on regeneration indicate that gap sizes need to be limited when drought intensity increases in order to safeguard regeneration success.

**00068**

## **What processes lie behind the recent changes of forest vegetation ? An insight on thermophilization and B-diversity**

Oral

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<sup>1</sup>Umr Silva Agroparistech - Nancy (France)

### Abstract

Climate change is already reshuffling forest communities toward an increase in warm-adapted species, at the expense of cold-adapted species, the so-called thermophilization. Thermophilization has been widely studied as an increment of the mean climatic optimum (in °C) of species present in a given community. However, such measures overlook the demographic dynamics at play, extinction of present species and colonization of new species, and the impact of these dynamics on landscape-scale diversity,  $\beta$ -diversity.

We used the French National Forest Inventory to pair geographically close floristic plots done ten years apart. This balanced pairing across the territory is then used to infer thermophilization and  $\beta$ -diversity changes at the Sylvocoregion scale, a unit that divides French forests based on homogenous soil and climate condition. We then partitioned both of these changes into four components; extinction and colonization, of cold and warm-adapted species. We also assessed the relationship between those components and climate.

We found a significant thermophilization of 0.10°C/decades, driven almost exclusively by the extinction of cold-adapted species. Thermophilization was faster in Mediterranean climates (up to 0.25°C/decades), due to a greater contribution of extinction. While we didn't observe a significant  $\beta$ -diversity change at the Sylvocoregion scale, we found a previously hidden pattern with opposite directions: Extinction of cold-adapted species and colonization of warm-adapted species are detrimental to  $\beta$ -diversity.

Those results confirm previous thermophilization studies but complement them by integrating the community dynamic underlying them. An extinction-driven thermophilization challenges the idea that thermophilization is a signal of community adaptation, as it reflects the dieback of already present species. We did not observe significant  $\beta$ -diversity change, but the detrimental effect on  $\beta$ -diversity of cold-adapted species loss reveals that rare species are as much impacted as common species, as a result, warm-adapted species may become more common.

Climate change have visible impact on ecosystems, such as thermophilisation but also subtle or slow changes, such as  $\beta$ -diversity change. By studying hidden pattern, we can deepen our understanding of the processes at play, as well as detects early indicators of visible changes.

00079

## Interactive effects of abiotic factors and biotic agents on Scots pine dieback : A multivariate modeling approach in southeast France

Oral

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Abstract

Forests are increasingly subject to the risk of dieback with climate change. Productivity losses and increased defoliation and mortality rates have already been recorded for many tree species worldwide. However, dieback is a process that depends on complex interactions between many biotic and abiotic environmental factors acting at different scales, and is thus difficult to address and predict.

**Our aim was to build tree- and stand-level foliar deficit models integrating biotic and abiotic factors** for Scots pine (*Pinus sylvestris* L.), a species particularly threatened in Europe, and especially in the southeastern part of France. To this end, we quantified foliar deficit in 1740 trees from 87 plots distributed along a set of environmental gradients. We also measured tree annual radial growth and the abundance of two parasites: the pine processionary moth (*Thaumetopoea pityocampa* Den. & Schiff.) and mistletoe (*Viscum album* L.). Topographic, soil, climate and water balance indices were assessed for each plot, together with the stand dendrometric characteristics. Given the large number of environmental factors and the strong correlations between some of them, models were developed using partial least square (PLS) regression.

All the models pointed to a **preponderance of biotic factors** (mistletoe and processionary moth) in explaining the intensity of foliar deficit at both tree- and stand- level. We also show that **strong interactions between climate, soil, water balance and biotic factors help explaining the intensity of dieback**. Dieback was thus greater in the driest site and climatic conditions where the mistletoe and processionary moth were present.

Dieback risk models were also computed. They are used in the **Android application Bioclimsol**. This tool is designed to be operational in the field. It also allows foresters to feed the database with new observations and interpretations, and thus to continuously help improving the models.

This is a **great innovation** in the context of climate change.

We present a example of using bioclimsol for the complex decline of Scots pine but this type of model has presently been developed for 12 tree species.

00131

## Tree species, soil texture and landscape fragmentation shape ant communities in urban Mediterranean woodlands

Oral

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<sup>1</sup>Cefe, Univ Montpellier, Cnrs, Ephe, Ird, Univ Paul Valéry - Montpellier (France)

### Abstract

Urbanization contribute to the decline of biodiversity by impacting the environment at the local scale and at the landscape scale. In spite of this observation, woody spaces remain in cities and are considered as “hot spots” for some organisms but little is known about the biodiversity sheltered in their soils. Among soil organisms, ants are considered as engineers and ensure many ecological functions (cycle of organic matter, biocontrol). The scarcity of studies is even greater in Mediterranean context, despite the fact that this region is a hot spot for ants but also suffers a strong urbanization.

The main objective of this study is to explore the effects of urbanization at the local (dominant tree species, vegetation measures and soil variables) and landscape (composition and configuration) scales on ant communities. We compared two types of woodlands characteristic of the Mediterranean region: dominated by holm oak species and dominated by Aleppo pine species. In 24 sites located in the metropolis of Montpellier (France) and distributed along a gradient of urbanization, we sampled ants with the method of trap-pots placed in spring 2020. We also measured the physico-chemical properties of the soil (texture, organic matter, trace metals), the vegetation and the landscape.

Our communities are composed mainly by common species of the Mediterranean woodlands like *Aphaenogaster ichnusa*, *Crematogaster scutellaris*, *Temnothorax lichtensteini* and *Formica gagates*. In total 15 species were sampled with an average of  $5 \pm 2$  species per site. Using GLMs and RDA we found a significant effect of tree species on ant with a positive effect of pine on specific abundance and richness. A significant negative effect of landscape (fragmentation) and positive effect of soil (texture/heavy metals) were also found. Our study has allowed us to highlight factors influencing ant communities at both local and landscape scales, allowing a better understanding of the response of ants to urbanization in the Mediterranean urban woodlands

00146

## How do tree size, functional traits and climate drive disturbance-induced tree mortality across European forests?

Oral

J. Barrere <sup>1</sup>, B. Reineking <sup>1</sup>, T. Cordonnier <sup>1</sup>, N. Kulha <sup>2</sup>, J. Honkaniemi <sup>2</sup>, M. Peltoniemi <sup>2</sup>, G. Kunstler <sup>1</sup>

<sup>1</sup>Inrae Lessem - Grenoble (France), <sup>2</sup>Luke - Helsinki (Finland)

### Abstract

Tree mortality is a major demographic process, which can occur both steadily in time and space (i.e., background mortality), and sporadically due to biotic (e.g. herbivory) and abiotic (e.g., windstorm, wildfire) disturbances. As the severity and frequency of disturbances are predicted to increase, identifying how disturbance events drive tree mortality is crucial to predict the influence of climate change on forest dynamics. Local studies have identified tree size and species-level traits as potential drivers of disturbance sensitivity, but a quantification of the effect of these factors at the continental scale and for various types of disturbance is still lacking. Furthermore, it remains largely unknown whether and how climatic conditions influence disturbance mortality.

In this study, we used more than 10000 permanent plots of the French, Spanish and Finnish National Forest Inventories (NFIs) that were disturbed, with three categories of disturbances: storm, fire and "other". We used a Bayesian framework to model annual disturbance-induced mortality probability for the main European tree species. We tested the correlation between the modelled disturbance sensitivity and species traits and optimal climatic conditions.

We were able to estimate disturbance-induced mortality as a function of tree size, dominance status, disturbance nature and intensity. Tree size had an overall negative effect on fire sensitivity, and a positive effect on storm sensitivity for dominant trees. Species with a high height to dbh ratio and low wood density and root depth were more sensitive to storm, while species with high leaf thickness and low wood density and stomata conductance were more sensitive to fire. Species optimal climatic conditions were not related to their sensitivity to disturbances.

Our results provide crucial knowledge to understand how changes in disturbance regimes might affect forest community assemblies in Europe.

**00160**

## **Biodiversity and carbon sequestration in forests along a management intensity gradient**

Oral

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### Abstract

Forests shape the landscape in Central Europe. They play a crucial role both in terms of biodiversity conservation and carbon sequestration. They are also of great economic importance in the context of timber production. However, knowledge about the interaction between site type, forest use, biodiversity and carbon storage is still scarce.

In our project, we established in total 200 plots in four regions in North Rhine – Westphalia, Germany, representing four typical forest types in this area. In each of these four regions, we span a management intensity gradient ranging from unmanaged deciduous forests to intensively used forests dominated by non-native tree species (mainly coniferous trees). On these plots, we generated amongst others data on above- and belowground carbon stocks, forest development and forest structure, chemical and geophysical soil properties, vegetation structure and composition and above- and belowground animals ranging from springtails to birds.

First results show, that tree species identity has strongest effects both on carbon sequestration and plant- and animal community composition with big differences in coniferous forests compared to deciduous forests. Within deciduous forests, we see higher above- and belowground carbon stocks in older, unmanaged forests compared to managed sites. However, herbaceous plants benefit from skid trails in managed forests. Some animals (e.g. beetles) are not affected regarding individual numbers or species richness but show a species turnover between different forest stands with many specialists associated with specific microhabitats or plant species, whereas other animals (e.g. earthworms) seem to be almost not affected by forest management.

Within the project, we stand in contact with forest practitioners and hope to propose general recommendations how forests owners can cultivate their forests that all three goals: biodiversity, carbon storage and sustainable timber production can fit together.

## Forest ecology in a context of global change (2/3) - Salle 1 22/11 ; 13:45-15:45

00179

### Local and regional variability in crown dieback of European beech after the 2018 drought depends on climatic and edaphic drivers

Oral

S. Klesse<sup>1</sup>, E.R. Frei<sup>1,2</sup>, A. Neycken<sup>3</sup>, G. Von Arx<sup>1,4</sup>, M.M. Gossner<sup>1,3</sup>, Y. Vitasse<sup>1</sup>, V. Queloz<sup>1</sup>, A. Gessler<sup>1,3</sup>, F. Hagedorn<sup>1</sup>, M. Lévesque<sup>3</sup>, K. Meusburger<sup>1</sup>, A. Rigling<sup>1,3</sup>, T. Wohlgemuth<sup>1</sup>

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Abstract

The exceptional hot drought 2018 in Central Europe caused widespread premature leaf senescence in European beech (*Fagus sylvatica* L.) forests. We monitored the development of crown condition in more than a thousand mature beech trees of even-aged beech-dominated stands in northern and north-western Switzerland from 2018 to 2021 and related the observed damage to multiple climate- and stand-related parameters. In addition, we analyzed tree-ring widths of a subsample of trees aiming at identifying predisposing factors responsible for differences in crown damage across and within stands such as tree growth characteristics (ring-width patterns) and site conditions (e.g., soil properties).

Cumulative tree mortality continuously increased from 0.0% in 2018 to 4.4% in 2021. Mean crown dieback in surviving trees peaked at 25.3% in 2020. Thereafter, trees showed first signs of recovery. Generally, crown damage was related to the climatic water balance and radial growth to soil water availability. Recovery was slower in trees growing on drier sites, which generally showed a higher level of crown damage. Within-stand variation of post-drought crown damage corresponded to growth rate and tree diameter, i.e., smaller and slower-growing trees under higher inter-individual competition were associated with increased crown damage after the drought 2018.

These findings point to context-specific differences in beech mortality and recovery reflecting the importance of regional and local climate and soil conditions. Our results suggest that European beech is less likely to cope with future climate change-induced extreme droughts on shallow soils with low water retention capacity. This underlines the importance of adapting management strategies to increase forest resilience.

S.K. and E.R.F. are co-first authors.



**00194**

## **The effects of retention forestry on large terrestrial mammals in Central European forests**

Oral

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### Abstract

Retention forestry – the retaining of deadwood and a portion of the original stand at the moment of harvesting - was introduced as a conservation tool to mitigate the negative impact of transformation and homogenization of forests. As it is now common practice in Central European forests, the design of efficient retention strategies hinges on ecological knowledge, yet research-based evidence for its effectiveness is lacking especially for the terrestrial mammals in temperate forests. We addressed this knowledge gap by investigating how the large mammal community changed in response to varying levels of retention forestry in the Black Forest in Southwestern Germany. We deployed camera traps in 135 one-ha plots embedded in patches of mixed-montane forests, and that differed along two gradients of retention forestry and landscape fragmentation. We used multispecies hierarchical modelling in a Bayesian framework to estimate occupancy of mammal species. A total of 17 species was recorded, and while species richness did not differ with different amount of standing deadwood (a proxy for retention amount), species composition changed with both standing deadwood and forest cover surrounding the plots. Specifically, the majority of the species benefited from a higher amount of standing dead trees, possibly because of more abundant hiding cover, and forage availability. In contrast, a few species such as the marten and the roe deer were more abundant in areas with lower retention. A thorough understanding of how mammals respond to retention forestry and landscape configuration is important to develop accurate guidelines for sustainable forest management. Such Knowledge is also relevant as the Black Forest is located in the middle of other large forest massifs in Central Europe and therefore potentially acts as a stepping stone for forest species of conservation concern such as the Eurasian lynx that require large tracts of forest.

00212

## Impacts of tree species conversion on soil fauna and fungi communities in temperate forest.

Oral

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Abstract

In temperate forests, climate change is characterised by changes in local temperature and in precipitation intensity and temporality. Hence, present tree populations face in a near future the risk of living out of their optimal ecologic range. This would aggravate forest dieback and also impact forest services such as woody biomass production and ecosystemic carbon storage, that are critical for the mitigation of climate change. In order to adapt forests to global change, forest managers are changing their practices, thus impacting current biodiversity for instance in forest soils hosting complex multi-taxonomic networks. What soil species are being sent to the front against climate change by adaptive forestry and what are the functional traits linked to them? In partnership with the ONF (French national forest office) we selected 4 types of tree species substitution in five Normand forests along the Seine river encompassing 69 independent stands. The two first substitutions involve deciduous trees: from mature *Fagus sylvatica* towards young *Quercus* sp. with either a regular (plantations) or irregular (selective regeneration) management. The two others are substitutions from mature *Pinus sylvestris* to young *Pinus nigra* var. *corsicana* or to *Quercus rubra* plantations. We sampled soil (0-15cm) and litter in 5 points within each stand to monitor soil fauna and fungal biodiversity by metabarcoding with the loci CO1 and ITS, respectively. Using the BOLD and UNITE databases we assigned a taxonomical identity to sequences using DADA2. Soil parameters were measured as well (total N content, litter C/N, soil water retention capacity), along with botanical surveys and trees basal area and light transmittance. We used LIDAR cartography and archeological expert knowledge in order to understand the potential impact of past land use. We identified the impacts of substitution on soil fauna and fungi using common descriptors of community diversity and also using the co-occurrence Dark biodiversity approach. Also, community composition data was used along ecological traits retrieved from databases (Funguild, Nemaguild, BETSI) to highlight what traits and ecological functions can be associated or lost with practices of climate change-adapted forestry.

00216

## Drivers and dynamics of the timing of foliar senescence in temperate deciduous forest trees at their southern limit of distribution in Europe

Oral

P. Zuccarini <sup>1</sup>, N. Delpierre <sup>2</sup>, B. Marien <sup>3</sup>, J. Peñuelas <sup>1</sup>, M. Campioli <sup>3</sup>

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### Abstract

Autumn phenology is traditionally less studied than spring phenology in deciduous forests, but its comprehension is crucial for understanding and simulating future tree growth. This is especially needed at the southern edge of the European temperate zone where climate change impacts are expected to be particularly intense. We monitored the autumnal patterns of foliar chlorophyll content and canopy greenness, from which we derived the timing of foliar senescence, for mature stands of *Fagus sylvatica* L., *Populus tremula* L., *Betula pendula* Roth, *Quercus petraea* (Matt.) Liebl., and *Quercus robur* L. during four years (2017-2020) in northern Spain. Senescence timing was correlated to meteorological conditions and compared to similar relationships for central temperate forests from Belgium. We also compared these data to longer-term time series (1997-2019) of senescence timing and their relationships with climatic variables for southern edge temperate forests in southern France. Senescence dynamics differed significantly among the species analysed, on the basis of foliar growth patterns (indeterministic vs deterministic) and different wood anatomies (ring-porous vs diffuse-porous). The senescence timing of the different species was sensitive to different climatic factors, e.g. both precipitation and temperature for *Q. petraea*, while only temperature for *F. sylvatica*. Long-term data series from the French sites did not identify significant interannual trends in the timing of senescence and thus no delay or advance in the last 25 years. In the long-term, the main driver of the timing was late spring/early summer temperature. Populations of *F. sylvatica* and *B. pendula* from Belgium, at the centre of their distribution, were more prone to earlier senescence in dry and warm years than their counterparts from Spain. This indicates relatively limited constraints represented from heat stress or water scarcity at the southern limit of distribution, especially for *F. sylvatica*. We can conclude that temperatures have a stronger discriminant role than precipitations on autumn phenology of temperate forests at their southern edge, and that despite the liminal area of distribution analysed and the ongoing climate change, water and heat stress do not impair yet their overall vegetative performances. Future studies covering periods longer than 25 years would be useful to highlight ongoing phenological trends.

00259

## Patterns of carbon allocation to fine root exudation in monospecific and mixed stands of a temperate forest under drought and after re-watering

Oral

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Abstract

In recent years, important processes controlling ecosystem carbon dynamics have been connected to fine root exudation of soluble carbon compounds. Root exudates influence plant interactions and plant susceptibility to, and recovery from drought. Recent investigations suggest that root exudate release is correlated with soil water content, but quantification of the amount of carbon released from roots across soil depths with differing water availability or species interactions, are missing.

We tested if root exudation rates were negatively correlated with soil water content across soil depths under drought and if trees recovering from drought exuded more carbon when root growth resumed compared to drought-stressed trees. We further tested if species in mixture, usually more drought resistant, exuded more carbon under drought and returned to exudation rates of control trees faster after re-watering than species in monospecific environments. Exudates were sampled in a mature *Fagus sylvatica* L. and *Picea abies* (L.) Karst. forest at the end of a five-year throughfall exclusion period and again after one year of drought recovery. We quantified root exudates and their variation with soil depth for both tree species in monospecific and mixed species zones.

Carbon exudation increased in fine roots exposed to dry soils (< c. 10vol-% SWC), with fine roots growing in surface soils exuding the most, even one year after re-watering. Under drought, exudation amounted to 1.0% ( $0.11 \pm 0.04$  g m<sup>-2</sup> d<sup>-1</sup>, *F. sylvatica*) and 2.5% ( $0.12 \pm 0.04$  g m<sup>-2</sup> d<sup>-1</sup>, *P. abies*) of net carbon assimilation, respectively. One year after drought release, overall exudation rates by single root segments were unchanged compared to drought conditions, but increased root production suggested increased belowground carbon allocation to exudates during drought recovery. *Fagus sylvatica* tended to exude more carbon when in mixture with *P. abies* compared to its monospecific zone, especially under drought, while mixing had no effect on the quantity of carbon exuded by *P. abies* trees.

Our results demonstrate that carbon is released preferentially in the surface soil layers exposed to more variable soil water contents and whole-tree exudation is maintained even among variable carbon assimilation rates throughout dry and moist environmental conditions.

00327

## Monitoring saproxylic beetles and fungi in Swiss forest reserves – baseline reveals moderate differences in diversity patterns compared to managed forests

Oral

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Abstract

Setting aside forest areas as natural reserves is one important measure for the conservation of biodiversity in Central European forests. This measure aims at fostering late forest development phases which are extremely ecologically valuable, but rare in managed forest landscapes. Through increasing the occurrence of old moribund trees and the amount of dead wood, these forests can develop to biodiversity hotspots, especially for deadwood dependent organisms (saproxylics). In Switzerland, most of these reserves are still quite young and recovering from intensive management in the past. This represents an ideal baseline for a monitoring program. We sampled saproxylic beetles and fungi on 176 plots within eight study regions in European beech forests (*Fagus sylvatica*) in the Swiss lowlands. As reference for unmanaged forests, a comparable managed forest stand was selected for each reserve and sampled using the same methods.

Beetles were sampled using flight interception traps. Fungi were recorded on 4 standardized lying deadwood objects per plot and complemented with an opportunistic visual search. Both taxa were sampled during two consecutive years per region. Additionally, structural forest variables such as dead-wood volume, tree species and diameter, tree related microhabitats and canopy openness were documented on each plot.

Gamma diversity was significantly higher in forest reserves than in managed forests for both taxa, whereby the differences were greater for fungi than for saproxylic beetles. Species richness between the two management categories differed from region to region with certain managed stands showing a higher species richness than the corresponding reserve. Alpha diversity was mainly driven by the management type (managed and reserve) and the interaction between management type and deadwood volume showing stronger positive effects of dead wood in managed stands than in reserves. Our results show that setting aside forest reserves promote saproxylic species diversity already in the initial phase of recovering from management. The differences between the two management types are likely to increase in the next decades due to the increase in old-growth structures in reserves and the expected increase in pressure on managed forest because of rising wood fuel exploitation.

**00342**

## **Drivers of tolerance: ash saplings in a reciprocal transplant experiment**

Oral

K.S. Haupt <sup>1</sup>, K. Mausolf <sup>1</sup>, J. Schrautzer <sup>1</sup>, J. Richter <sup>1</sup>, A. Erfmeier <sup>1</sup>

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### Abstract

In the past decades, the ash dieback disease caused a rapid decline of European ash trees (*Fraxinus excelsior* L.) in forests all over Central Europe. Numerous studies focus on mitigating the negative impacts of ash dieback to forest ecosystems or identifying resistant genotypes. The role of natural adaptability of ash rejuvenation towards an infection with ash dieback is less frequently studied with experimental means to date. This is, however, directional in times of global change, because the preservation of ash trees in Europe's forests will depend, above all, on the adaptability of the future generations of ash trees.

In a reciprocal transplant experiment, we aim to quantify the extent and effects of ash dieback severity at origin and target sites for ash rejuvenation and identify the influence of additional environmental factors. Across ten sites in the eastern moraine landscape of Schleswig-Holstein, Germany, we established a reciprocal transplant experiment with one to two year old naturally rejuvenated ash saplings used as transplants. Forest stands were selected according to the infestation situation of the remaining mature ash trees, which resulted in five severely damaged and five moderately damaged stands. Along with the plot wise establishment of the experiment, a shading treatment was added to half of the plots.

With this approach, we tested sapling performance, productivity, functional parameters and susceptibility to ash dieback for a) origin effects (i.e. local adaptation), b) target site effects and c) interactions between origin, target site and functional parameters.

While performance (e.g. basal diameter increment) and productivity parameters (e.g. below ground biomass) were influenced by site conditions (e.g. soil pH) and damage severity at the target site, functional parameters (e.g. specific leaf area) were also affected by site conditions and damage severity of their home site. Most notably, saplings from severely damaged home sites showed significantly fewer symptoms of ash dieback infection than saplings from moderately damaged home sites. Such pronounced effects due to the sapling's origin suggest some filtering processes to act among regenerating ash juveniles. Evidence of natural selection for more resistant genotypes and their contribution to the adaptation of ash will be discussed.

## Forest ecology in a context of global change (3/3) - Salle 1 22/11 ; 16:15-18:15

00388

### Maturation size in forest trees driven by maximum size, also depending on climate

Oral

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Abstract

Maturation size could be controlled by environment or by a simple scaling with maximum tree size. Size at maturity affects population dynamics, fitness, and recovery from disturbance, so understanding how it varies across species and environments is a goal of ecological research. Because trees can require several decades to reach maturity, and reproduction is extremely variable from year to year, estimating size at maturity is challenging. Dynamic models mostly assume a fixed size threshold for reproduction, while some literature suggests that maturation size increases with the maximum potential size for the species. Additional factors, such as reproductive traits (seed mass and species fecundity) and climate might contribute to variation of species tree size at maturity. Using a global synthesis of seed production from tropical to boreal tree species, we estimated individual fecundities considering tree attributes and climate. The large Masting Inference and Forecasting (MASTIF) network allowed us to estimate maturation sizes on 500 species. Maturation sizes ranged from 4 to 51 cm, explained primarily by maximum diameter. However, the overall ratio between maturation and maximum sizes indicates an allometry to its own maximal diameter (scaling exponent = 0.65) resulting in smaller relative size at maturity for species with large maximum diameter. In addition to the effects of maximum size, maturation size decreases with temperature and, to a lesser extent, it increases with seed size. Results have immediate application to regeneration processes in forest models used to understand dynamics and resilience.

00415

## The effect of stand species composition on the spring phenology of four common European tree species

Oral

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### Abstract

Phenology is the study of regular reoccurring life cycle events and their timings. One of the most visual phenological events in plants is the budburst and following greening in deciduous trees. This marks the start of the tree's growing season and therefore the production of photoassimilates, water uptake and gas exchange among many others. A multitude of studies has established climatic cues, especially temperature, as the main driver of budburst timing. Despite this, however, current phenology models, based on climatic factors only, still fail to accurately predict the timing of budburst, and in turn the overall growth season length, at the regional and continental level. In fact, at larger scales, budburst shows spatial variability among forests, of which only about half can be attributed to the variability of climatic factors. We hypothesize that the local species composition could shape plasticity in spring phenology on a stand level as the risk-benefit balance for having a very early, or vice-versa very late, budburst depends on the number of competitors for a species-specific budburst timing. We tested this by studying the spring phenology of four common, but ecologically quite different, European tree species (*Fagus sylvatica*, *Quercus robur*, *Tilia cordata* and *Betula pendula*) at the FORBIO experimental site in Zedelgem, Belgium for two seasons. FORBIO is a common garden experiment established in 2009 with tree stands of varying species composition. We conducted spring phenology observation in the monospecific stands and in stands composed of four different species, establishing several proxies describing the overall process of leafing out e.g. the established variable at which half of the observed buds have reached budburst and the start and end of the leaf-out process. While budburst timing of three species showed no difference between these configurations, *Fagus sylvatica*'s spring phenology was significantly advanced in the four species environment in 2021 by about 17 days. The data from a second field campaign (in 2022) will also be presented in this contribution to consolidate these findings and include different spring conditions. Our results highlight the importance to integrate non-climatic factors into current phenology models.



00474

## Three centuries of changes in fire frequency in Corsican black pine forest inferred from dendrochronology

Oral

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Abstract

Mediterranean-type ecosystems and landscapes have been shaped in large part as a function of the flammability of vegetation and by the frequent fires induced by climate and human activities since centuries to millennia. Land abandonment of farming and forestry uses led to a recent increase of the fuel load. The combined effect of fuels and climate warming likely increase the fire risk.

Corsican black pine (*Pinus nigra* var *laricio*) is an endemic species of Corsica forming pure or mixed woodlands in the montane belt, threatened by the more fire prone and competitive *Pinus pinaster* in lower altitude. Model-based studies suggest that the natural area of *P. laricio* is altered by natural disturbance (wildfires) and by human activities (pasture, logging and fires).

Here we test the hypothesis that fire frequency decreased since the late 19th century and that fire severity increased during the 20th century. We inferred fire occurrence and frequency is inferred from dendrochronological analysis (crossdating of tree-rings) of fire scarred tree samples, and fire severity from the extent of stand-replacing fire in Vizzavona-Sorba Pass (1000-1400 m elevation) situated in the center of Corsica. Fire scars revealed a pattern of fires over the last three centuries, but the fire regime changed between early and late 20th century. Fire size varied between fires, from a few hectares (stand scale) to thousands of hectares (the whole forest). Fires occurred mainly when trees produced their latewood, suggesting a peak of the fire season in summertime.

Combined with a geomatic approach, dendrochronological results allow us to analyze changes in fire regimes (frequency, season, area) in the Corsican black pine forest ecosystem. In subsequent analyses, the main climatic and societal drivers that drove the change in fire regimes will be enhanced by cross-analyses with climatic and land use data (forestry, traditional husbandry, land use map). These outputs will contribute to improve the knowledge on drivers of change in fire regimes in the Corsican black pine forest, providing stakeholders and land managers with rational information in a perspective of sustainable forest management in a threatened southern European socio-ecosystem.

00517

# Drought impacts on tree annual growth, vitality, and mortality risk

Oral

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Abstract

Drought is a key limiting factor of vegetation development, whose importance increased with climate change. Among others, drought-induced reductions in forest productivity and increases in mortality rates have been reported over the last decades in many biomes. In this presentation, we will detail some mechanisms behind these observations by focusing on the impacts of drought on tree annual growth, vitality, and mortality risk.

Concerning tree annual primary and secondary growth, we analyzed stem radial growth, shoot elongation, the number of ramifications, and leaf size and number from Aleppo pine (*Pinus halepensis*) growing at the Font-Blanche long-term monitoring site. There, we studied the development of pine trees for 14 years in two control plots, a rainfall exclusion plot where 30% of the rain have been excluded by PVC gutters, and a plot that was irrigated in 2009-2010 and in 2021-2022. In addition, sap velocity and the main environmental drivers (meteorological and soil conditions) have been recorded to highlight how drought-induced changes in tree growth and leaf area affects the water and carbon demand and use (Moreno et al. 2021).

We will then show that these functional and structural changes can be also observed at larger scales by analyzing multi-species databases of tree leaf deficit from French and European networks. They can also impact mortality probability through hydraulic failure and/or carbon starvation as shown in modelling experiments (Trugman et al. 2018), controlled chamber experiments (e.g., Adams et al. 2017), but also indirectly in the field by comparing the growth patterns between dying and surviving trees, what we have done for 36 species at 190 sites (Cailleret et al. 2017; De Soto et al. 2020).

These results highlight the need for an integrated approach considering short- and long-term impacts of drought on various components of tree growth to better understand and predict the mortality process.

## References

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**00553**

## **How do irradiance and leaf phenology influence the carbon storage dynamics along the vertical gradient of mature tree crowns?**

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.  
Eco-physiology

Oral

C. Zahnd<sup>1</sup>, L. Zehnder<sup>1</sup>, M. Arend<sup>1</sup>, A. Kahmen<sup>1</sup>, G. Hoch<sup>1</sup>

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### Abstract

Irradiance is strongly reduced along the vertical gradient of mature tree crowns, leading to reduced assimilation rates in lower leaves. With leaf phenology potentially varying along the same gradient, it is likely that seasonal non-structural carbohydrate (NSC) dynamics differ considerably between twigs in the upper and lower crown.

We utilised the Swiss Canopy Crane II research site near Basel, Switzerland to study how the light environment and leaf phenology influence the NSC dynamics along the vertical canopy gradient of mature temperate trees. Throughout the year 2020, we measured NSC concentrations in twigs from the upper- and the lower crown of mature trees from six broadleaved and three conifer species. We further assessed leaf phenology along the vertical gradient and continuously recorded irradiance in various locations within the tree crowns.

In the broadleaved species, there were barely any differences in the bud break timing within the crowns, however, the lower branches of the conifer trees opened buds between 2 and 7 days earlier than the top branches. Daily irradiance in the lower crowns was reduced by ca. 70% relative to the top throughout the season. Despite these strong differences in light availability, NSC concentrations in upper and lower twigs were strikingly similar in most species throughout the year, particularly so towards the end of the season. Only the two ring-porous species *Quercus petraea* x *robur* and *Fraxinus excelsior* showed some differences in the NSC dynamics: in both, shade twigs reached the minimum xylem starch levels after bud break ca. 1 week later than the sun twigs and were delayed in the subsequent refilling of reserves.

The very similar NSC concentrations support the idea of an actively regulated, rather than passively driven NSC pool in trees. Calculating a twig-level carbon balance will help to clarify whether morphological acclimations (e.g. specific leaf area and leaf area to twig mass ratio) fully compensate for the lower assimilation rate in the shade twigs or whether these twigs invest proportionally more assimilates in their NSC pools.

00645

# Climate change and tree growth dynamics of European beech and Scots pine across strong precipitation gradients in North Germany

Oral

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Abstract

Increasing exposure to climate warming-related drought and heat threatens forest productivity in many regions on earth, with the trees' vulnerability likely depending on local climatic aridity, recent climate trends, edaphic conditions, and the drought acclimatization and adaptation of populations. Studies exploring tree species' vulnerability to climate change often have a local focus or model the species' entire distribution range, which hampers the separation of climatic and edaphic drivers of drought and heat vulnerability. We explored recent radial growth trends and the sensitivity of growth to drought and heat in central populations of the widespread and naturally dominant forest tree in Europe, European beech (*Fagus sylvatica*), at 30 forest sites across a steep precipitation gradient (500–800 mm year<sup>-1</sup>) of short length in order to assess the species' adaptive potential. We compare the results of beech with the important timber species Scots pine (*Pinus sylvestris*) at 10 sites along a similar gradient. In beech, size-standardized basal area increment trends were stable during the period of accelerated warming since the early 1980s in populations with >360 mm growing season precipitation (April–September), while trends declined at sites with <360 mm. A decadal decrease in summer climatic water balance was the most important factor leading to growth decline, amplified by higher tree density. Drought is the most influential climatic factor for annual increment variation, with the effect being stronger at warmer and sandier sites with higher competition intensity. Pine, on the other hand, did not experience a significant decline in growth, probably because its sensitivity to drought and heat is still offset by the warming in spring, which stimulates growth in this evergreen conifer. We conclude that beech is recently facing growth declines at drier sites in the centre of its distribution range due to climate change-related aridification. The productivity of Scots pine may also decline in the future if warmer springs can no longer compensate for the negative effects of warmer and drier summers. However, our results also caution against deriving local predictions of tree vulnerability from climate projections alone, as soil and stand properties emerged as factors mediating climate sensitivity.

00653

## Successional rates on deadwood resource resemble botanical succession and are not affected by abiotic harshness

Oral

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Abstract

Ecological succession is the study of the sequence of species after a disturbance. The pattern of succession depends on the succession system. Currently, it is not well understood whether successional rates on deadwood resources follow the successional patterns of ephemeral resources or those of classical botanical succession.

To test botanical and ephemeral successional pattern for dead wood resources, we used a dead wood experiment with a time series of 10 years, standardized for a shared disturbance event (cutting). We quantified successional rate as species gain/loss. Following successional theory, we tested whether succession of wood-inhabiting fungal communities follows a decelerating decrease (botanical succession) or linear decrease (ephemeral succession) pattern. We further exposed logs and branches of dead wood of two tree species to favorable and unfavorable conditions (canopy openness). From successional theory we would expect significantly different initial succession with lower gain rates for unfavorable conditions.

We found that succession of fungi on dead wood was best described by decelerating decrease, suggesting pattern and processes similar to botanical succession. The species gain rates did not significantly differ among tree species and size. Further, although species gain rates exponentially declined, they occurred in recurrent waves if year-to-year means are considered. Our results indicate congruency between classical botanical succession and succession on dead wood resources, however, also challenge predictions of successional theory, as we did, not observed altered successional trajectories under unfavorable conditions.

00665

## Previous year's climatic conditions drive foliation response of European beech (*Fagus sylvatica* L.)

Oral

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Abstract

In the wake of recent drought events such as 2018-2019 as well as the last known benchmark year 2003 a decline in crown vitality was observed across Central Europe for European beech (ICP Forests Technical Report 2020). Therefore, it becomes more and more important to investigate short-term impacts of the previous year's climate on the foliation responses, governing carbon fixation and indicating tree vitality. Here we apply a moving window analysis (dendroTools package in R) to detect the strongest correlations between daily climate data and foliation responses of European beech (*Fagus sylvatica* L.) on 30 Level II plots across Germany. A generalized linear model revealed foliation to be negatively influenced by the daily mean temperature and positively by the daily precipitation sum of previous year's summer across 30 plots. A positive significant effect at  $p < 0.1$  was found for temperature across a climatic water balance (CWB) gradient, indicating a stronger negative influence of temperature on drier sites. Across different soil types, the model also revealed significantly different responses on the effect of temperature on foliation. However, foliation recovery rates did not differ significantly between 2003 and 2018. Recovery in 2003 changed positively across CWB gradient, with some differences among soil types, but not in 2018. 2018 imposed more variations across plot-wise recovery responses, indicating that site climatic conditions or soil type alone may not influence the drought response. More information on soil properties such as available water capacity (AWC), as well as stand density information is needed to better quantify drought recovery of foliation. These will be included in the model to quantify the foliation recovery in European beech. A link between the legacy effects of foliation, and growth in future studies will be established to better understand responses of beech to exogenous influences. In the future, the investigation of lagged responses might reveal more accurate time estimates within a year triggering the physiological response. Moreover, buffering effects should be included in future analysis to quantify adaptive responses, especially under drought.

00062

## Context matters: the landscape matrix determines the population genetic structure of insect-pollinated forest herbs in European agricultural landscapes

Oral

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### Abstract

Plant populations in agricultural landscapes are mostly fragmented and their functional connectivity often depends on seed and pollen dispersal by animals. However, little is known about how the interactions of seed and pollen dispersers with the agricultural matrix translate into gene flow among plant populations. We aimed to identify effects of the landscape structure on the genetic diversity within, and the genetic differentiation among, spatially isolated populations of three temperate forest herbs. All three species are typical, slow-colonizing forest specialists, but differ in their reproduction strategy and associated pollen and seed dispersal vectors. We asked, whether different arable crops have different effects, and whether the orientation of linear landscape elements relative to the gene dispersal direction matters. We analysed the species' population genetic structures in seven agricultural landscapes across temperate Europe using microsatellite markers. These were modelled as a function of landscape composition and configuration, which we quantified in buffer zones around, and in rectangular landscape strips between, plant populations. In all three species, allelic richness was significantly reduced in smaller compared to larger populations, and their genetic differentiation was increased in smaller and spatially more isolated populations. Besides these effects of habitat loss and fragmentation *per se*, genetic diversity and differentiation were affected by a multitude of landscape effects. These were often contrasting between species, reflecting their association with different pollen- or seed dispersal vectors. Differentiating crop types rather than lumping them together yielded higher proportions of explained variation. Some linear landscape elements had both a channelling and hampering effect on gene flow, depending on their orientation. Our study shows that landscape structure is a more important determinant of the species' population genetic structure than habitat loss and fragmentation *per se*. Even species of the same ecological guild might show distinct responses to the landscape structure.

**00100**

## **The new assets of landscape ecology in the face of global challenges**

Oral

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Abstract

In an ever-changing world threatened by multiple, wide-ranging and sometimes sudden crises, the ecological sciences need to assess how they can contribute to effectively addressing these emerging issues. Landscape ecology has evolved significantly in recent decades. Its concepts, methods, tools and results open new perspectives and are particularly relevant to address problems for which intermediate scales, such as landscapes, seem to be the most appropriate for action. Moreover, landscape ecology can be mobilized to address a wide range of interrelated issues such as global health, climate change, biodiversity conservation and food security. Spatio-temporal heterogeneity, at the heart of landscape ecology concepts, is now seen as a way of adapting to global changes. Remote sensing data and methods could also provide useful information for analyzing evolution trajectories and steering the socio-ecosystems. Developments in spatial modelling are contributing to society debates with increasingly refined scenarios of expected or desirable changes to guide realistic and fair transitions. However, the production of new, finer and more precise data and knowledge is not always enough to trigger the necessary changes and to anticipate future crises. Interactions between scientists and territorial stakeholders are often crucial to move from knowledge development to action. Because landscapes are socio-ecological systems, the social dimension of landscape analysis, such as developed through european landscape ecology is an important axis in which a development of tools and concepts is urgently needed. This presentation urges scientists to take up these issues, to develop transdisciplinary research questions and methods and to disseminate their results widely to accelerate the necessary transitions.



00148

## Predicting species distributions from sparse survey data and remotely sensed environmental predictors – a how-to guide for everyone with basic knowledge in R

Oral

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Abstract

Species distribution models are important tools for explaining and predicting the spatial distribution of individual species or communities of species. Techniques capable of estimating precise species makeups of communities tend to be highly data intensive. A community composition modelling approach which allows to predict species distributions based on sparsely sampled survey data was proposed already in 2011. A basic idea of the approach is to combine  $\alpha$ - and  $\beta$ -diversity estimates. We hypothesize that missing easy-to-use software so far hindered the wider application of this method. The recently published *spectre* R package allows researchers to make predictions from sparse survey data in an easy-to-use fashion. Still, the complete path from collected survey data and environmental predictors to reliable species distribution predictions remains challenging, mainly because information about how to approach each individual step in the prediction process is distributed across a number of different publications. In short, the following steps are to be taken: estimate  $\alpha$ - and  $\beta$ -diversity distributions from field and remotely sensed data (i.e., species presence-absence data, environmental data); identify prediction sites; apply *spectre* to predict species presence-absence at prediction sites. We here present two complementary worked examples and a sensitivity analysis, and aim to answer the three following questions. How to generate the algorithm input estimates? How to identify which potential new sites are eligible to make predictions for them? How does uncertainty in input estimates affect the prediction quality? Using bird survey data and environmental predictors collected in Bangalore, India as an example, we predict species distributions in time (Example 1) and space (Example 2) and investigate the sensitivity of the algorithm to uncertainty in estimated  $\alpha$ - and  $\beta$ -diversity. At the end of this talk, the listeners will have a sound idea how this modelling approach works and if it is applicable to their data and research interests.

# 00204

## Follow the link(er)

Oral

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### Abstract

In agricultural landscapes, forest herb populations live in small, spatially isolated forest patches. For their long-term survival those populations depend on animal vectors as genetic linkers that provide pollen- or seed-mediated gene flow among the forest patches. However, whether insect pollinators serve as genetic linkers among spatially isolated forest-herb populations in agricultural landscapes remains to be shown. Pollinator types that differ in flight ranges and behavior have a different potential to transport pollen among forest patches. We used population genetic methods to test whether the genetic diversity and genetic differentiation of populations of two common, slow-colonizing temperate forest herb species in spatially isolated populations within three agricultural landscapes in Germany and Sweden are linked to the movement activity of their most relevant associated pollinator species, i.e., the bumblebee *Bombus pascuorum* (Scopoli, 1763) and the hoverfly *Melanostoma scalare* (Fabricius, 1794), respectively, which differ in their mobility. For the forest herb that was associated with bumblebees we found an increase of genetic diversity and a decrease of genetic differentiation with higher pollinator movement activity among forest patches. In contrast, we did not find such a correlation for the hoverfly and its associated forest herb. For movement indicators that reflected the total movement activity we found negative correlations for both plant-pollinator pairs. The most likely explanation of these unexpected patterns is an accelerated genetic drift due to enhanced sexual reproduction of the clonal forest herbs. Our integrated approach revealed that bumblebees serve as genetic linkers of associated forest herb populations, even if they are more than 2 km apart from each other.

**00234**

## **The older the better? How population age affects the genetic structure of spatially isolated forest herb populations.**

Oral

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### Abstract

Temperate forest is the common habitat for many herb species. It once covered a large part of central and Western Europe in preindustrial time. As time passed by, the landscape became deforested and changed into an intensively used agricultural landscape, i.e. a mosaic of patches mainly used for agricultural purposes, interspersed with patches of (semi-) natural habitats, such as forest fragments. Forest herb species living in these habitats lack traits for long-distance dispersal or fast colonizing and thus are threatened by long-term genetic erosion.

As a result of multiple land-cover changes, forest patches have different ages. Herb populations living in these patches can only be as old as the habitat itself. Older populations had a longer time for genetic exchange and mutation accumulation. Their current genetic structure may still reflect past landscape configurations, in which the landscape was less fragmented and more permeable for seed or pollen dispersion. Thus, we expect the age of populations to influence both their genetic diversity and genetic structure, and further their long-term fitness.

To test this hypothesis, we applied a multi-landscape setup and used both traditional population genetic measures as well as measures developed from population graph to compare the genetic structure of forest herbs populations with different population ages. We tested whether the relationships would be different among three slow colonizing herb species with different mating systems and associated pollinators.

We found that younger populations generally had a lower genetic diversity and a lower overall genetic connectivity compared to older populations. However, this effect was differently shaped in three species and not independent from population size and population spatial connectivity. In addition, pairwise genetic differentiation of population pairs involving young populations was higher than that of older population pairs. Genetic distance was longer than expected purely from geographical distance in younger population pairs while shorter than expected in older population pairs. Based on these, we could conclude that in a fragmented habitat, older slow colonizer populations are genetic fitter than younger populations.

**00254**

## **Can landscape resistance to gene flow be inferred by genetic distances? A simulation study to evaluate the performances of landscape surface optimization.**

Oral

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Abstract

Landscape genetics is a fast-growing field with great promise for addressing major biodiversity conservation issues. It aims at explaining the spatial distribution of genetic variation according to the landscape heterogeneity. Resistance surfaces are commonly used in this field to model the resistance of landscape elements to gene flow. However, there is no consensus on which methods to use for resistance surface parameterization. To overcome the subjectivity of parametrization based on expert opinion, the ResistanceGA algorithm proposes an objective framework of optimization and selection of resistance surfaces using pairwise genetic distances. Although widely used and promising, the validity of its inferences has rarely been tested. We therefore conducted a simulation study to assess the ability of the ResistanceGA algorithm to recover the true resistance surface according to two ecological parameters: i) the grain and the level of aggregation of the landscape and ii) the level of habitat specialization of the target species, modeled by different contrasted cost scenarios. The results should provide insight into the landscape context and species ecological profile for which habitat cost inferred from resistance distance optimization are reliable. We also implemented a new functionality allowing to use a subset of the matrix of pairwise genetic distance, in order to account for the spatial scale at which the landscape is expected to influence gene flow. We evaluated the contribution of this new implementation to the optimization performances of ResistanceGA. Results will be discussed and repositioned in the context of conservation issues, particularly concerning habitat connectivity.

00218

# The potential of remote sensing time series for disentangling pollinator community structures in highly heterogeneous low mountain regions

Oral

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Abstract

Central European low mountain regions harbor high diversities of pollinators, as geological and environmental factors favor extensive land-use. They could therefore be considered as model regions for evaluating future management strategies that will be needed to mitigate the effects of climate change and associated biodiversity risks in agriculturally intensive regions. However, this approach is notoriously difficult because of the high degree of management heterogeneity and correlation between environmental factors at the local and landscape scales. Here we explore how habitat availability and variability across spatial scales shape pollinator communities in 13 extensively managed mountain hay meadows in the Vogelsberg region, Hesse, Germany. Study sites ranged in habitat area from 1,500 m<sup>2</sup> to 35,000 m<sup>2</sup> and in grassland cover within a 500 m buffer from 1.5 % to 75 %. Pollinator samples (2,832 wild bees and 511 hoverflies) were collected on five separate occasions between July and August 2018 and identified to species level. Specifically, we were interested in whether landscape indices obtained from satellite remote sensing time series dealing with heterogeneous and highly covariant spatial data provide reasonable proxy indicators explaining pollinator diversity across landscapes. We derived landscape composition metrics from contemporary land cover maps. We extended our analysis with intra- and inter-annual metrics from multispectral Sentinel-2 time series to additionally capture spatiotemporal landscape dynamics. Wild bees and hoverflies responded contrastingly to habitat availability at local and landscape scales, suggesting a filtering effect for wild bees and supporting the habitat amount hypothesis for hoverflies. These differences were corroborated by opposing responses of pollinator groups to spectral-temporal metrics from remote sensing time series. Wild bees responded to tasseled cap components related to brightness and wetness of grassland cover whereas metrics of vegetation greenness were more important for hoverflies. There was little indication of differences in responses to average spectral-temporal metrics within and across years, but spatial variation in these metrics among years seemed more important for hoverflies and within years for wild bees. Overall, disentangling local and landscape level drivers in mountainous regions remains challenging, but remote sensing time series provide a promising tool in monitoring the taxon-specific status of pollinator habitats.

**00281**

## **Upscaling ecosystem services must account for spatial configuration of landscape features**

Oral

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### Abstract

Maps of ecosystem service (ES) supply are frequently used to guide spatial planning and management. However, most attempts to upscale ecosystem services lack a strong mechanistic basis, and also neglect spatial biodiversity dynamics and interactions among landscape components that can modify ES provision. Here we used the comprehensive Biodiversity Exploratories database in Germany, to assess i) how strong a role do surrounding conditions play in driving ecosystem service supply and thus in upscaling prediction? ii) which ecosystem services require a component of spatial context when upscaling? We evaluated 28 plot-level indicators of 14 ecosystem services in grasslands and developed semi-mechanistic statistical model for their upscaling using proxy drivers related to topography, soil attributes, plot-level management, landscape structure, landscape management, and biodiversity. We found that landscape aspects contribute between 34-50% of the explained variance of local-scale ES supply across regions. As expected, some services are primarily driven by physical and physiological processes, including soil carbon storage and nutrient cycling, while mobile organism-mediated ecosystem services, such as pest control and pollination, had a stronger component of spatial context. These findings indicate that upscaling which accounts for the spatial configuration of landscape features is required for many ecosystem services, especially if results are to be used in spatial planning and decision making.

00302

## The influence of habitat properties on sex determination and resource allocation in cavity-nesting Hymenoptera

Oral

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### Abstract

Unravelling the relationships between insect population dynamics and habitat properties is often complex. Established theoretical concepts, which describe the influence of available resources to sex determination, still need to be better connected to quantitative research. Cavity-nesting Hymenoptera are suitable to assess the influence of habitat properties on reproductive parameters, as haplodiploidy enables direct responses to local conditions. We hypothesize that with increasing resource availability, the population sex ratio (share of females to all individuals), sex allocation preference per individual offspring and resource allocation per brood cell will be favouring females. We sampled offspring of *Osmia cornuta*, *Osmia caerulescens* and *Trypoxylon figulus* using trap nests on 30 sites in a varied agricultural landscape in southwest Germany (March to August 2020). Also, provisioned resources in each brood cell were recorded. The potential influence of food availability, landscape metrics, temperature and nesting opportunities on sex and provisioned resources was afterwards tested. On population level, sex ratio did not shift with any habitat features except day temperature on *O. cornuta*. On individual level, however, sex allocation depended on several variables including cavity size and habitat connectivity, which pronounced differences among species. Resource allocation, in turn, was mainly influenced by sex. We conclude that features of a local population (i.e. individual size/weight) are most likely filtered by available resources, which leads to a relatively stable sex ratio and resource allocation balance on a landscape scale. On individual level, the influence of habitat properties is still substantial. As such, sex determination and resource allocation are essential life history properties in populations of sexually reproducing organisms.

**00390**

## **The Prediction of the Biodiversity of Culicidae in association to a gradient of Land use**

Oral

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### Abstract

Land use intensification, habitat destruction and climate warming are among the most important drivers, responsible for the global decline of insect diversity and abundance. Suitable habitats for many species are decreasing while some opportunistic species are thriving. These effects also have an influence on mosquitoes in Germany. In Germany, more than 50 mosquito species are known, which breed in various types of standing water bodies and can be highly abundant in a wide variety of ecosystems. However, mosquitoes are usually perceived and studied mainly due to their role as nuisance and vector of pathogens, but Culicidae may also play a crucial role in ecosystems, e.g. in the food-chain of aquatic or terrestrial habitats. To investigate the spatial-temporal patterns of mosquito diversity and land use intensity, we collected Culicidae at 28 different localities all over Germany. Therefore, we used mosquito adult traps, which attract host-seeking female mosquitoes by using CO<sub>2</sub>. We separated the locations along a land use gradient extracted from remote sensing data. The captures took place over the entire season from April until October 2021, in bimonthly intervals. Afterwards the species were identified morphologically. To predict the spatial-temporal diversity of Culicidae, site-specific biodiversity indices were calculated along the land use gradient over time. Since mosquitoes are relatively easy to catch and can be quite specific regarding resting or breeding site selection, the information can be also used to extrapolate to habitat diversity and therefore to general insect diversity.



00393

## Beech-dominated forests provide inferior foraging resources for honey bees

Oral

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### Abstract

1. Woodland is considered as native habitat of the Western honeybee (*Apis mellifera*) and is assumed to provide important pollen and nectar sources. However, resource supply might be spatially and temporally restricted and landscape-scale studies in European forest regions are currently lacking.

2. Capitalizing on the unique communication behaviour, the waggle dance, we investigated honeybee foraging in a deciduous forest region in southern Germany. We analysed 2022 waggle dances performed by bees of twelve colonies placed at locations with varying degree of forest cover (50-99% at a 2 km radius) from March–August 2019, thereby identifying foraging distances and habitat preferences over almost an entire foraging season. By connecting dance information with colony weight recordings, we estimated the contribution of the different habitat types to colony weight gain.

3. Foraging distances generally increased with the amount of forest in the surrounding landscape. Yet, this effect strongly depended on the season and was more pronounced for pollen than for nectar foraging. Even though colonies in forest-dominated landscapes had to fly further, colony weight was not affected by forest cover.

4. Compared to expectations based on the proportions of different habitats, colonies foraged more frequently in grasslands and cropland than in deciduous and coniferous forests, with late summer being an especially difficult period for pollen foraging in forests. During a phase of colony weight gain in early summer, the use of forests for nectar/honeydew foraging was close to the expectation, highlighting forests as an important source of carbohydrates during short periods of the year.

5. Policy implication. The ecological and economic value of managed forest as habitat for honeybees and other wild pollinators could be significantly increased by the continuous provision of floral resources, especially for pollen foraging. We therefore recommend diversifying forest stands with insect-pollinated trees, permitting secondary successions in forest gaps, and at larger scales, creating forest landscapes with high habitat diversity.

**00404**

## **Searching for optimal sampling design for landscape-scale biodiversity surveys**

Oral

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### Abstract

Evaluating the spatial autocorrelation in species distribution is a necessary step for many applied ecological questions at landscape scale, like building a reserve network or implementing an efficient monitoring program.

Autocorrelation range can be inferred from spatial sampling. However, there exists a trade-off between estimating of the autocorrelation range of a species distribution and estimating trends in the mean species abundance or occupancy among sites, which is also a question of interest in many studies. For instance, the random sampling design is a good heuristic to estimate autocorrelation range, as pairwise distances among samples cover a wide array of possible autocorrelation ranges. By contrast, the grid design is a better choice for estimating trends of the mean among sites as it eliminates small pairwise distances prone to pseudo-replication. Hybrid strategies mixing random and grid are thought to yield a polyvalent design able to cope with both conflicting objectives. Yet, fractal sampling designs could also show such intermediary performance, for it preserves some regularities associated to grid, but also contains various spatial scales browsing a wide array of possible autocorrelation ranges.

Here, we studied for which questions fractal or hybrid design could be advantageous sampling strategies. We used optimal design theory to compare the accuracy of random, grid, hybrid and fractal designs at estimating mean and autocorrelation range of a field of values.

We retrieved that the hybrid strategy is a Pareto-optimal intermediary strategy between grid and random designs. Fractal designs showed distinct properties : they performed better than both random and grid designs for estimating small autocorrelation ranges, but worse than other designs for estimating intermediate autocorrelation ranges and mean value of a target field.

Overall, hybrid designs seemed appropriate when looking for a polyvalent design. Fractal designs could constitute a valuable alternative when specifically aiming at estimating of small autocorrelation ranges while tolerating a cost on other objectives. Thus, the interest of fractal designs appeared quite circumscribed in our study. More generally, harbouring explicit spatial scales may be a clear advantage of fractal designs for the analysis of biodiversity patterns when distinct biological processes occur at distinct spatial scales.

00441

## Positive response of flower-visiting insect abundances to landscape context relies on nectar productivity

Oral

A. Alignier<sup>1,2</sup>, N. Lenestour<sup>1</sup>, E. Jeavons<sup>1</sup>, J. Van Baaren<sup>3</sup>, S. Aviron<sup>1</sup>, L. Uroy<sup>1,4</sup>, C. Ricono<sup>3</sup>, C. Le Lann<sup>3</sup>

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Abstract

In agricultural landscapes, flower-visiting insects such as domestic bees, wild bees and hoverflies ensure pollination of many crops and wild plants. Landscape studies aiming to explain flower-visiting insect abundance mainly focus on land cover maps. This structural landscape view has been challenged by many authors who pointed out the need for a functional approach that considers the fundamental ecological requirements of species ("species-centered") to better understand biodiversity patterns and functions. Here, we proposed a functional landscape view based upon the attractiveness, accessibility and profitability of floral resources, from both crop and non-crop habitats and across several spatial scales to explain abundance of flower-visiting insects. We translated land-cover maps of 40 landscapes of 250 m, 500 m and 1000 m radius into floral resource maps, using pre-existing vegetation surveys and floral traits databases. In the centres of the landscapes, abundances of flower-visiting insect groups (i.e. domestic and wild bees, bumblebees and hoverflies) were recorded in organic winter cereal fields. We showed that floral resource maps significantly explained the abundances of flower-visiting insect groups. Insect abundances were consistently higher in landscapes with high floral resource profitability. Domestic and wild bees < 1 cm responded positively to nectar productivity at the largest spatial scale, i.e. 1000 m landscape radius. Using functional maps based upon floral resources, we succeed in explaining flower-visiting insects' abundances, identifying which category of floral resources organisms require, and in which habitat types these resources prevail. Our results open new research area aiming to manage the environment by optimizing floral resources for species conservation or maintaining ecosystem services.

00555

## A literature review of the metrics used to study the effect of landscape on open habitat butterfly communities

Oral

C. Lecerf <sup>1</sup>, P. Jay Robert <sup>1</sup>, C. Leandro <sup>1</sup>

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Abstract

### **A literature review of the metrics used to study the effect of landscape on open habitat butterfly communities**

Herbaceous natural ecosystems (grassland, prairie, savanna...) are rich in numerous arthropod species. This biodiversity largely depends on the landscape which is often characterized by three metrics: connectivity between patches, heterogeneity (in composition and structure), and habitat fragmentation. Whether transient or climatic, these biotopes are now threatened by a wide array of phenomena, like habitat loss, change in agricultural practices or biological invasions. The way the aforementioned metrics are used to study the effect of the landscape properties and changes on arthropod communities may help us to understand how this research field was structured in a temporal and spatial way.

We performed a systematic review with butterflies for biological model. Data were acquired using a Boolean research string on Web of Science. We identified 97 articles published from 1994 to 2021. Landscape metrics allowed to document a vast array of responses either for species richness, population abundance, dispersion or patch occupancy.

The bibliometric analysis also explored the research ecosystem within which the scientific works were performed. The analyses showed a contrasted field with temporal discrepancy in the use of the different metrics, from connectivity to heterogeneity, reflecting on a changing research interest over time. Moreover, a vast spectrum of scientific questions and aims in the studies lead us to think that landscape ecology applied for butterflies is overarching with different approaches, both applied and fundamental. Therefore, the image given by our work is one of an evolving field, still developing new methods and new research questions to adapt to a growing awareness for the need of a new conservation framework towards habitat centered preservation. Despite this growing awareness, one can ask why some of the largest open habitats on Earth, located in Africa, Eurasia or South America remain understudied, hence undermining the understanding of these processes at a global scale and especially on several biodiversity hotspots.

**00575**

# **Disturbance-driven alteration of patch connectivity determines local biodiversity recovery within metacommunities**

Oral

C. Jacquet <sup>1</sup>, F. Munoz <sup>2</sup>, N. Bonada <sup>3</sup>, T. Datry <sup>4</sup>, J. Heino <sup>5</sup>, F. Jabot <sup>1</sup>

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Abstract

Understanding the capacity of ecological systems to withstand and recover from disturbances is a major challenge for ecological research in the context of environmental changes. Past research has mostly focused on the local effects of disturbances on biodiversity recovery, while alterations of inter-patch connectivity induced by disturbances have received comparatively less attention. Here, we investigated the effect of disturbances on local biodiversity recovery within metacommunities. Our specific focus was on drying river networks, which are characterised by a high variability of patch connectivity. We found marked variations of local biodiversity recovery among sites and among groups of organisms with contrasting dispersal modes, which were explained by the amount of patch connectivity loss due to drying events. As a general rule, loss of patch connectivity decreases community recovery, regardless of patch location in the river network, dispersal mode, or drying intensity. The relationship between patch connectivity loss and community recovery we found in river networks is general and applicable to any spatial network with a high variability of patch connectivity.

**00650**

**Influence of semi-natural habitat quantity and fragmentation on the diversity and abundance of invertebrates and bats at wildflower compensation areas in Schleswig Holstein, Germany.**

Oral

D. Bennett <sup>1</sup>, S. Lange <sup>1</sup>, T. Diekötter <sup>1</sup>

<sup>1</sup>Christian Albrechts Universität zu Kiel - Kiel (Germany)

Abstract

Wildflower compensation areas in agricultural ecosystems are becoming increasingly common methods to support wildlife populations in the landscape. However, little research has been done as to what factors influence their effectiveness for wildlife conservation and ecosystem services. In particular, the quantity of semi-natural habitat and the degree of habitat fragmentation may influence whether wildlife can colonise these areas.

We are using several methods, including bioacoustic recording with Audiomoth detectors, pan trapping, nest traps, botanical surveys and pitfall traps to assess biodiversity at 37 wildflower compensation areas across Schleswig Holstein, northern Germany. This is combined with high resolution spatial data on semi-natural habitats and modelling of habitat fragmentation (using the MESH and Connectance indexes) within a 3km radius of each study site. Our preliminary results indicated a significant positive relationship between bee (Apidae) species richness and both semi-natural habitat percentage and the two fragmentation indices. However, we have not yet detected a significant relationship between semi-natural habitat or either habitat fragmentation metric for the richness/abundance of hoverflies (Syrphidae), ground beetles (Carabidae), spiders (Araneae), grasshoppers and bush crickets (Orthoptera) or bats (Chiroptera). The study will be repeated and expanded (to 43 study sites) in summer 2022, and we will also implement an eDNA method for detecting insects visiting wildflower heads.

## Methodologies and infrastructures for large and long term dataset (1/2) - Salle 9+10 22/11 ; 16:15-18:15

00370

### A pipeline for in-situ plankton imaging data: Improving our understanding of ocean particle distribution and carbon fluxes using morphological traits

Oral

M. Beck <sup>1</sup>, S.D. Ayata <sup>2</sup>, M. Picheral <sup>1</sup>, F. Lombard <sup>1</sup>, R. Kiko <sup>1</sup>, L. Stemmann <sup>3</sup>, L. Guidi <sup>1</sup>, J.O. Irisson <sup>1</sup>

<sup>1</sup>Lov, Sorbonne Université/cnrs - Villefranche (France), <sup>2</sup>Locean-Ipsl, Sorbonne Université - Villefranche (France), <sup>3</sup>Lov, Sorbonne Université/cnrsipsl, Sorbonne Université - Paris (France)

Abstract

Sinking marine snow particles constitute an important part of the organic biomass in the ocean and, through the biological carbon pump, supply carbon from the surface to deep ocean layers. This export is largely driven by the gravitational sinking of these particles. Numerous studies have shown that size of particles and aggregates is a significant driver of these fluxes but composition also matters and is still overlooked. Morphological characteristics (or traits) of the particles, such as shape or porosity can significantly control their aggregation and sinking.

Quantitative imaging techniques have increasingly been employed to sample plankton and particles. Compared to traditional net counts or sediment traps, which can only provide limited contextual information on the collected objects and risk destroying them, in situ imaging instruments, such as the Underwater Vision Profiler (UVP), enable the study of fragile objects (e.g. gelatinous plankton, marine snow aggregates) at fine vertical resolution. Besides that, they give access to compositional information because some morphological traits of objects can be measured on the images. This can improve our estimations of carbon fluxes and understanding of biogeochemical cycles. However, such trait-based approaches require an objective and reproducible way to extract information from the images.

We present the design and implementation of a pipeline for the automated processing and objective categorization of marine snow particles. Besides size, we will consider contour and grey level descriptors that are related to important particles traits (e.g. shape, porosity, density). The pipeline will be prototyped using a subset of the worldwide UVP database, containing several million images, and then made operational to anyone interested in applying this method with their data. UVPs are used globally, by several laboratories and were already deployed at 19,000 sites collecting 72 million images. This data further grows by over 1000 profiles and several million images per year. We will investigate the best way to extract descriptors, reduce their dimension and define particle types by unsupervised clustering, in order to provide a scalable and reproducible pipeline. This richer description of marine snow particles will allow to better describe the intensity and distribution of the biological carbon pump.

00016

# Exploring the drivers of past occupancy changes in Central European insects

Oral

E.K. Engelhardt <sup>1</sup>, D.E. Bowler <sup>2</sup>, C. Hof <sup>1</sup>

<sup>1</sup>Biochange Lab, Terrestrial Ecology Research Group, Technical University Of Munich - Freising (Germany), <sup>2</sup>Uk Centre For Ecology & Hydrology - Wallingford (United Kingdom)

## Abstract

Recent changes in climate and land-use are having substantial impacts on biological organization including population declines, range shifts, and changes in community composition. In contrast, conservation policy like the European Habitats Directive aims to protect biodiversity from negative impacts. However, few studies have managed to compare these influencing factors among multiple taxa, particularly because of a lack of standardized time series data over long periods. To make matters worse, existing datasets are typically of low resolution or poor coverage, thereby limiting what inferences can be made from their use. Here, we analyse occupancy changes in butterflies, grasshoppers, and dragonflies using an extensive dataset of highly heterogeneous observation data collected in the central European region of Bavaria over a 40-year period. Using occupancy models, we show that the occupancies (the proportion of sites occupied by a species in each year) of cold-adapted species across taxa have already declined in past decades, while those of warm-adapted species have increased. In butterflies, habitat specialists also decrease, while in the other taxa there was no difference between habitat generalists and specialists. We show that although the Habitats Directive increased monitoring efforts towards species protected in its annexes, occupancy trends both improved and deteriorated after its implementation. Therefore, contrary to its main goal, the European Habitats Directive did not prevent a worsening of species' status. Our findings illustrate not only why butterflies, grasshoppers and dragonflies showed differing trends in the past as well as the effectiveness of Europe's most important nature protection instrument, but also how we might mitigate the detrimental effects of human development on the species' diversity in the future.



**00023**

# **The entangled phenology of the olive tree: A compiled ecological calendar of *Olea Europaea* L. in Sicily over the last two millennia**

Oral

V. Ferrara <sup>1,2</sup>, D. Ingemark <sup>1</sup>

<sup>1</sup>Department Of Archaeology And Ancient History, Uppsala University - Uppsala (Sweden), <sup>2</sup>Department of Human Geography, Stockholm University - Stockholm (Sweden)

## Abstract

Thanks to its unique position in the Mediterranean, Sicily is home to important ecological reservoirs, a special case for their long-term entanglements with humans.

The island has been a crossroad of diverse ethnic and cultural groups for millennia. The persistence of certain biocultural refugia, as the olive tree, is the result of a long-term negotiation process between the ecological knowledge of locals and the ecological practices introduced by new settlers at different points in time, and between them and the natural environment.

With time, the olive has become a Cultural Keystone Species, and its cultivation has more and more played a crucial role for biodiversity conservation, livelihood of rural communities and their deep enrooted cultural identity. Under critical pressure due to global market forces and climatic changes today, these long-lasting agrosystems may nonetheless offer anticipatory insights on how to tackle adaptation challenges to ensure agrobiodiversity in the future.

Our contribution looks at the management of these complex agro-ecological systems along centennial time-scales through a transdisciplinary approach, which combines local ecological knowledge in the form of oral traditions, landscape archaeology, and historical sources dating from different periods. By integrating reconstructions of temporal variations in the olive phenological stages (extracted from compiled ecological calendars) and spatial components of local cultivation practices over time, we open a window on nature- human adaptation strategies for the future.

00122

## A sensor-driven approach for analyzing a beehive's state

Oral

P. Davidson <sup>1</sup>, A. Hotho <sup>1</sup>, A. Krause <sup>1</sup>

<sup>1</sup>University Of Würzburg - Würzburg (Germany)

### Abstract

Assessing a colony's state is one of the key components in apiculture. In recent years precision apiculture has emerged as a field of study to quantify the analysis of beehives with objective sensors (e.g. temperature within the beehive).

One objective of analysis is the study of semantically consecutive time spans, sometimes covering several months. A common task for example could be detecting the different breeding periods in a year. A change in semantics is called a change point, which can be detected by rule-based knowledge (for example from the beekeeper), or an automated procedure called change point detection (CPD). Detecting the onset of succinct periods enables the beekeeper to provide specific care for each period. Within these longer time spans, short term events can occur, mostly specific to the semantic context. For example swarming can only occur in the summer breed rearing period. On the other hand, the death of a colony is more likely to happen during the winter seasons. These events are also known as anomalies, as they deviate from the expected normal behavior during that time span. Like for CPD, anomalies can be detected via certain rules, or automatically detected using an anomaly detection algorithm.

In this study we investigate the use of machine learning algorithms to analyze a beehive's state. With the data from multiple precision apiculture projects (BeeConnected, we4bee, HOBOS), we evaluate different algorithms to this end. This also enables us to not only study behavior at different locations but also with different sensor setups. We study the usage of single and multiple temperature sensors, but also integrate a scale for our purposes, and evaluate which combination of sensors yields the best results from an algorithmic standpoint. Besides quality of detection, we can also assess the applicability of specific sensors for beekeepers, keeping ease of use in mind.

We hope our studies support beekeepers to gain new insight into their colonies for a better understanding. This also creates a feedback loop with the algorithms to improve prediction quality in the future.

**00135**

# **Machine Learning and Deep Learning – A review for Ecologists**

Oral

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## Abstract

When analyzing data, the popularity of Machine learning (ML), Deep learning (DL) and more generally artificial intelligence has sharply increased in recent years. In ecology and evolution (E&E), ML and DL are used to process images and other complex data (e.g. for automatic species identification) or to build predictive models for conservation, biodiversity assessment, and risk estimation.

Despite their recent rise in popularity, the inner workings of ML and DL models are often perceived as opaque, and their relationship to more classical tools of data analysis, in particular statistical models, remains debated. For example, is it still true that ML and DL are good tools for predictions, but statistics remains the choice when it comes to (causal) inference?

Here, we provide an overview of the principles of ML and DL, starting with their historical developments, how these tools differ from traditional statistical tools, and what that means when applying ML. We then discuss why and when ML and DL models excel in predictive tasks, and where traditional statistical methods are preferable, highlighting also current and emerging applications for ecological problems. We conclude by summarizing emerging trends, in particular scientific and causal ML, that may significantly impact ecological data analysis in the future.

**00191**

## **Automated detection for bird monitoring – the challenges of detection distance and accurate localization**

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.  
biodiversity, monitoring

Oral

**C.M. Buchmann<sup>1</sup>, S. Klos<sup>1</sup>, M. Kasten<sup>1</sup>, T. Köhler<sup>1</sup>, F.M. Schurr<sup>1</sup>**

<sup>1</sup>University Of Hohenheim - Stuttgart (Germany)

Abstract

New technology in combination with deep learning (DL) algorithms in principle allow for efficient biodiversity monitoring, e.g. for birds. Particularly autonomous (sound) recording units (ARU) and automated species identification algorithms like the DL network BirdNet have become very powerful and can be valuable tools for studying bird distributions. For unbiased estimates of bird density and diversity it is, however, essential to assess the ability of ARU-DL-combinations to detect birds in dependence of the distance between ARU and the singing location of the bird. A next step towards distribution data at much higher spatial resolution would be to calculate the exact locations of the singing birds by synchronizing recordings of several ARUs. We here present one study in which we recorded forest birds with ARUs that were placed at different distances from the forest edge (up to 170m) and assessed how BirdNet performs in bird detection and identification, specifically how the number of detections of forest birds and the mean confidence of identification decreases with distance to the forest edge. We found that both, detection number and mean confidence decrease with distance in a non-linear fashion and that these distance effects are significantly affected by mean species body mass. Heavier birds can not only be detected with a higher confidence, but also confidence is less strongly decreased with detection distance. In a second study we present results of a sound localization approach. By synchronizing four ARUs located around a soccer field, it was possible to extract temporal offsets of signals on different ARUs and subsequently calculate locations on the field at which bird sounds were played (with a mobile speaker) with very high agreement. A first test with real bird calls recorded in the wild indicated the challenge of accurately synchronizing the sound signals and hence determining their temporal offset on different ARUs. Here more research is needed to move from the determination of spatial bird distributions based on information on detection distance to automated exact localization of single birds in the wild.

00367

## A post hoc observatory of functional trait change: novel spectroscopic methods allow trait measurements and comparisons of historical herbarium and recent field specimens in a resurvey project

Oral

P. Kühn <sup>1,2</sup>, R. Umazekabiri <sup>3</sup>, C. Römermann <sup>1,2</sup>, H. Bruelheide <sup>4,2</sup>, K. Wesche <sup>5,3</sup>

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### Abstract

Herbaria represent valuable archives for historical distribution patterns of plants. Various functional traits can also be obtained from Herbarium samples, but the study of leaf functional traits has been hampered by the frequent necessity of destructive laboratory analyses. In this project, a resurvey approach is combined with the use of Near-Infrared Reflectance Spectroscopy (NIRS) to study long-term changes in leaf traits of plant species common to mesic grasslands and field margins of central Europe. These habitat types have undergone significant changes in cultivation and management practices over the last centuries and are expected to have caused corresponding changes in the functional traits of the plant species that inhabit them. In this study, leaf traits of specimens from the collections of the herbaria in Görlitz (GLM) and Jena (JE) in Germany were compared with recent field samples. Species lists compiled by previous studies on these habitats were used as a starting point for the selection of herbarium specimens, with the main criteria for the inclusion of a specimen being that it was sampled in the proximity of the respective herbarium and that its label precisely described the sampling locality. Fresh plant samples were taken from these same locations in the field, resulting in pairs of one historical herbarium specimen and one or more recent field specimens. A NIRS workflow was used for the trait analyses of these specimens, the traits of leaf carbon and leaf nitrogen content as well as the leaf carbon-to-nitrogen ratio being predicted through non-destructive NIR spectral readings. The historical trait dataset contained hundreds of entries from the middle of the 19th century onwards to the early 2000s, while the recent field samples also numbered in the hundreds. Changes in leaf nitrogen over the years were clearly dependent on species identity, but some wider trends could be discerned for the habitat types in general. The results of this study indicate the utility of herbaria for the investigation of long-term trends in functional traits and open the door to future research tying historical changes in vegetation patterns to changes in functional traits.

**00005**

## **Artificial intelligence at the service of marine biodiversity: start of an unprecedented scientific challenge**

Oral

L. Mannocci <sup>1</sup>, A. Delavaud <sup>2</sup>, Y. Lebras <sup>3</sup>, O. Norvez <sup>3</sup>, O. Galibert <sup>4</sup>, V. Barbosa <sup>4</sup>

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### Abstract

The "IA-BIODIV challenge", co-funded by Agence nationale de la recherche (ANR) and Agence française de développement (AFD) ambitions to tackle issues surrounding marine biodiversity by relying on artificial intelligence (AI). Three consortia have been selected to participate in this challenge launched on February 2022 for a duration of 4 years. By supporting multidisciplinary research projects developing innovative AI methods, this "challenge" aims to predict changes in biodiversity and develop reliable indicators.

The work of the consortia will focus on the biodiversity of the marine environment in the Mediterranean Sea and the Pacific Ocean. The AIME project (Intelligence artificielle pour les écosystèmes marins) is carried out by a French-African consortium. The SMART-BIODIV project (Technologies d'intelligence artificielle pour la recherche en biodiversité) and the FISH-PREDICT project (Prédire la biodiversité des poissons récifaux) are carried out by French consortia.

This "challenge" is a new way of doing research: a fourth consortium (called COPé) catalyses research of consortia through actions mixing collaboration and competition.

-It establishes an exclusive and common virtual research environment (called AI-BiodivNet) bringing together links to open datasets and AI algorithms.

-The consortia's algorithms and results will be evaluated annually on an independent test dataset.

-At the end of each evaluation campaign, a collaborative workshop will allow to share the results and to work collectively on topics (scientific, technical or methodological) of interest to all.

-In the last two years, a training session, widely open to research communities, will allow the dissemination of the results produced by the consortia.

This presentation will present the virtual research environment AI-BiodivNet and discuss the first achievements of the COPé.

## Methodologies and infrastructures for large and long term dataset (2/2) - Salle 9+10 23/11 ; 10:00-12:00

00376

### Classification and detection of collembola from microscope slide images using deep learning for soil bioindication

Oral

T. Oriol <sup>1</sup>, J. Cortet <sup>1</sup>, J. Pasquet <sup>2,3</sup>

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#### Abstract

Collembola are very abundant organisms in soils (several thousand individuals per square meter of soil) and are now considered to be good indicators of soil quality. These indicators are based on the number of individuals observed (abundance per square meter of soil), but also the singularity and number of species present (species richness).

A limitation that comes with the usage of collembola as an indicator is the complexity of the identification of the species under microscope and how time-consuming it is. Another big challenge in the collembola identification is the morphologic similarity between some species. Deep learning approaches have been very successful in the resolution of image base problems, but no work yet exists that uses deep learning in the recognition of collembola, which raises the question “can it help automate this task?”. In this work, we explore and evaluate the performance of state of art deep learning techniques over the identification of collembola on a manually annotated dataset.

No annotated dataset previously existed. We therefore created a dataset of images of collembola on microscopic slides, that were manually annotated by an expert. Containing 1316 bounding boxes from 18 species of the most common collembola found in agricultural areas.

We then evaluated the performance of such a dataset with state-of-the-art deep learning techniques in computer vision.

Preliminary experiments show the ability of deep learning models to identify intraspecies similarity and interspecies difference even with morphologically close species.

Such a tool could allow the automation of this task and would be a key component in the mass use of this indicator, saving a huge amount of time in the identification process of main collembola species.

00386

## Biodiversity time series are biased towards increasing species richness in changing environments

Oral

L. Kuczynski <sup>1</sup>, J.A. Freund <sup>2</sup>, H. Hillebrand <sup>3</sup>

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### Abstract

In the face of global biodiversity decline, a series of landmark meta-analyses on local time series showed that on average species richness remained constant or even increased for most regions and organism groups. This discrepancy between global loss and local neutrality led to debates on the quality of data and systematic biases in monitoring programs and on the suitability of species richness as a metric to capture actual changes in biodiversity. Here, we show that even more fundamentally the null expectation is likely wrong in that way that neutral changes in composition (i.e., when extinction and colonization rates are equal) appear as positive richness trends in time series rather than no net change. We analyzed highly curated global river fish time series and found an overall increase in richness (positive slope with time across sites). This apparent increase reflected a systematic bias towards earlier detection of colonizations than of extinctions. In order to understand how much this bias influenced the richness trends, we simulated neutral diversity dynamics over different time series length and diversity for which no richness trend is expected. Still, these simulated time series showed significant increases of richness over time independent of time series length. These results challenge our equilibrium-based expectation as, in a constantly changing environment, new species will always establish faster than native species decline towards extinction or detection limit. The finite nature of time series and the long persistence of exponentially declining populations leads to increases in species richness as long as communities continue to change. We conclude that temporal analyses of richness must incorporate this bias. Previous reports on neutral richness slopes over time most probably reflect a more negative than so far observed local biodiversity trend. Conservation goals are usually formulated in the absence of negative trends as in the narrative of “bending the curve” of biodiversity trends or the quest for reducing extinctions. However, these goals are difficult to communicate in light of widespread local biodiversity increases. It is therefore mandatory to develop approaches beyond univariate trends of emergent properties such as richness, acknowledging that biodiversity is constantly turning over.



**00405**

# **Extracting Information on Plant Species Abundances from Images using Convolutional Neural Networks**

Oral

**M. Körschens<sup>1,2</sup>, S.F. Bucher<sup>1</sup>, P. Bodesheim<sup>2</sup>, J. Denzler<sup>2</sup>, C. Römermann<sup>1</sup>**

<sup>1</sup>Plant Biodiversity Group, Friedrich Schiller University - Jena (Germany), <sup>2</sup>Computer Vision Group, Friedrich Schiller University - Jena (Germany)

## Abstract

The composition of plant communities strongly reflects changes in the environment, making it an essential indicator in ecology research. The species composition is usually quantified by estimating the cover of all plant species occurring in the respective vegetation plot. However, doing vegetation relevés in the field is not only extremely laborious and time-consuming, especially for a large number of plots, but also subject to human error and bias. Utilizing automated camera setups in conjunction with state-of-the-art image analysis methods would not only mitigate the aforementioned issues but would also provide information about the investigated plant communities in a high temporal resolution.

In this contribution, we propose utilizing convolutional neural networks (CNN) to estimate cover values for all co-occurring species in vegetation plots in an automated way. Specifically, we investigate grassland plots containing herbaceous species. Moreover, we show how freely available plant image data from web sources can be exploited to improve the performance of the network through pre-training. As annotation data for training a CNN for cover estimation is laborious to generate, we also demonstrate a way to utilize CNNs to estimate the plant cover of vegetation plots directly. This direct application relies entirely on pre-training imagery; hence, there is no need to train on any dedicated cover estimation data. This method drastically reduces the amount of work required to adapt our approach to new datasets and environments, resulting in a flexible estimation system.

In upcoming work, we will develop an open-access application where pictures from vegetation plots can be uploaded, and the identified species, together with their plant cover will be returned. The system is developed in interdisciplinary cooperation between biologists and computer scientists.

**00495**

## **Matching species names across biodiversity databases: sources, tools, pitfalls and best practices for taxonomic harmonization.**

Oral

M. Winter <sup>1</sup>, M. Grenié <sup>1</sup>, E. Berti <sup>1</sup>, J. Carvajal-Quintero <sup>1</sup>, D. Louise <sup>1</sup>, A. Sagouis <sup>1</sup>

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### Abstract

Quantity and quality of ecological data have rapidly increased in the last decades, bringing ecology into the realm of big data. Frequently, multiple databases with different data characteristics are combined together to address research questions. Taxonomic name harmonization, i.e. the process of standardize taxa names according to common sources (i.e. taxonomic backbones, TB), is necessary to properly combine multiple databases through species names. In order to be able to develop proper data matching workflows, TBs and tools using them need to be clearly and comprehensively described. But this is currently rarely the case. Common problems users have to deal with are: not well described taxonomic concepts behind biological databases, lack of information if TBs are actively updated, information from where the primary source of taxonomic information comes from and software to access these TBs are partly redundant or developed following non-compatible standards. Researchers face a jungle of primary and secondary TBs with a diversity of tools. As results, taxonomic name harmonization has become a major obstacle because it is hard for users to know which TB, tool and workflow leads to the most robust results when combining different biological data sets.

Here, we present best practice principles to harmonize taxonomic names and to avoid common pitfalls when properly harmonizing taxa names (Grenie et al. 2022). We developed a shiny app summarizing meta-data and linkages among TBs and R packages (available at <https://mgrenie.shinyapps.io/taxharmonizexplorer/>). This is particularly helpful to help users decide on the TBs and tools that best fit the tasks and data at hand and to develop more informed workflow for taxonomic name harmonization.

To our knowledge, this study represents the most exhaustive review of TBs and R tools for taxonomic name harmonization. Our intuitive shiny app can help taking practical decision when harmonizing taxa names across multiple datasets.

Grenié, M., Berti, E., Carvajal-Quintero, J., Dädlow, G.M.L., Sagouis, A. & Winter, M. (2022) Harmonizing taxon names in biodiversity data: a review of tools, databases, and best practices. *Methods in Ecology and Evolution*. <https://doi.org/10.1111/2041-210X.13802>

00540

## Promoting long-term time series on species occurrences by text mining in historical biodiversity literature

Oral

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Abstract

Knowledge about the occurrence of species is mandatory for many aspects of ecological research and policy-making. Tracking species distributions over time facilitates the detection of regional species declines, shifts and invasions. Anthropogenic factors in particular have been identified as a main driver of environmental changes and the resulting threats to certain populations and biocoenoses. Therefore, the need for long-term records of species distribution data, especially of those originating from periods prior to agricultural industrialization, is increasing. Environmental observations of the past two centuries can fill existing data gaps and will help to better understand and to address the biodiversity crisis. *The Specialized Information Service Biodiversity Research* (BIOfid, [www.biofid.de](http://www.biofid.de)) focuses on data mobilization from primarily Central European German biodiversity literature of the 19<sup>th</sup> and 20<sup>th</sup> centuries, including digitization of printed sources. Here, BIOfid will present the development and application of various tools for machine-based data extraction from text. Use cases will illustrate the process chain from the original text source via its NLP-based (Natural Language Processig) preprocessing to the extracted data set and its scientific use. The link between data extraction and its use is provided by a semantic search tool chain especially generated for BIOfid. Moreover, BIOfid will provide a preview of planned expansions of existing services with particular focus on promoting FAIR (Findable, Accessible, Interoperable, Reusable) data. This will especially concern making our tools available and usable beyond BIOfid.

**00578**

## **Ecotopes and ecopatches: dataprisms for ecological models combining remote sensing and ancillary data**

Oral

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### Abstract

Most of the variables that define biotopes on Earth cannot be directly observed by remote sensing. However, land cover and topography provide meaningful information about ecosystems. With the availability of high resolution images from space, driven by Sentinel-1, Sentinel-2 and Landsat satellites, high spatial resolution land cover products are now available. Furthermore, topographic information is also collected by remote sensing, e.g. using photogrammetry, LiDAR or interferometry. Combining topographic and land cover information allows us to delineate ecotopes: the smallest spatial unit with homogeneous ecological functions.

A proof-of-concept ecotope database has been produced in Belgium in the frame of the European Research Infrastructure Consortium for biodiversity and ecosystem research (Lifewatch-ERIC). It divides the landscape in irregular polygons based on information provided by LiDAR and aerial images using an automated process called image segmentation. We demonstrated that landscape partitioning based on this hybrid source of information increased the homogeneity of the ecological functions and improved the quality of habitat suitability models derived from it compared with regular grids of the same size.

For the needs of subsequent models, the resulting polygons are characterized by quantitative land cover variables and a distinct land use descriptor, with the same logic than the EAGLE concept implemented in the second generation Corine Land Cover. But it also compiles a large number (>100) of characteristics from different database, including information about soils, climate, topography and spatial context. This information allows to distinguish different biotopes and to monitor their land cover status.

The concept of landscape partitioning with ecotopes was transferred to the continental scale to yield ecopatches at the Pan-European level. The metric resolution was then replaced with decametric precision: the delineation and characterization method was applied on a 10m resolution Sentinel-2 image mosaic stacked with ancillary information derived from a digital elevation model (potential solar illumination and topographic position index). A set of abiotic variables including climatic and topographic information has also been synthesized for each ecopatch. Multiple categorical legends are derived from these variables, which enhance the interoperability of the dataset and provide additional information

00580

## Skylark's decline in the Long-Term Social Ecological Research Site "Zone Atelier Plaine & Val de Sèvre" and impact of spatial sampling designs.

Oral

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Abstract

We are currently facing a biodiversity crisis with a decline in the overall animals' abundance. Among birds, the steepest decline is seen in farmland populations, with more than half of them that has disappeared over the past 30 years. Such trends have been observed at national or continental scales based on standardised protocols, with usually one trend corresponding to one protocol. As a result, there are very few local scale studies, and this limits our ability to establish causal relationships. Moreover, monitoring, mainly relies on systematic longitudinal surveys although random designs are recommended, and the modelling approach is far from being established.

We sought to fill these gaps of knowledge by focusing on the most abundant farmland bird species, the skylark (*Alauda arvensis*), which has been monitored in the Long-Term Social Ecological Research Site "Zone Atelier Plaine & Val de Sèvre" since 1995. Three spatial designs have been used since 2009, all of them with the same counting protocol. We first used the longest time series based on a longitudinal spatial design and developed a modelling approach to explore the relationship between counts and year accounting for the effects of a set of co-variates, known or expected to affect the outcome of bird counts. Once we calibrated the best fitted model, we applied the same modelling approach to compare Skylark population trends among the three spatial designs.

The long-term trend obtained in LTSER between 1995 and 2021 revealed an important decline of Skylark population (-41.3%). This decline is not linear, with a strong drop in the first 17 years (-35.7%) and a more moderate decline in the last decade. However, comparison of the three spatial designs since 2009 shows that the longitudinal design has the lowest decline over this period. This difference is partially due to the heterogeneity of habitats within the different designs, highlighting the importance of knowing the ecology of the species studied and the environments sampled when characterising long-term trends.

00482

## Fat chance: estimating the lipid content of Arctic zooplankton from in situ images

Oral

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Abstract

Plankton imaging systems supported by automated classification and analysis have improved ecologists' ability to observe aquatic ecosystems. Today, we are on the cusp of reliably tracking plankton populations with a suite of lab-based and in situ tools, collecting imaging data at unprecedentedly fine spatial and temporal scales. But these data streams have potential well beyond examining the abundances of different taxa; the individual images themselves contain a wealth of information on functional traits. Here we outline traits that could be measured from image data, suggest computer vision approaches to extract functional trait information from the images, and discuss promising avenues for novel studies. The approaches we discuss are data agnostic and are broadly applicable to any aquatic organisms. We illustrate the potency of this approach by a case study of Arctic copepods that dominate the zooplankton assemblages in these ecosystems, in part because of their large lipid content. Lipid is the staple of trophic networks and copepods tend to store them in large lipid sacs that can occupy up to 80% of their body volume. We trained a U-net algorithm to high-resolution in situ images of these organisms to provide accurate estimates of individual lipid content, opening for the first time a window on interindividual variability in lipid content, as well as global estimates that could reveal the organization and inner functioning of Arctic marine ecosystems.

**00054**

**There's a place for every animal, but not in my back yard: a survey on attitudes towards urban animals and where people want them to live**

Oral

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Abstract

Animals are a constant presence in urban environments. While there's a handful of studies that have addressed which urban animals people like, there is little knowledge on where people want animals to be in cities. With the ongoing initiatives to introduce more greenery and nature in general to urban environments and limited knowledge on where people in cities would want different animals to be, there is the risk of a misalignment between human urban inhabitants' wants and needs and the results of urban renaturing initiatives.

We conducted a survey on inhabitants of Munich, Germany, to investigate their attitudes towards 32 different urban animals and where they want them or don't want them to occur. These places range from very near, such as within their own home or garden, to further away, such as outside of the city.

We found that there are clear differences in human attitudes towards different animals and that urban inhabitants prescribe varying locations to the different animals in the city. In general, more animals were wanted further away than close by the survey participants' homes. Additionally, the more a certain animal was liked, the closer to home people wanted these animals to be and the more locations people wanted an animal to be in. For example, cockroaches and rats are severely disliked and are wanted far away from people's homes, while ladybugs and squirrels are very much liked and are also wanted relatively close to people's homes and on more places. Furthermore, the animals that people wanted on more locations are also the animals that they want closer to their home, indicating that people chose progressively more locations starting from far away locations to locations closer to home as locations where they wanted an animal to be, increasing with a better liking for the animal.

Information on where inhabitants of a city want different animals to be in cities can help guide urban nature conservation and renaturing strategies by avoiding the severest animal-human conflicts, and help pinpoint where mismatches between human attitudes towards the animals and ecological necessities might be.

**00083**

## **Covid lockdown walks reflect different modes of relations to urban nature**

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.  
Social Ecology, Relational Values

**Oral**

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**Abstract**

Bending the curve of biodiversity loss will require a substantial change of everyday life practices for both rural and urban communities. Key to this transformative change is the incorporation of so-called 'relational values' of biodiversity. With advancing urbanisation, an increased proportion of the human population has a deficit of interactions with those ecosystems that are often labelled as 'natural' or 'wild': a general extinction of experience and thus also erosion of relations to nature has been hypothesized. However, the urban flora and fauna, however, is not to be considered a mere substitute for 'real' nature but rather provides a specific backdrop for interactions with nature. Urban nature is being experienced, exploited and appreciated by the urban population in its own mode.

By accompanying city dwellers in Frankfurt am Main, Germany, on recreational walks they established as a regular routine during the COVID lockdowns, we documented individual perspectives on relationships with places, plants and animals. The go-along interviews have been analysed qualitatively to distinguish symbolic and material aspects of these relationships at the individual level.

We found that besides a cognitive 'discovery' of the generic components or processes of the urban biodiversity, many participants name relational aspects that can be summarized as 'immersion': memories of past experiences, routinized interactions with non-human individuals and places, and personal associations with nature up to a sense of a transcendent self. While 'discovery' is driven by individual curiosity or acquisition of knowledge and is enhanced by the information sphere, 'immersion' is driven by the uniqueness of place and time, personal biography, immediate bodily experience and peace of mind, and is enhanced by collective activities of appropriation and building up responsibility. We also found that these two modes of relations to nature interact in intricate ways.

By distinguishing and explicating these different modes of relations to nature in cities, we gain a better understanding of the 'relational values' of biodiversity in an urban context and how they can be integrated in decision-making to better support a good quality of life and counter a possible extinction of experience.



00111

## Can automated plant identification apps provide local phenology data?

Oral

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### Abstract

Plant phenology is the timing of seasonal events in plants, e.g., budburst, flowering, fructification, or senescence. Plant phenology is strongly linked to local climatic conditions, which are currently subject to substantial alterations due to climate change. Changes in phenology can have far-reaching consequences, from affecting species dispersal and disrupting species interactions to altering the carbon cycle and, in turn, influencing the global climate itself. Therefore, great efforts are being made to observe, detect and predict changes in the timing of phenological events.

In Germany, phenological observation data are obtained by volunteers organized in a network with hundreds of stations operated by Deutscher Wetterdienst (DWD). They are broadly distributed across the country to cover the total variability, varying locally over several weeks depending on elevation and geographic position.

However, the number of observers is steadily decreasing, and alternative sources for collecting phenology data are urgently needed.

Automated plant identification apps, such as Flora Incognita, provide ten thousand daily plant observations during the vegetation season. For many species, the observation patterns are strongly linked to the phenology of the species.

Here, we will compare the phenology data of five common plant species in Germany (*Tussilago farfara*, *Taraxacum*, *Malus sylvestris*, *Sambucus nigra*, and *Artemisia vulgaris*) from the DWD annual phenology network with Flora Incognita app users' observations data for the year 2020 and 2021. We show that the peaking of app observations is related to the phenological phases obtained by the DWD observers on local scales. Our results imply that phenological monitoring can significantly benefit from opportunistic observations of plant identifications of app users due to the high number of observations.

**00199**

# **The importance of old man-made landscape structures for biodiversity. Case study of the Czech Republic**

Oral

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## Abstract

The cultural landscape covers large areas in Europe and is a result of long term development and land use changes. The negative impacts of human activities on biodiversity are topics of many studies worldwide. On the other hand, areas and regions with long-term sustainable development (i.e. historical cultural landscapes) were proved as areas with high habitats and species diversity.

The first part of the paper presents the richness of the historical cultural landscapes and structures on the national level (case study the Czech Republic). We distinguished several old man-made (traditional) landscape structures (e.g. alleys, veteran trees, hedgerows, small-scale vineyards and orchards, coppice forests, small mining pits) as results of different human activities in the past. In the first step, we evaluated the importance of the old manor gardens for biodiversity. One hundred manor gardens were randomly selected in the Czech Republic and buffers around them were created. Data about biodiversity according NATURA 2000 mapping were compared for the gardens and their surroundings. Additional measurement for the 26 largest gardens was made. It was proved that old manor gardens are important biodiversity pools especially when they are surrounded by urban or intensive agriculture landscape of large open field. The importance of the manor garden for biodiversity positively correlate with the extent of the garden area. When we focused on the habitat diversity inside the garden areas, edges are generally more diverse than the core place around the manor house but exceptions exist. In the second step, we are going to extend our evaluation to another old man-made landscape structure. Now, we are selecting species that will be correlated with presence or absence of the old man-made landscape structures. In the presentation in autumn, we would present preliminary results.

00209

## Under shadows: How floating photovoltaic energy may impact freshwater biodiversity and ecosystem functioning?

Oral

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### Abstract

Climate change, driven by greenhouse gas emissions, has critical implications for biodiversity and ecosystem functioning. The need to mitigate climate change effects has led to the rapid development of novel technologies such as floating photovoltaics (FPV), which are arrays of photovoltaic panels floating on waterbodies (e.g., reservoirs, ponds, gravel pit lakes). FPV is exponentially growing across the globe, despite a limited knowledge on its ecological impacts. FPV might affect lake ecosystems through abrupt changes in environmental conditions, notably by altering light arrival, wind at water surface and water temperature, that can subsequently alter structure and compositions of freshwater communities, having cascading effects on ecosystems functioning. Here, we will present an ecological perspective on the potential impacts of FPV on lake biodiversity and ecosystem functioning using ecological theory and analog literature on the effects of light, temperature, and wind on freshwater ecosystems. To date, the proportion of solar panel coverage has been recognized as the determinant factor defining the ecological impacts of FPV on freshwater ecosystems. Current FPV models predicted reductions in light arrival, wind speed and, consequently, water temperature with increased FPV coverage. These changes in light and water temperature can modify individual rates such as metabolism, and photosynthesis, affecting for instance, primary production and the energy flux within lake food chains. Furthermore, FPV can alter thermal functioning and oxygenation of water column while providing artificial habitats for organisms. Such modifications can not only affect organism individual behavior and life-story (e.g., phenology, dispersion), but also alter the composition of plant and animal communities, trophic interactions, ecosystem metabolism and greenhouse gas balances. FPV can also compromise socioecological activities related to lake use, modulating human activities and pressure at the meta-ecosystem level. The ecological impacts of FPV are likely to be highly context-dependent, varying across ranges of environmental conditions and industrial considerations (e.g., level of solar panel coverage). Given the rapid scaling-up of this technology and its ecological and socio-economic implications, empirical studies are urgently needed to ensure that FPV meets its decarbonization goals while guaranteeing a sustainable environmental management across all freshwater ecosystems where it is installed.

**00211**

# **Land-use trajectories for sustainable land system transformations: Identifying leverage points in a global biodiversity hotspot**

Oral

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## Abstract

Sustainable land system transformations are necessary to avert biodiversity and climate collapse. However, it remains unclear where entry points for transformations exist in complex land systems. Here, we conceptualize land systems along land-use trajectories, which allows us to identify and evaluate leverage points; i.e., entry points on the trajectory where targeted interventions have particular leverage to influence land-use decisions. We apply this framework in the biodiversity hotspot Madagascar. In the Northeast, smallholder agriculture results in a land-use trajectory originating in old-growth forests and spanning from forest fragments to shifting hill rice cultivation and vanilla agroforests. Integrating interdisciplinary empirical data on seven taxa, five ecosystem services, and three measures of agricultural productivity, we assess trade-offs and co-benefits of land-use decisions at three leverage points along the trajectory. These trade-offs and co-benefits differ between leverage points: two leverage points are situated at the conversion of old-growth forests and forest fragments to shifting cultivation and agroforestry, resulting in considerable trade-offs, especially between endemic biodiversity and agricultural productivity. Here, interventions enabling smallholders to conserve forests are necessary. This is urgent since ongoing forest loss threatens to eliminate these leverage points due to path-dependency. The third leverage point allows for the restoration of land under shifting cultivation through vanilla agroforests and offers co-benefits between restoration goals and agricultural productivity. The co-occurring leverage points highlight that conservation and restoration are simultaneously necessary to avert collapse of multifunctional mosaic landscapes. Methodologically, the framework highlights the importance of considering path-dependency along trajectories to achieve sustainable land system transformations.

**00277**

## **How can citizen scientists contribute to stream and aquatic insect monitoring? Comparison of citizen science data with expert data and pesticide measurements**

Oral

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Abstract

Only about 7% of rivers and streams in Germany are in a good ecological status. High pesticide concentrations are a major cause of insect decline in lowland streams. To effectively preserve and restore stream habitats, standardized stream monitoring data and societal support for freshwater protection are needed. Citizen science has important innovation potential to both complement national and international freshwater monitoring schemes, as well as generate public support for conservation. Using the biological indicator SPEARpesticides based on benthic invertebrate community composition we assess pesticide exposure of streams. To investigate citizen science data quality, we compared citizen science and expert monitoring data for 28 Central German stream sites.

Around 300 citizen scientists participated in a preparatory training on field sampling methods and invertebrate identification, and then sampled 28 stream sites from April to early July 2021. At the same sample sites, experienced ecotoxicologists conducted comparative measurements and installed automated (EDS) samplers to measure pesticide concentrations. We found good agreement between citizen science- and expert assessments of stream hydromorphology and macroinvertebrate communities, and citizen science-generated SPEAR index values aligned well with measured pesticide concentrations. Based on these results we discuss how citizen science monitoring design and training can be improved to ensure high data quality.

**00289**

## **Connection to nature and time spent in gardens predicts social cohesion**

Oral

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### Abstract

A person's health and wellbeing are contingent on the amount of social support that they receive. Similarly, experiencing nature has been shown to improve people's health and wellbeing. However, we do not know how relationships between social cohesion, nature experiences and nature connection could interrelate and vary across different types of urban green spaces, and in non-Westernised cultures. We conducted a study on 1,249 residents in Singapore, a tropical city-state, and measured three dimensions of social cohesion (i.e. general social cohesion; trust and sense of community; and social interactions), various types of nature experiences, and three dimensions of one's connection to nature: self-identity with nature, desire to experience nature, and environmental concern (using the nature relatedness scale). We found that people who strongly identify with nature, who enjoy being in nature, and who had more frequent gardens visits were more likely to have a stronger sense of social cohesion across two dimensions. However, those with stronger environmental concern reported an overall weaker sense of social cohesion, possibly due to the perception that society's contributions to conserve environmental problems was insufficient. We propose that strategies targeted at encouraging people to engage in nature-related, collaborative activities at the local community level, such as spending time in local gardens, will increase urban residents' daily nature experiences and its associated benefits such as improving social cohesion.

**00201**

# **Drivers of environmental best management practices in agricultural landscapes of south-central Ontario, Canada**

Oral

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## Abstract

Intensive agriculture is one of the primary factors of loss of ecological function, biodiversity and ecosystem services globally. Effective conservation planning and policy to reduce these negative impacts require understanding of the drivers of farmland management. Farmland makes up over one third of all land in south-central Ontario, Canada. Consequently, environmental practices on Ontario farms have a large impact on the entire environment in south-central Ontario. Unfortunately, adoption of environmental best management practices (eBMPs), which can improve economic and environmental sustainability of farm operations, often is lower than desirable. The reasons for low adoption of eBMPs are not fully understood in the Ontario context. To close this knowledge gap, we investigated adoption of “structural” vegetation eBMPs, i.e., windbreaks, riparian buffer strips, and farm forests, which can provide ecological function (e.g., landscape connectivity) and ecosystem services (e.g., erosion control). We collected data on eBMP adoption, socio-economic factors as well as demographic factors and farmland characteristics, using a large-scale survey of Ontario farmers, in-depth farmer interviews and remotely sensed imagery of regional farmlands. We investigated the data with structural equation modeling, logistic regression, and qualitative content analysis. Our results show that farm forests were fairly widespread in the agricultural landscape, but that windbreaks and riparian buffers were less common. Our results also suggest that farmers understand the benefits of eBMPs at the farm-scale and beyond, and they believe they should adopt them. However, various resource constraints limit them to do so, especially labor availability. A majority of farmers are unaware of any financial subsidy programs that could help them in funding eBMP adoption, despite the availability of such programs, which may contribute to low eBMP adoption rates. Building on our findings, we make recommendations for enhanced agriculture programs and policy in support of increased adoption of eBMPs and ecological sustainability of farmland in south-central Ontario.

00477

## Analysis of the determinants of social demand as a lever for a better consideration of the ecological impacts of land use planning

Oral

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### Abstract

Citizens' expectations are increasingly strong in terms of limiting the environmental impacts of land-use planning, particularly with respect to linear transport infrastructures (LTIs) development because of its large spatial footprint and major environmental impacts (Villemey et al. 2018). Recent academic literature focuses on issues of social acceptability and environmental justice around the development of linear transport infrastructures (Martinez-Alier, 2021). This leads to citizen struggles with an ecological purpose, which are a form of response by societies to the ecological crisis described as "social innovations" (Bouleau, 2019). They reflect an evolution of social demand and individual behaviors, and can be drivers for a better consideration of ecological issues in the development models of societies both at local and global scales (Lascoumes, 2018). While the manifestations of this social demand are increasingly important, few academic works have proposed to study them and to characterize their determinants, and none at the French national scale. Faced with these academic and societal challenges, it seems particularly relevant to assess the "ecological social demand" related to the development of LTIs in France. We proposed to assess citizens' preferences for different types of ecological and spatial integration of LTIs using an original method that combines a discrete choice experiment and a deliberative evaluation (Howarth et al. 2006). Based on quantitative and qualitative surveys conducted on a national scale, we revealed strong heterogeneity in social preferences induced by geographic, historical, and socio-economic characteristics. We tested the contributions of such a methodology to better understand the social demand in the face of expected ecological transformations of societies.

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**00486**

## **Perception of the scientific expertise within an environmental controversy due to pesticides contamination: the Cleurie River (France) case study**

Oral

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Abstract

In France, many rivers face complex cocktails of contaminants at concentrations sometimes close to environmental quality standards (EQS). This type of complex pollution is typically encountered in the case of pesticides, and is usually poorly reflected by the bioindicators currently implemented within the European Water Framework Directive. This is typically the case of the contamination that has been observed for several years in the Cleurie River (Eastern France, Vosges), thereby raising concern among local end-users.

Due to industrial activities (textiles), this headwater forested stream exhibits a complex cocktail of molecules but below EQS. This cocktail is characterized by relatively high concentrations of glyphosate and its degradation products as well as a high load of dissolved organic matter dominated by optical brighteners and dyes. The current media coverage of glyphosate associated to frequent changes in the colour of the water feed a local environmental controversy involving numerous local actors, from environmental NGOs to fishing associations. In response to the general public awareness, stakeholders solicited our scientific expertise in order to test more subtle indicators able to detect early signs of changes in water quality but also to assess the possible associated indirect effects (e.g. propagation of effects in the food chain, and from upstream to downstream) and their consequences on the functioning of ecosystems.

For this purpose, an in-situ monitoring has been initiated in order to identify global indicators based on phototrophic biofilms, a pivotal ecological player in these ecosystems. Beyond the relevance of these indicators for environmental risk assessment, they are likely to be perceived differently, depending on the level of expertise of the audience as well as the reception context. To document this, our results are being used within the framework of a broader interdisciplinary approach aiming at studying the circulation of scientific knowledge between the different actors (researchers, end-users, stakeholders...) involved in this local controversy which is part of the more general and ongoing one concerning the toxicity of pesticides and its environmental indicators. In a context in which scientific expertise is often questioned by the public, this presentation will provide the first results of this novel approach.

00565

## CiTIQUE : producing scientific quality-grade results with citizen on ticks in an open laboratory

Oral

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Abstract

CiTIQUE is a participatory science program whose main goal is to study the ecology of ticks and tick-borne pathogens in order to improve prevention. Its principle is based on collaboration with citizens, who can report their tick bite and send the biting ticks to a laboratory. Most programs stop there, with citizens as data providers, but we decided to involve citizens more in the program by working with them in a research lab open to citizens, the Tous Chercheurs laboratory. There, citizens can participate in 2-days workshops during which they co-construct a research question with a scientist and then analyze ticks to answer the question.

Several participants told us that they were bitten by ticks brought home by their pets. Ticks take a while to bite their host, and can move on to another. This raises the question: is there a risk to human health when humans come into contact with ticks from their cats or dogs? To date, more than 230 citizens have worked together to analyze ticks biting cats or dogs in France. More than 811 ticks have been identified morphologically using a citizen-friendly identification key and more than 152 ticks have been analyzed by PCR for the presence of *Borrelia burgdorferi sensu lato*. The quality of the results produced by the citizens was compared to that of scientific experts.

89% (624/811) of the ticks were adults and 12% (96/811) were nymphs. 83% (671/811) belonged to the genus *Ixodes* while *Dermacentor* were only found in dog-biting ticks. Both genus are known vectors of human diseases such as Lyme disease. These results show that ticks brought by our pets can represent a risk for human health. Furthermore, these results show that it is possible to produce scientific-grade results by working with citizens in a research laboratory.

00590

## Impacts of forest anthropisation on links between wild micromammals communities and their gut microbiota

Oral

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Abstract

The gut microbiota provides essential services that contribute to host health. Biotic and abiotic factors may influence the diversity and composition of this ecosystem. This variability may enhance hosts' capacities to adapt to new environments. Nevertheless, some disturbances, in particular derived from human activities, can lead to dysbiosis - a disruption of the microbiota homeostasis - with potential impacts on hosts' fitness. In wildlife, the responses of gut microbiota to anthropic pressures have been investigated for particular animal species only and remain scarcely studied. Another effect of anthropisation on wildlife consists in an alteration of the host population composition and diversity. The interlinkages between the impact of anthropisation on gut microbiota on one hand, and on host communities and on the other hand, have not been explored yet. Here we address this issue by studying terrestrial micromammals sampled along a gradient of forest anthropisation (from rural forests to urban parks) in autumn 2020. The digestive tract was collected, and bacteria were described using a 16S metabarcoding approach. We estimated the alpha and beta diversity of amplicon sequence variants and potential metagenome functions. We tested whether anthropisation leads to changes in micromammal communities and negatively impacts gut microbiota with a dysregulation of essential functions. We found that anthropisation affected the composition and diversity of micromammal communities and host's gut microbiota. The abundance of forest specialists decreased with anthropisation, by contrast with the generalist *Apodemus sylvaticus* and commensal species *Rattus norvegicus* and *Mus musculus*. The gut microbiota's diversity and composition varied along the anthropisation gradient and differed strongly between micromammal species. Commensal species in urban parks had high gut microbiota diversities with many rare taxa and greater variance in microbial composition than other species. This pattern is representative of dysbiosis with an assemblage subject to stochastic effects. The gut microbiota diversity of forest species increased with anthropisation. Surprisingly, the generalist *Apodemus sylvaticus* had a gut microbial composition similar to more specialist species (*M. glareolus* and *A. flavicollis*) that was not affected by anthropisation. In conclusion, this study shows that anthropisation may have complex and intricated effects on micromammal communities and their microbiota.

**00593**

## **Comparison of arthropods communities between French military training and civil areas in a Natura 2000 context**

Oral

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### Abstract

Military training areas (MTA) are both disturbed and preserved sites. MTA can be degraded by military activities but are also preserved from intensive agriculture and urbanisation. These enclosed lands can therefore be considered as important potential reserves for biodiversity.

As part of the project Life NaturArmy, a comparison between Natura 2000 sites under military and civilian status is implemented. This Life project is coordinate by the French Ministry of Armed Forces and the federation of conservatories of natural areas. The research project is implemented by the Research team "Géoarchitecture" from the University of Western Brittany. The aim is to highlight the specificities of military training grounds in order to enable the MINARM to improved environmental management on its sites. Thus, the state of conservation of different habitats was evaluated on six MTA throughout France notably by studying the flora and fauna. Vegetation and arthropods communities were sampled on several dunes, calcareous grasslands, forests and hedgerows. Here results concerning Arthropods communities will be presented.

Pitfall traps were set at 5 study sites in order to determine the arthropod communities present in and around the MTA. The dunes of Plouhinec, the camp Avon's hedgerows and the forest of Montmorillon, Auvours and Romorantin-Pruniers were sampled from April to July 2021. All traps were sorted, and beetles, spiders and ants were set aside for identification. Individuals were identified to the highest possible taxonomic rank. This presentation will focus on coleopteran results. The aim of analyses is to compare both the structure and the composition of Coleopteran communities under the two land-use modalities. This oral presentation will describe the first results of this study and discuss their potential consistency with the results of the flora survey.

**00492**

## **From gravel to nature gardens - differences for supporting local biodiversity**

Oral

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### Abstract

In Germany about 17 Mio. private gardens cover 2% of the total land area. These gardens differ in their facilities, design and cultivation practices. The so-called gravel „Gardens of horror “are expected not to support biodiversity whereas nature gardens are supposed to facilitate biodiversity.

In the project gARTENreich, we investigate preferences and constraints for biodiversity conservation in private gardens as well as their potential to maintain biodiversity. Different methods to characterize biodiversity will be tested. Indices from literature like the wildlife resource index (Goddard, Dougill, & Benton, 2013) or the biodiversity scores (Chamberlain, Cannon, & Toms, 2004; Tzoulas & James, 2010) are tested and compared to the “real”, i.e. measured, biodiversity of plant species. Using these data, we will investigate the influence of different habitat and garden structures on biodiversity.

First results show that species numbers differed strongly between the two extreme categories gravel and nature gardens. However, for the gardens not belonging to these two extremes, the number of plant species is not always representing the expected biodiversity friendliness of the garden as derived from the wildlife resource index.

### Sources:

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00543

## Understanding farmers' adoption of agri-environmental schemes. Insights from farmer interviews and geospatial regression models

Oral

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Abstract

Agri-environmental schemes (AES) belong to the main instruments of the European Union's Common Agricultural Policy to foster sustainable farming practices that contribute to the conservation of biodiversity, ecosystem services, climate change mitigation and adaptation. However, until today, the uptake of AES remains below expectation.

We studied the factors influencing farmers' attitude towards and adoption of AES in an intensively farmed catchment in Saxony, Germany, using a set of complementary methods.

First, we combined biophysical maps with spatially-explicit agricultural payment data to model the influence of farm characteristics and landscape context on AES implementation at both farm and field level. Based on a set of regression models, we showed that the spatial patterns of AES adoption can be predicted based on farm structural and environmental variables. Our analysis revealed that AES tend to be implemented by larger farms specialized in permanent grassland cultivation and are typically located in protected areas with lower soil fertility or close to water bodies and small woody features. Our study thus supports previous evidence criticizing the global tendency to allocate environmental protection measures in regions with low agricultural value, which results in conservation goals not being met.

Second, we conducted 14 semi-structured interviews with local farmers and empirically reconstructed their decision-making processes using qualitative content analysis. In a heuristic framework, we were able to distinguish a decision-making sequence consisting of decision-making context, leeway in decision-making and decision-influencing factors. We found that farmers' AES adoption can only be increased by better understanding the restrictions farmers face along the decision-making process. The sequence and practical meaning of decision-making elements is crucial to understand how farmers make acreage-by-acreage decisions with regard to AES. In specific constellations, economic incentives and administrative factors may be less important than non-AES related land-use commitments.

The findings presented here can support the development of future AES, e.g. by developing schemes tailored to fit farms and fields that are currently unlikely to adopt AES, thus improving their effectiveness. We conclude that farmers' practical experiences need to be better integrated into AES policy and suggest a paradigm shift towards real profit for farmers' environmental services.

**00607**

# **Novel Systems, Novel Approaches: Integrating ecological science into complex Social-Ecological-Technological Systems with Urban Green Infrastructure**

Oral

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## Abstract

Cities around the world are changing rapidly to deal with intersecting challenges of population growth, climate change, and social demand for high quality urban environments. To meet some of these challenges, ecological science has become increasingly important for the planning and design of cities. A predominant approach for integrating green and ecological elements in cities is through Urban Green Infrastructure (UGI). UGI knits together ecological systems with engineered infrastructures to achieve socially negotiated goals. Existing approaches for understanding cities as socio-ecological systems has thus evolved to explicitly consider technologies within the built environment, characterizing cities as complex urban social-ecological-technological systems (SETS). Within these complex systems, ecological structure, functions, and processes underly the provision of socially valuable urban ecosystem services. Social demand for ESS in turn exist alongside, and occasionally conflict with, existing infrastructures and planning priorities. Integrating green elements and biodiversity into existing urban fabrics thus requires new knowledge and design tools whose application often requires transformations in urban governance. To meet these challenges, the TUM Urban Green Infrastructure Research Training Group of over 54 interdisciplinary researchers is working towards a novel synthetic framework to provide for project level, thematic, cross cutting, and decision-making integration of multi-faceted and transdisciplinary knowledge around UGI. This includes the investigation of the role of governance in creating existing and future urban green infrastructure, sustainable transit, building energy, and urban drainage systems, how UGI is experienced and valued by different residents, its ecological functions and processes and relationships with biodiversity. In this talk we present our approach towards this integration through an elaborated SETS-UGI conceptual framework coupled with a knowledge-to-action plan in order to provide policy support for transformative governance, develop design tools that allow for green element integration at multiple spatial and temporal scales, and facilitate broader public outreach and education on UGI.

# Phenotypic plasticity, epigenetic, and environmental change - Salle 2 22/11 ; 10:15-12:15

00035

## Temporal dynamics of multiple phenotypic traits and the meaning of reaction norms

Oral

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### Abstract

Reaction norms are commonly used to quantify phenotypic plasticity along a gradient of environmental conditions. Assembling a reaction norm usually requires to measure a phenotypic trait at a chosen time following environmental changes, but the decision of when is an understated degree of freedom. In this regard, most reaction norms seem to rely on the assumption that plasticity should both be rapid and reach an asymptote, such that the phenotype at the time of observation would correspond to a stable state in the environment of exposure. Yet, very few experimental designs allow this hypothesis to be verified. As such, our use of reaction norms expose us to the risk of deriving unrepresentative measures of plasticity by neglecting the temporal dynamics of phenotypes. In order to question and discuss these considerations, we exposed three species of the genus *Tetrahymena* to a gradient of acute thermal stress while monitoring the dynamics of multiple phenotypic traits at a high temporal resolution. By doing so, we precisely reconstruct short-term changes in trait values and in the resulting reaction norms. We show that the dynamics of the phenotype differ between measured traits and exposure conditions, without systematically reaching a stable state. Subsequently, we show that these temporal dynamics result in highly time-dependent reaction norms. We ultimately integrate these results within more theoretical considerations surrounding the meaning of phenotypic plasticity, its potential adaptiveness and the way we ought to implement these findings into plasticity studies.



00195

## A story of individuals: leaf trait variation is driven by interdependent species diversity and soil nutrients

Oral

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Abstract

Examples of positive diversity effects on ecosystem functions have kept multiplying in the last two decades. In the quest to better understand the mechanisms underlying ecosystem functioning, plant functional traits have been a tool of choice for investigating the relationship with its drivers. In particular, the variation of traits seeks to capture the adaptive potential of plant individuals in changing environments. However, while often considered between, and more recently within-species, trait variation at the individual scale as largely been ignored so far, despite being the very scale at which it most likely has a defining importance for the ecosystem, that is, the scale at which plants interact.

In our project, we investigated diversity effects in tree-tree interactions, by quantifying within-individual leaf trait variation at local scales and its relationship with species diversity and soil nutrient conditions. For doing so, we used optical spectroscopy to measure and predict nine leaf traits from >400 trees representing 14 species in a large subtropical biodiversity-ecosystem functioning experiment. In addition, we evaluated the local soil nutrient conditions and surrounding tree species diversity for each tree individual.

We found that within-individual variation represented on average >25% of total trait variation, exceeding between-individual variation for all the traits, and even between-species variation for specific leaf area and leaf C:N ratio. We also found support for positive effects of soil nutrients and species diversity on within-individual trait variation, however conditional on each other's values. Indeed, trait variation increased with soil nutrients at intermediate diversity but decreased at low and high diversity.

Overall, our results quantify the importance of the within-individual level for leaf trait variation, and indicate that soil nutrients can alleviate competition or enhance complementarity between tree individuals depending on local diversity. Our findings highlight the necessity of integrating the within-individual perspective to understand the trait-based mechanisms behind ecosystem processes.

**00382**

## **Thermal generalism and underlying phenotypic plasticity mediate response to thermal fluctuations in microcosms**

Oral

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### Abstract

Understanding how do organisms deal with environmental fluctuations has attracted much attention. Theory predicts that relatively constant environmental conditions should generally favor specialists, while genotypes able to tolerate a broader range of environmental conditions should be selected under fluctuations. However, organisms able to live in a wide range of relatively stable conditions might in contrast perform badly under fluctuations. Whether and how does classic measures of performance across gradients of constant conditions and their potential underlying mechanisms correlate with organisms' performance under fluctuations are thus crucial questions to answer. Here we tested experimentally whether niche width and phenotypic plasticity mediate performance under thermal fluctuations, using microcosms of a ciliate. As expected, we found that thermal generalism comes with higher phenotypic plasticity. Furthermore, while thermal fluctuations generally impeded performance compared to constant conditions, the magnitude of fluctuations effects on growth depended on thermal niche width. Thermal specialists perform better under fast or negatively autocorrelated fluctuations. On the contrary, plastic generalists perform better under slow or positively autocorrelated fluctuations, possibility since lag times in the expression of phenotypic plasticity limit its potential benefits under rapid fluctuations. This study points out the importance of further investigating the mechanisms underlying organisms' response to environmental fluctuations, from the kinetic of phenotypic plasticity and its potential reversibility to its links with performance across diverse constant and fluctuating scenarios.

00413

## Food quality effects on ectotherm performance in thermally fluctuating environments

Oral

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### Abstract

According to theory, thermal variance effects on performance are explained by Jensen's inequality (JI) and the non-linearity of the ectotherm thermal performance curves (TPC). However, using TPC implies an instantaneous acclimation of the organisms whatever the temporal scale of environmental temperature fluctuations or the dietary context. We analyzed how the temporal scale of thermal variance interacts with the nutritional context of *Daphnia magna*. We fed *Daphnia magna* with 3 food treatments consisting of 3 different algae (*Cryptomonas*, *Chlamydomonas*, *Synechococcus*) differing in terms of polyunsaturated fatty acids (PUFA) and sterols contents (molecules known for their importance in temperature acclimation) and measured their growth and fecundity rates under constant and fluctuating temperatures at three different frequencies (temperature change every 12h, 24h and 48h). We show that except for the lowest PUFA and sterol supply (*Synechococcus*), temperature fluctuations consistently decreased growth rate compared to constant conditions. However, the decrease was stronger than expected from JI predictions, indicating that acclimation of *Daphnia* might lag behind the tested fluctuating environments. Furthermore, in the intermediated supply (*Chlamydomonas*), growth rate decrease was stronger for lower fluctuation frequencies. Fecundity also strongly decreased under lower fluctuation frequencies but only in the higher PUFA and sterol supply (*Cryptomonas*). We argue that the nutritional context and its effects on temperature acclimation need to be considered in any attempt to predict the performance of aquatic ectotherms in thermally fluctuating environments.

00449

## Thermal plasticity of insecticide sensitivity in an invasive pest species

Oral

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### Abstract

The number of species displaced by human activities is constantly increasing due to trade acceleration and global warming. The impact of invasive alien species is generally considered to be harmful to human or animal health, the environment, and the agricultural sector. From an academic point of view, the success of an invasive species is an ideal situation to study the processes operating at short time scales i.e. phenotypic plasticity. *Drosophila suzukii* Matsumara is a species native to Asia that was first observed in 2008 in Europe and North America where it has spread very rapidly. In addition to its remarkable capacity of invasion, the females of this species, contrary to other fruit-eating drosophila, have the particularity of being able, thanks to their sclerotized ovipositor, to lay their eggs in healthy fruits still on the plant. The damage is caused by the larvae developing inside the fruit but also by the arrival of secondary infections of bacteria and fungi which will accelerate the decomposition of the fruit. Since its introduction, *D. suzukii* has been the subject of numerous studies, both from a fundamental and an applied point of view: in particular on the importance of its plasticity to temperature to explain its invasive success, or on its sensitivity to active substances used in insecticide control. However, the combined effects of these two variables had never been studied. We therefore wanted to test if the sensitivity to insecticides was temperature dependent in *D. suzukii*, and if this plasticity was variable between sexes and populations. The major result of this study is that the sensitivity to insecticides increases dramatically with the temperature (LD50 between 25 and 21 times higher at 15°C compared to 29°C respectively for spinosad and phosmet). The sensitivity differences between sex decrease with temperature. These results show that temperature plays an important role in the action of insecticides, which should be taken into account in their application modality in a context of global warming.

**00551**

## **Acute temperature variation and extreme starvation involved two divergent but successful stress response strategies in the sea anemone *Nematostella vectensis***

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.

Acclimation, Ecophysiology

Oral

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Abstract

Four and a half billion years of environment evolution on Earth have generated a diversity of stress resistance mechanisms among species. Molecular biology and genomics approaches have already identified central molecular processes (such as improved DNA repair, high protein turnover, lowered insulin/IGF-1 signal) selected in natural environment for the successful implementation of stress tolerance. Among metazoans, cnidarians emerged as biological models of cellular tolerance to environmental disturbances, as they evolved facing continuous abiotic fluctuations (temperature, salinity, light, oxygen). *Nematostella vectensis* is a widespread estuarine sea anemone (Cnidarian, Anthozoa), exposed to large daily temperature fluctuations (+/-20°C) and food availability. However, the acclimatization process involved in this extended plasticity remain poorly understood. In this work we then wanted to understand the physiological limits and molecular response strategies underlying this plasticity in *N. vectensis*.

To address this fundamental question, we submitted *N. vectensis*, to i) acute temperature variations (+/- 18°C maintained for up to 7 days) and ii) complete food deprivation for up to 6 months. We then applied a multi-marker approach measuring the physiological state (respiration rate), the stress resistance (level of protein damages), and the activation of compensatory mechanisms (antioxidant potential, chaperone protein, ubiquitin-proteasome system, apoptosis, and autophagy). The results show that temperature variations and starvation induced contrasting physiological responses. Regarding the foremost, the limit of resistance was between 35°C and 40°C as 100% mortality was reached at the highest temperature. Below this limit, the acclimation success was associated with an activation of ROS scavengers, a drop of respiration rate and an induction of caspases/cell death. Strikingly, pan-caspase inhibition sensitized the individuals to temperature variations confirming the role of cell-death in temperature resistance. On the other hand, starvation was associated with drastic size reduction, long term respiratory metabolism changes, global reduction of caspase activities and the maintenance of redox balance. These divergent results shade light on two successful types of molecular strategies emphasizing the complexity of the Cnidarians stress response to environmental changes.

**00681**

## **Reproductive plasticity of the shrimp *Palaemon serratus***

Poster

J.B. Baudet <sup>1</sup>, B. Xuereb <sup>1</sup>, M. Danger <sup>2</sup>, V. Felten <sup>2</sup>, G. Schaal <sup>3</sup>, A. Duflot <sup>1</sup>, A. Poret <sup>1</sup>, E. Maniez <sup>1</sup>, F. Le Foll <sup>1</sup>, R. Coulaud <sup>1</sup>

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Abstract

In marine crustaceans, there is a great inter- and intraspecific variability of reproductive strategies. This is reflected in particular in the ecological trade-off between fertility and maternal investment. From the tropics to the poles, the reproductive strategies of crustaceans follow macro-ecological trends, from several reproductive episodes per year with many relatively low-energy eggs, to a single reproductive episode with few relatively rich eggs. In temperate environments, in response to the significant variability of temperature and resources during the year, an intermediate pattern is generally observed with several breeding episodes, each following a strategy consistent with environmental conditions. During embryonic-larval development, developmental plasticity allows organisms to cope with these variable conditions by adapting their resource consumption and developmental duration. At their metamorphosis, the phenotype of juveniles responds to an interaction between maternal investment and developmental environment. In this context, we are interested in the reproduction of an emblematic caridean shrimp of European coasts, *Palaemon serratus*, which reproduces one to three times a year depending on its age. For this, we study in the laboratory the single spawning of newly mature females, the winter spawning of 3-year-old females as well as their summer spawning, in different thermal and food quality conditions. Several traits are then compared during early development, such as survival, growth, number of larval stages, duration of development and use of energy reserves.

**00457**

## **Long term eco-evolutionary impact of the Chernobyl nuclear accident on tree frog populations**

Oral

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### Abstract

The Chernobyl nuclear accident (Ukraine, 1986) led to the contamination of the environment by radionuclides. Due to this contamination, in the vicinity of the power plant, an area called Chernobyl exclusion zone has been abandoned by humans. Although the richness of wildlife in this area seems high today, organisms are still exposed to ionizing radiation. While several effects of ionizing radiation on organisms were observed in the first years after the accident when contamination was higher, the long-term effects of current contamination are still debated. In particular, after several generations exposed to ionizing radiation, the intensity of evolutionary processes is expected to be modified, but studies focusing on evolution in contaminated areas are still scarce. Yet, these evolutionary processes may have an impact on the ability for populations to cope with ionizing radiation and are thus essential to characterize the status of wildlife in contaminated areas, which appears as a major scientific and societal environmental issue. To move forward on this issue, we investigated the evolution of tree frog (*Hyla orientalis*) populations after the Chernobyl nuclear accident by combining population genetics and transcriptomic analysis. We first explored the intensity of evolutionary processes in the Chernobyl exclusion zone. We showed a decrease of nuclear genetic diversity (transcriptome-based SNP) and an increase of relatedness along the contamination gradient and the existence of limited asymmetrical gene flows towards the most contaminated places. We concluded to the existence of small effective population size in the most contaminated places. The analysis of a mitochondrial genetic marker (cytochrome b coding gene) points towards a substitution rate hundred times higher for mitochondrial DNA, and also confirms a likely reduced effective population size. We then evaluated the potential parallel functional processes that could be affected in tree frogs and showed by combining differential gene expression analysis, dose-response modelling and co-expression network analysis the impairment of mitochondrial energetic processes. Together, these results display the central role of mitochondria and ATP synthesis as the target of the disturbance due to ionizing radiation, and highlight the role of plasticity on evolutionary processes in a response to such a fast environmental change.

**00020**

**Frost resistance in herbaceous species: A driving factor for plant performance in response to global change**

Oral

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Abstract

Frost resistance (FR) is a major driver of plant distribution, especially in temperate regions, and ensures the survival of perennial plants. However, research on FR and plant distribution has largely been carried out only on trees, neglecting herbaceous species, for which patterns might be different as they are often insulated by snow cover in winter. The investment in FR is energy-demanding. Our previous studies showed that FR varies in herbaceous species depending on abiotic conditions, defines the plants occurrence along temperature gradients, and follows a trade-off with traits related to plant performance as plants need to balance their energy investments. However, it is not clear what impact this has on plant behaviour, such as reoccurring life history events (phenology). Phenological adaptations are well-documented responses of plants to changing climate. Spring phenology especially was found to shift to earlier dates with warmer climate in most species, thus the growing season is prolonged. However, this shifting to earlier dates bears a higher risk of frost damage for the plants, as late frost events still occur and potentially can cause much damage. Thus, adjusting FR with changing spring phenology might be crucial for a species' long-term adaptation to warming temperatures and might be one of the main drivers for a species' ability to shift its phenology to earlier dates.

In this research, we measured FR on herbaceous species and their phenology. We additionally measured data on plant functional traits related to plant performance such as specific leaf area and leaf nitrogen and analysed the current plant distribution to answer the following questions:

Is FR linked to realized niche cold limits of herbaceous species?  
Is FR linked to phenological adaptations in plants and in fact a crucial driver of species-specific responses?

Our research will shed new light on FR in herbaceous species, their distributional limits, and the drivers of plant phenology, and will thus make a contribution to explain spatial and temporal changes in plants, e.g. biodiversity patterns and processes, as well as the functions of biodiversity, as e.g. the provision of flowers is crucial for pollinators.



00276

## Competitive ability and drought escape, rather than drought tolerance, determine fitness of annual plant ecotypes along precipitation gradients in Mediterranean areas

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.  
fitness, ecotypes

Oral

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### Abstract

Ecotyping and the resulting higher fitness are often a reason why widespread plant species can exist along precipitation gradients in Mediterranean regions. Along such gradients, water availability and the length of the growing season decrease with decreasing precipitation. In contrast, as precipitation increases, productivity and thus competition along the gradient increases. However, most studies have focused on the influence of drought on ecotyping along such gradients, and there is little experimental evidence to date of fitness advantages of ecotypes to competition at more productive sites and whether fitness advantages to competition and aridity can also be found at small-scale levels. Therefore, we collected individuals of *Brachypodium hybridum* and *Hedypnois rhagadioloides* from 15 sites each on north and south slopes along a natural precipitation gradient in Israel and grew them in the greenhouse under drought, competition and standard conditions to determine fitness at early and late time point. We hypothesize that ecotypes of annual plant species from arid regions will exhibit higher fitness under drought and a shortened growing season. In contrast, ecotypes from productive sites should show higher fitness under competition. The assumptions of the large gradient should also be reflected at each of the sites on the more mesic north and more arid south slopes. In agreement with our hypotheses, our results show that under competitive conditions, the fitness of both species increases along the gradient with increasing precipitation. We also show strongly that with a shorter growing season, fitness along the large-scale gradient increases with decreasing precipitation and is greater on south-facing slopes than on north-facing slopes. Adaptation to drought is ambiguous depending on species and slope. With our results, we can show that ecotypes of more productive habitats are more competitive and that ecotyping can also take place on a small-scale level. Our results contribute to a better understanding for predicting future climate change impacts on local populations and communities, and are relevant for planning and implementing conservation and restoration projects built on species reintroduction.

00306

## Effects of macrocyclic lactone anthelmintics on seed germination of temperate grassland species

Oral

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### Abstract

Macrocyclic lactone anthelmintics play a central role in controlling livestock parasites, such as mites and gastrointestinal nematodes worldwide. Since macrocyclic lactones enter the environment via dung, they pose a threat to non-target species of grasslands. This has been shown extensively for arthropods, such as dung beetles. In contrast, knowledge about anthelmintic effects on plants is scarce. An important developmental stage at which plants can come into contact with anthelmintics is the seed stage. The seeds of many plant species are able to pass through the gastrointestinal tract of ungulates and are partly excreted in viable condition with dung. The few existing studies on phytotoxicity of anthelmintics showed effects on seed germination. However, these studies included only one to three plant species and mostly one active ingredient.

Therefore, we set up a standardised germination experiment where we exposed seeds of 20 typical temperate grassland species to three concentrations of four common macrocyclic lactones as pure substances, i.e. ivermectin, moxidectin, abamectin and doramectin. In case of ivermectin and moxidectin, we included also their formulations, i.e. Ivomec® and Cydectin®, respectively. Seed batches not exposed to a pure substance or formulation served as controls. As response variables we assessed germination percentage, mean germination time and germination synchrony.

We found significant effects of all tested drugs on all response variables, the effects depending on species and concentration. Germination percentage was affected in 12, mean germination time in 15- and germination synchrony in seven species. Most significant differences from control occurred when seeds were subjected to the highest concentration of macrocyclic lactones used in the experiment. Across all treatments, germination percentage was decreased by 31 % and mean germination time was increased by four days compared to the control. Synchrony was increased to a lesser extent. We found significant differences between the macrocyclic lactones tested, suggesting differences in effect size on seed germination, despite similar molecular structure.

These findings have implications for grazing management, since the impact of macrocyclic lactones on plant regeneration might alter plant composition in the long run.

00375

## Orchid mycorrhizal networks are more specialized in Mediterranean than in Central Europe

Oral

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Abstract

Orchids are known to form complex networks of interactions by associating with numerous orchid mycorrhizal fungi (OMF), mainly from Tulasnellaceae, Ceratobasidiaceae, and Serendipitaceae families. These bipartite networks may differ in architecture according to the specificity level of each partner: the modular network (dominated by highly specific interactions) and the nested network (dominated by generalist interactions with low specificity). Although there is evidence about the influence of biotic factors (e.g., level of specificity) on the network structure, there is still a lack of studies demonstrating the effect of abiotic factors on bipartite networks. Climatic conditions (e.g., annual temperature or precipitations) could influence the network architecture by creating different stress levels on orchid species that would further influence their specificity toward fungal partners. To understand the potential influences of both biotic and abiotic conditions on orchid-OMF networks, we identified the OMF communities of 17 orchid species from two different climatic regions (Czechia and Southern France) by using next-generation sequencing and we analysed the architecture of four orchid-OMF networks. Our results showed that OMF communities differ across co-occurring orchid species within each sampling site, with orchid species sharing more OMF within Czech sites compared to French ones. In general, the networks across all sites were significantly nested and modular but more modular in Southern France than in Czechia. These results may suggest that orchids' specificity towards their OMF partners may increase under higher hydric stress observed under a Mediterranean climate with a longer drought season.

**00409**

# **Patterns in phenology and functional traits of herbaceous species change along a gradient in species diversity – lessons learnt from a field study in dry grasslands**

Oral

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Abstract

AIM

Many studies have shown changes in plant phenology as a response to variations in climate conditions. Little is known on the effect of changes in biotic conditions such as species diversity mitigating these responses. In this study, we aim at identifying the influence of biodiversity on the phenology of herbaceous species in dry grasslands. More specifically, we ask:

- 1) Does species phenology differ in dry grasslands representing a diversity gradient on the community as well as on the species level?
- 2) What is the relative influence of species diversity, climate and abiotic site conditions on species phenology?

METHODS

We established six semi-dry grassland sites in Central Germany, representing six diversity levels. We did weekly phenological observations from March to November in 2019 and 2020 to detect leaf and flowering phenology of all flowering species co-occurring on these sites. Additionally, we performed vegetation relevés and measured abiotic habitat parameters in 2020.

RESULTS

Our results indicate differences in flowering duration on the community level, with higher diversity levels showing a more dispersed flowering pattern than lower diversity levels. Accordingly, also on the species level we identified highly species-specific patterns in first flowering day (FFD) and peak flowering day (PFD), though the direction of change was less clearly related to species diversity.

CONCLUSIONS

We conclude that a higher plant diversity clearly affects community-level phenology with an increase of overall flowering time due to decreased synchrony. It may thus function as a buffer for changes in climate and therefore stabilize the functioning of ecosystems e.g., by providing a reliable energy resource for pollinators.

00453

## Spatio-temporal scaling of rainfall drives vegetation dynamics of savannas – evidence from a rangeland simulation model

Oral

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Abstract

Savanna landscapes consist of a dynamic mosaic of patches in varying degrees of co-dominance between the grassy and woody components. Many different factors acting at various scales determine the current state of the savanna patches, such as heterogeneous precipitation patterns, soil moisture, vegetation competition and succession, fire events, seed availability, grazing and browsing, wood reduction by firewood removal or through arboricides, as well as other factors such as livestock type and stocking density, type and characteristics of the grazing system, and farmer back-up plans for drought periods. The vegetation dynamics of savannas are complex and multifactorially interconnected. Spatially explicit, process-oriented rangeland models are ideal tools to study these complex vegetation dynamics and the phenomenon of bush encroachment (densification of shrubs and trees). These models can aid in optimizing type and characteristics of the grazing system to reduce bush encroachment, and can guide future research on the key factors influencing vegetation processes and bush encroachment in savannas.

Here, we present Midessa, a process-oriented rangeland simulation model developed to analyse the complex spatio-temporal, multi-scale cause-and-effect relationships in savanna rangelands. Most savanna models assume spatially homogenous rainfall. We will show that spatially heterogeneous distributed precipitation has a major impact on the spatiotemporal distribution of vegetation types, including a higher prevalence of bare soil, which has important repercussion for realistically modelling livestock condition and developing sustainable management practices. Highly localized rainfall is typical for savannas and other arid and semi-arid ecosystems. Unfortunately, detailed spatio-temporal rainfall data are scarce and therefore we conclude with a call to collect such data.

00595

## Plants stand still but hide: imperfect and heterogeneous detection is the rule when counting plants

Oral

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### Abstract

1. The size of populations and their variation over time and space are of central importance in ecology and conservation. Their estimation largely relies on counts of individuals, generally made on spatial units such as quadrats or sites. Imperfect detection, i.e. missing some individuals during counting, results in biased estimates of population sizes and trends. Since the 1970s, imperfect detection has been shown to be the rule in animal studies, and most studies now correct for this bias by estimating detection probability. However, this remains exceptional in plant studies, suggesting that most plant ecologists implicitly assume that all individuals are always detected.

2. To verify the validity of this hypothesis, we conducted a field experiment in which we estimated the individual detection probability in plant counts conducted in 1x1 m quadrats. We selected 30 herbaceous plant species covering a gradient of conspicuousness, at 24 sites covering a gradient of habitat closure, and asked groups of observers to count individuals in 10 quadrats using three counting methods requiring increasing counting time (quick count, unlimited count and cell count). In total, 159 participants took part in the experiment, and we analysed the results of 5,040 counts.

3. Over all field sessions, no observer succeeded in detecting all the individuals in the 10 quadrats. The mean detection rate was 0.44 (range from 0.11 to 0.82) for the quick count, 0.59 for the unlimited count (range 0.17-0.87) and 0.74 for the cell count (range 0.46-0.94).

4. Detection probability increased with the conspicuousness of the target species and decreased with habitat closure. The experience in botany of the observer had little effect on the detection probability, whereas it was strongly affected by the time the observers spent counting. Although the more time-consuming methods increased the mean detection probability, none did not achieve perfect detection, nor did they reduce the effect of the variables we measured on detection probability.

5. Given that detection was always imperfect and highly heterogeneous, we argue that plant ecologists must abandon the use of raw counts, and that detection issues must always be taken into account when studying plant populations.

00631

## Plants response to variation in estuarine constraints: a study in controlled conditions of salinity and inundation gradients

Oral

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Abstract

Estuarine wetlands span a wide array of environmental constraints. As ecosystems at the interface between marine and terrestrial environments, salinity and inundation are among the most important factors impacting soil biology and plant community structuration. Both of these parameters are mostly gradual, resulting in a two-dimensional map of gradients in estuarine wetlands. Vegetation is under high stress in areas where both gradients meet at their high point (close to the river and/or low altitude, resulting in frequent inundations from the tide, and close to the sea, where water salinity is at its highest due to the mixing of fresh water and salt water) and plant communities are shaped by the harsh environmental conditions. On the opposite end of these gradients, in higher wetlands further away from the sea, abiotic constraints are lower and plant communities are the result of intrinsic biotic interactions. Through these gradients, estuarine wetlands present characteristic zonation patterns of plant communities [Day et al. (2012). *Estuarine Ecology*. John Wiley & Sons, Inc., Hoboken, USA]. In the current context of climate change, a rise in sea water levels will displace salinity and inundation gradients in estuaries and their associated wetlands. This will significantly change the physical and chemical parameters of the soil types and impact the plant communities within estuarine ecosystems. We therefore set out to determine the effect of the modification of water salinity and submergence frequency on plant productivity in a pot experiment in controlled conditions. Five individuals of three species (*Alopecurus geniculatus*, *Festuca arundinacea* and *Holcus lanatus*) of estuarine wetlands were exposed to three saltwater concentrations (15 g.L<sup>-1</sup>, 7.5 g.L<sup>-1</sup> and 0 g.L<sup>-1</sup>) and three submergence frequencies (tidal movements one week out of two, one week out of four, and no tides) in a total of nine sets of conditions. Growth and biomass production of each individual were assessed non-destructively through photography weekly for 3 months. Leaf traits (SLA, LDMC and chlorophyll content) were also measured at the end of the experiment. We will present the design of this experimental setup, the photography tool developed especially for this study, as well as the final results.

# Population and community ecology, from micro to macroorganisms - Salle 3 22/11 ; 16:15-18:15

00039

## Non-target chironomids respond to an anti-mosquito agent - Analysing communities using metabarcoding and joint species distribution modelling

Oral

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### Abstract

Emergent aquatic insects serve as an important subsidy for adjacent riparian ecosystems. Thus, anthropogenic stressors in aquatic environments might have a substantial impact on terrestrial systems. So far, studies have focused on stressor-induced changes in numbers or biomass of emergent insects. However, investigating changes in the community composition of emergent insects is equally important, as terrestrial predators might be adapted to prey-specific traits (e.g., body shapes or emergence patterns). Therefore, we used DNA metabarcoding and joint species distribution modelling to reveal effects of the mosquito control agent *Bacillus thuringiensis israelensis* (Bti) on the highly diverse and abundant non-target dipteran family Chironomidae. Aquatic insects were sampled once or twice a week in a replicated but natural pond system over a period of sixteen weeks. We used floating emergence traps in twelve ponds, with six of them being treated three times with Bti at realistic field rates used in mosquito control. State-of-the-art DNA metabarcoding was conducted to characterise the chironomid community composition per pond for each sampling date. Additionally, for all chironomid taxa, information on phylogenetic relationships and ecological traits were gathered. All data sets were used to model the effect of Bti on genetic diversity and community structure of emergent chironomids by hierarchical modelling of species communities (HMSC). Preliminary results indicate a Bti-related effect on chironomid diversity that changed over time. Genetic diversity was marginally higher in the first third and considerably lower in the last half of the study period in Bti-treated ponds as compared to the control. This pattern occurred in the subfamilies Chironominae and Orthocladiinae, while Tanypodinae diversity seemed not to be affected by Bti. As Tanypodinae larvae are predominantly predators, we assumed that feeding types represent a relevant ecological trait determining the sensitivity to Bti. Furthermore, the modelling approach allowed us to assess the contribution of common ancestry (phylogeny) and a number of relevant ecological traits to the chironomid taxa's Bti susceptibility or tolerance. An in-depth analysis in this context is in progress, also allowing us to estimate consequences for terrestrial predators.



00089

## Stochastic processes, deterministic models. How to deal with process and observation error in microcosm population time series?

Oral

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### Abstract

Population and community ecology traditionally has a very strong theoretical foundation with well-known models, such as the logistic and its many variations, and many modification of the classical Lotka-Volterra predator-prey and interspecific competition models. More and more, these classical models are confronted to data via fitting to empirical time-series from the laboratory, for purposes of projections or for estimating model parameters of interest. However, the interface between mathematical population or community models and data, provided by a statistical model, is far from trivial.

In order to help empiricists make informed decisions, we here ask which error structure one should use when fitting classical deterministic ODE models to empirical microcosm data, from single species to community dynamics and trophic interactions. We use both realistically simulated data and empirical data from microcosms to answer this question in a Bayesian framework.

We find that pure observation error models mostly perform adequately overall. However, state-space models clearly outperform simpler approaches when observation errors are sufficiently large or biological models sufficiently complex.

We show that deterministic models can be sufficient to describe dynamics from stochastic population process that include process variability and observation error. Also, many models do not require a complex state-space model formulation and simpler trajectory matching is sufficient for accurate parameter estimates.

00156

## Climate effects on phenology and morphology often have strong population consequences but no consistent trend across animals globally

Oral

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Abstract

Consideration of phenotypic traits in population ecology is especially timely given that traits such as phenology and morphology were shown to respond to climate change and to influence population dynamics. However, we still have a limited understanding of the magnitude and sign of the trait-mediated climate effects on population growth across species. Here, we assembled hundreds of time series on animal traits and population sizes into a global dataset and matched it spatially with temperature and precipitation data. Our meta-analysis corroborates previous findings on significant advancement of phenology with warming temperatures across studies. However, the effects of precipitation on phenology and the effects of both precipitation and temperature on morphology are highly heterogeneous across the studies. Such heterogeneity in trait responses is explained by the latitude, a species' thermoregulation type (ecto- vs endotherms) and generation time. We expected the signs of the climate relationships to traits and the traits' relationships to population growth rates to be the same in the case that climate-driven trait changes have population consequences. This expectation is fulfilled for the majority of studies on phenology, whereas for the studies on morphology the signs of both relationships varied greatly. Using structured equation modelling we found high heterogeneity in trait-mediated effects of climate on population growth rate: while some studies show strong effects, the average effect across the studies is close to 0. We developed a simulation model based on reaction norms to assess a set of scenarios about climate effects on population dynamics. Our model indicates that trait-mediated effects around 0 are found if the magnitude of gradually changing climate is rather low. To sum up, some studied species experience strong population consequences of climate-driven trait changes. However, globally, the magnitude of climate change is still too low to invoke a consistent response at the population level across species. We caution that the majority of these long-term studies stem from temperate regions and focus on very abundant common species, so that we still do not know how traits moderate climate change effects on population dynamics of rare species and species inhabiting other regions.

**00300**

## **Plants and bacteria mutually effect each other's successions in a glacier forefield**

Oral

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### Abstract

Worldwide, global warming already caused unprecedented glacier retreats, which are expected to continue and even accelerate. Thus, ecological successions along glacier forefields will be an important factor shaping the distribution and composition of biodiversity in alpine regions and may serve as blueprint for the restoration after anthropogenic disturbances. These successions are shaped by time since deglaciation, environmental conditions and by interactions between organisms. However, taxonomic groups such as plants and bacteria are mostly studied in isolation despite their tight relationships that may mutually affect each other's community assembly. In glacier forefields in the Austrian Alps, we showed that plant and bacterial diversities have different trajectories along successional gradients, but that the composition of plant and bacterial communities are linked. In lab experiments, we confirmed this correlative field finding by demonstrating a) that soil bacterial communities clearly respond to plant species composition and diversity and b) that bacteria affect the phenotype of plants with potential consequences for the plants' establishment and ecosystem function as protection against erosion. We conclude that plant-bacteria interactions are key in understanding successions and the emergence of diverse and functional ecosystems.

00305

## Ground-dwelling arthropods as mobile linkers for phytopathogenic fungi in agricultural landscapes

Oral

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### Abstract

Moving organisms link habitats and shape communities by transporting propagules of plants, microorganisms, or fungi (zoochory). In the mobile link concept, mechanisms like zoochory are connected with the movement behavior of the dispersing organisms to explain the effects this causes on other species. We investigated if ground-dwelling arthropods, especially carabid beetles, transport multiple species of the crop-pathogenic fungi *Fusarium* and *Alternaria* in wheat fields and act as mobile linkers. Both fungi are often associated with different arthropod species, but arthropod-mediated dispersal remains for many fungal species and in agricultural habitats unknown.

We found *Alternaria* DNA (exo- and endogenous) in 98 % of the carabid beetles and viable *Fusarium* propagules on the body surface (only exogenous) of 49% of the carabids, which both increased with the body size of the carabids. Additionally, we detected three species-rich distinct *Fusarium* communities on ground-dwelling arthropods (only exogenous), in arable soil, and in the litter of semi-natural habitats with a moderate overlap. The arthropod-associated *Fusarium* community relates to both semi-natural litter and arable soil and showed the highest number of species (Arthropod: 15 species, Litter: 12 species, Soil: 13 species). Furthermore, the results suggest that the dispersal of *Fusarium* propagules by ground-dwelling arthropods is not selective or limited to certain *Fusarium* species.

In the next step, we will investigate the movement pattern of carabid beetles between semi-natural habitats, which are a potential source for *Fusarium* fungi, and adjacent crop fields. By using directional pitfall traps, we want to identify the predominant movement direction of various carabid species to estimate their potential to link these two habitats and disperse pathogens into the crop fields.

Ground-dwelling arthropods are relevant dispersal agents for various fungal species including economically relevant species and they can link fungal communities in semi-natural and arable habitats. However, the positive or negative effects on the spatial-temporal disease patterns in the crop fields as well as on the microbial community, in general, remain unknown. It is very likely that a broad spectrum of microorganisms is dispersed by ground-dwelling arthropods linking microbial communities.

00389

## Reproductive senescence in female polar bears in a variable environment

Oral

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### Abstract

Reproductive senescence is ubiquitous in mammals. However, patterns of senescence vary across reproductive traits, even within populations, perhaps because of differences in selection pressures, physiological constraints, and responses to environmental conditions.

Here we investigated reproductive senescence in wild female polar bears (*Ursus maritimus*), using 28 years of capture-recapture data from the Svalbard area. We studied the influence of female age on litter production, litter size and litter mass, depending on environmental conditions using generalized linear mixed models. Further, using a capture-recapture model that handles the dependency between vital rates of individuals belonging to the same family unit, we assessed maternal-age-related changes in first year cub and litter survival.

We provide clear evidence for senescence in some reproductive traits in female polar bears. Litter production and litter size peaked in middle-aged females and declined sharply afterwards. By contrast, litter mass, and cub and litter survival did not decline after prime age. Overall, reproductive output declined with age. Reproductive output in all females was affected by sea-ice conditions and Arctic Oscillation during the previous year, but old females were affected the most.

Our results provide evidence for the asynchrony of senescence across reproductive traits in female polar bears and suggest that reproductive senescence is driven by failures in early stages of the reproductive cycle rather than in late stages, as predicted by evolutionary theory. Our findings thus highlight the need to study multiple reproductive traits when investigating reproductive senescence, and to interpret differences across traits in light of evolutionary theory and while considering the potential underlying physiological drivers. Finally, environmental conditions impacted the reproductive success of old females more than that of prime-aged females. This finding suggests that environmental variation may mask or exacerbate senescence, and should be taken into account, particularly when the average quality of the environment is shifting overtime.

00450

## Do elephant carrions benefit other African herbivores through modification of the coupling of populations of a facultative scavenger and its prey?

Oral

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Abstract

Management measures can have indirect effects on the functioning of communities. In Hwange National Park, Zimbabwe, culling of elephants and water provisioning resulted in a significant increase in the number of elephant carcasses from 1968 to 1986 and from the mid-90s to nowadays. In this ecosystem, one species of large predator, the spotted hyaena (*Crocuta crocuta*), is a facultative scavenger. The goal of the study is to test whether the addition of elephant carcasses in the landscape altered hyaena relationships with its usual live prey. We use mammal count data realized at the different waterholes of the park from 1972 to 2020, analyzed using multivariate autoregressive state-space models (MARSS). The data encompass three periods characterized by different levels of elephant carcass abundance, allowing to test whether interactions between hyenas and its preys have changed between them. Two hypotheses can be made about the potential effect of this increased presence of carcasses: the hypo- and hyper-predation hypotheses. They correspond to a decrease or an increase in predation pressure and depend on the balance between the carrion versus the live prey feeding rate and the increase in predator numbers. The results indicate that the management measures resulted in hypo-predation in parts of the park characterized by Kalahari sand soil, although less pronounced in the most touristic areas where carcasses were sometimes cleaned. In the basaltic soil areas, an increase in predation pressure is observed, but only in the parts of the park where spatial movement of hyaenas from the surrounding natural areas was possible. This was potentially caused by immigration of hyaena from outside of the park, or high competition with competing lions at carcasses. This shows that management measures must always be well thought out, as they can have unconsidered consequences on ecosystem functioning.

00473

# The interplay of natural forest development and elevation in shaping species communities

Oral

T. Richter <sup>1,2</sup>, L. Geres <sup>1,3</sup>, R. Seidl <sup>1,2</sup>, S. Seibold <sup>1,4</sup>

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## Abstract

To date, interactive effects of natural forest development and elevation (as a proxy of climate) on species communities remain incompletely understood. Given that climate is changing and forest dynamics are accelerating, we here aim to disentangle the effects of these two factors on species communities.

We conducted extensive biodiversity surveys for 150 forest sites within Berchtesgaden National Park, Germany, in 2021, covering all kingdoms and trophic levels. We stratified our sampling across three elevation belts (605-1725 m a.s.l.) and five forest development stages, from recently disturbed sites to old growth forest. We calculated alpha, beta, and gamma diversity for every development stage and tested for interacting effects of forest development and elevation.

Forest development was the main driver of alpha diversity of forest floor plants, which showed a u-shaped pattern along development stages at all three elevation belts. For beta diversity, we found interacting effects of forest development and elevation, resulting in different patterns at different elevations. Similar to beta diversity, gamma diversity showed different patterns at different elevations along development stages.

Elevation was the main driver of alpha diversity of birds. With increasing elevation, alpha diversity increased at all development stages. Similar to alpha diversity, beta diversity differed at different elevations, but with the highest beta diversity at submontane and the lowest at montane sites. For gamma diversity, we found no effects of forest development or elevation.

Alpha diversity of mammals remained on the same level along forest development and elevation. The same applies to beta diversity, however, we found a strong drop of beta diversity in the optimum stage at subalpine elevations, resulting in a u-shaped pattern along forest development. Gamma diversity showed mixed patterns along development stages at different elevations. At submontane sites, gamma diversity slightly increased, at montane slightly decreased, and was u-shaped at subalpine sites.

Our results show that the effects of forest development on species communities differ distinctly under different thermal regimes. This needs to be considered in conservation management, especially with regard to climate change, and our findings will help to guide conservation and land-use management decisions.

## Restoration ecology and ecosystem dynamics - Salle 6 24/11 ; 10:00-12:00

**00038**

### **Seeding and rewilding to counter the negative impact of frugivore loss on forest diversity in the Mascarenes**

Oral

S. Albert <sup>1</sup>, O. Flores <sup>1</sup>, D. Strasberg <sup>1</sup>

<sup>1</sup>Université De La Réunion - Saint-Denis Cedex 9 (Réunion)

#### Abstract

Most vertebrate populations are threatened at global scale, but islands display the bulk of vertebrate extinctions in the Holocene. Although belatedly colonized, archipelagoes such as the Mascarenes are therefore on the forefront of the consequences of plant / animal interactions disruption. Taking advantage of a long-term chronosequence of lava flows on Réunion, we first demonstrated that frugivore extinctions deeply altered the succession of the tropical rainforest. Likewise, using the differing levels of defaunation in the best-preserved native forests on Réunion and Mauritius, we then showed that the native plant diversity is much better maintained among saplings in remnants on Mauritius than on Réunion where all large native frugivores went extinct. Henceforth, how to restore the recruitment of extant disperserless species? To tackle this issue, we first undertook direct sowings on Réunion and showed that various large-seeded species can settle on the recent lava flows of the Piton de la Fournaise volcano when seed dispersal is experimentally restored. Ongoing field experiments allow to disentangle other recruitment limitations and also suggest that strong dispersal limitation leads to invasive plants winning by forfeit. However, despite promising perspectives, direct sowings cannot replace large frugivores in almost perpetual search of food and space. That is why we must protect extant native frugivores and should re-introduce frugivores, or functional analogs where they went extinct. Although the Mauritian flying-fox has undergone a dramatic mass cull on Mauritius, the recent return of this double-mutualist vertebrate on Réunion is both an amazing opportunity and a challenge for conservationists. Rescued on Mauritius, the Mascarene parakeet could be reintroduced in the coming years on Reunion thanks to conservationists' efforts. Lastly, the use of giant tortoises as ecological analogs of the endemic megafauna is growing in the Mascarenes, although their introduction "into the wild" remains unlikely on the main islands of the archipelago.



00123

## Habitat restoration and invasive species eradication using specifically trained goats of local breed

Oral

S. Jurjanz <sup>1, 2</sup>, L. Delagneau <sup>2, 3</sup>, P. Verte <sup>2, 4</sup>

<sup>1</sup>Ur Afpa, UI-Inrae - Nancy (France), <sup>2</sup>Association Chèvre de Lorraine - Vandoeuvre (France), <sup>3</sup>Service Biodiversité urbaine, city of Nancy - Nancy (France), <sup>4</sup>SPW DEMNA DNE - Gembloux (Belgium)

### Abstract

The feeding behavior of goats give them a specific role in habitat restoration by extensive grazing. Indeed, their exploratory behavior as well as their selective grazing with a preference for woody plants give them a complementary action compared to sheep and cattle. Especially rustic, local breeds like the "Chèvre de Lorraine", educated for eco-grazing, can play a key role to eradicate invasive plants like Japanese knotweed but also for the restoration of encroached grasslands in protected areas. Eco grazing of two sites was conducted around Nancy. One was completely covered by *Reynoutria sachalinensis* and pastured by two adult bucks, the other was covered by a mixed vegetation composed by a dry lawn and a ditch completely invaded by *Reynoutria japonica*, pastured by yearling females. On both sides, the goat pasturing made disappear the invasive knotweed from the surface although the presence of rhizomes maintained a risk of re-growth. The analysis of collected plants evaluated the nutritive supply of knotweed leaves very similar to grass but the value of stems deteriorates after early season very quickly. Experimental follow-up over several years showed perfectly normal performances of these animals, i.e. the young females grew 3-4 kg monthly without supplementary feed. A parallel experiment in controlled conditions showed that knotweed would transfer soil born heavy metals but without any bioaccumulation. Another experience has been implemented in Belgium to restore an encroached heathland where sheep grazing was not able to eradicate tree seedlings (*Betula pendula* and *Prunus serotina*). A flock of 20 bucks has been used over a very short time on a small surface, leading to very high instantaneous grazing pressure. This high density combined with the feeding behaviour of goat and the training of these animals allowed the elimination of all young trees. Since, the use of rustic goats for conservation grazing has been generalized for all cases where shrubs and trees succession is the main problem, as well as for very slopy sites. In both cases, the success is linked to the use of rustic, local goat breeds, but also to the training of the animals, who "learn" conservation grazing.

00182

## Restoration of dike grasslands: finding the right seed-substrate combination

Oral

M. Bauer <sup>1</sup>, J. Huber <sup>1</sup>, J. Kollmann <sup>1</sup>

<sup>1</sup>Technical University Of Munich - Freising (Germany)

### Abstract

Species-rich grasslands are world-wide endangered. Besides protection of existing grasslands, establishment of new ones can mitigate this negative development in urban and agricultural landscapes. Dike grasslands can perfectly combine ecosystem services, like erosion protection by dense vegetation cover, with conservation by harbouring endangered meadow types. The aim of our study was to find the best combination of specified substrates and seed mixtures, which provide a successful establishment of sown species, and a fast and dense coverage of the dike surface.

Thus, we established an experiment on river dikes with 288 plots and surveyed them over four years (2018–2021), with summer 2018 and 2019 being exceptionally dry and hot. Four treatments were studied: two seed mixtures (mesic and calcareous grassland), two seed densities, two substrate depths and three soil types. All 24 treatment combinations were established on both dike expositions and were replicated in six blocks; vegetation surveys were done using the Braun-Blanquet method.

There were no differences in vegetation cover caused by the different seed mixtures, and alpha diversity (i.e. Index of Favourable Conservation Status, FCS) was not influenced by substrate variation. The establishment of target species was slightly better on nutrient-poor substrates on northern slopes. Across all metrics, northern plots had higher values, though, on both expositions, species composition developed in the desired direction, albeit with a constantly decreasing change over the four study years. We conclude that the specified seed mixtures and substrates show minor effects on the development of dike grasslands, while the main effects are succession and exposition. The exposition effect is most likely due to the two weeks delay in seeding the south plots; this confirms long-lasting effect of historic contingencies. In conclusion, our results did not reveal a single-best solution for dike grassland restoration. This means that a diversification of measures could benefit biodiversity.

**00365**

## **Intact ecosystems promote temporal population variability in ungulates**

Oral

O.L.P. Hansen <sup>1</sup>, J.C. Svenning <sup>1</sup>

<sup>1</sup>Department Of Biology. Center For Biodiversity Dynamics In A Changing World (biochange) & Ecoinformatics And Biodiversity, Aarhus University - Aarhus (Denmark)

### Abstract

Ungulates sometimes exhibit high population fluctuations. This temporal population variability could be influenced by anthropogenic effects such as reduced habitat area, other direct habitat modifications, or trophic downgrading. At the same time, temporal variability could be reduced in more intact ecosystems due to increased buffering from top-down regulation, resource limitations and higher variability in disturbances in more heterogenous landscapes. Conversely, more intact ecosystems could also increase temporal population variability through variability and lag-effects from resource availability, disturbances, or trophic interactions such as presence of predators.

We test these two alternative hypotheses with a global dataset on ungulate populations.

We found that temporal population variability increased with increasing temporal variability in precipitation, and, surprisingly, size of the natural area and presence of predators. Further, Europe and Asia had lower temporal variability compared to Africa. Notably, populations exposed to more predator species were associated with higher annual decreases and increases of populations regardless of body size.

Our results suggest that ungulates in relatively intact ecosystems have higher temporal population variability through increases in disturbances and predation. This result has implications not only for ecological theory, but also for ecosystem restoration and biodiversity conservation. Our results suggests that management of ungulate populations should not aim to dampen or prevent temporal variability in populations of ungulates.

00410

## Wetscapes2.0 - rewetting drained fen peatlands

Oral

J. Kreyling<sup>1</sup>, F. Tanneberger<sup>1</sup>, F. Jansen<sup>2</sup>, S. Van Der Linden<sup>1</sup>, J. Couwenberg<sup>1</sup>, H. Joosten<sup>1</sup>, B. Lennartz<sup>2</sup>, T. Urich<sup>1</sup>, M. Wilmking<sup>1</sup>, N. Wrage-Mönnig<sup>2</sup>, G. Jurasinski<sup>2</sup>

<sup>1</sup>University Of Greifswald - Greifswald (Germany), <sup>2</sup>University Of Rostock - Rostock (Germany)

### Abstract

Peatlands have been drained for land use for a long time and on a large scale, turning them from carbon and nutrient sinks into respective sources, diminishing water regulation capacity, causing surface height loss and destroying biodiversity. Over the last decades, drained peatlands have been rewetted for biodiversity restoration and, as it strongly decreases greenhouse gas emissions, also for climate protection. We quantify restoration success by comparing 320 rewetted fen peatland sites to 243 near-natural peatland sites of similar origin across temperate Europe, all set into perspective by 10k additional European fen vegetation plots. Results imply that rewetting of drained fen peatlands induces the establishment of tall, graminoid wetland plants (helophytisation) and long-lasting differences to pre-drainage biodiversity (vegetation), ecosystem functioning (geochemistry, hydrology), and land cover characteristics (spectral temporal metrics). The Paris Agreement entails the rewetting of 500,000 km<sup>2</sup> of drained peatlands worldwide until 2050-2070. A better understanding of the resulting locally novel ecosystems is required to improve planning and implementation of peatland rewetting and subsequent management.

**00547**

## **RegioDiv: Nationwide assessment of genetic variation in 30 grassland plants and the design of seed transfer zones**

Oral

W. Durka <sup>1</sup>, J. Höfner <sup>1</sup>, S.G. Michalski <sup>1</sup>

<sup>1</sup>Helmholtz Centre For Environmental Research-Ufz - Halle (Germany)

### Abstract

Seed transfer zones are a means to assure that regionally adapted seed material is used in ecosystem restoration. In Germany the existing seed zones were established based on ecoregions without empirical basis of genetic or phenotypic adaptation. Moreover, the existing seed zone systems applies uniformly to all grassland species. The RegioDiv project aims to provide empirical data of genetic variation for 30 plant species frequently used in seed mixtures for grassland recultivation. The existing seed zones should then be evaluated in the light of empirical data.

We hypothesize that 1) wind pollinated species (grasses) show coarser patterns of differentiation and fewer genetic groups than insect pollinated species (herbs); 2) postglacial recolonization has led to a frequent pattern of southern richness and northern purity; 3) clinal patterns of isolation-by-distance and isolation-by-environment without clear boundaries need to be taken into account in seed zone design.

We use an unprecedented nationwide sample comprising on average 450 sampling sites per species and a total of >10,000 samples genotyped with single nucleotide polymorphism (SNP) markers. We consider SNP markers to represent both, neutral and adaptive genetic variation. On the species level, we analyse patterns of genetic differentiation, the role of spatial and environmental gradients (soil, climate) and of genetic discontinuities to arrive at species specific maps of genetic clusters. Across species we synthesize patterns to arrive at general patterns across species or species groups that can guide seed zone design.

00539

## RegioDiv: Patterns of isolation-by-distance and effective migration across 30 grassland plant species

Oral

S. Michalski <sup>1</sup>, J. Höfner <sup>1</sup>, W. Durka <sup>1</sup>

<sup>1</sup>Department Of Community Ecology, Helmholtz Centre For Environmental Research-Ufz - Halle (Germany)

### Abstract

The spatial distribution of genetic variation is often characterized by 'isolation-by-distance' (IBD), where genetic differentiation increases as individuals and populations become more geographically distant. The rate of increase is known to be impacted by species specific, often spatially heterogeneous processes like genetic drift, gene flow and selection.

In Germany, the existing seed transfer zone system - a means to assure that regionally adapted seed material is used in ecosystem restoration – still lacks general empirical evidence based on patterns of population genetic variation and differentiation. The quantification, visualization and comparison of IBD patterns and effective migration surfaces across multiple plant species will significantly contribute in creating this necessary basic knowledge.

Using population genetic SNP data for several thousand individual samples of 30 common grassland plant species in Germany gathered within the RegioDiv project we derive qualitative and quantitative descriptors of IBD at individual and population level and visualize spatial population structure by estimating effective migration surfaces. Synthesizing across study species, we will test the following hypotheses:

1. Variation in IBD patterns across species can be explained by life history (e.g. wind-pollinated grasses vs. insect-pollinated herbs) and/or population density and abundance.
2. Common patterns of regional migration boundaries across species support seed zone delineation based on eco-climatic criteria.

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[Comment to symposium organizers: this is one of 3 contributions originating from the RegioDiv project:

1. Durka et al. "RegioDiv: Nationwide assessment of genetic variation in 30 grassland plants and the design of seed transfer zones"
2. This presentation
3. Hoefner et al. "RegioDiv: Genetic differentiation in mixed-ploidy species and consequences for the design of seed transfer zones"

If accepted as talks, we ask to arrange these in the same session and in the sequence given above.

**00562**

## **Monitoring of recolonization processes of the flora of small depoldered marshes in western France**

Oral

**M. Salgueiro-Simon <sup>1</sup>, X. Dauvergne <sup>1</sup>, S. Gallet <sup>1</sup>**

<sup>1</sup>Université De Bretagne Occidentale. Laboratoire Geoarchitecture, Territoires, Urbanisation, Biodiversité, Environnement - Brest (France)

### Abstract

Located at the interface between land and sea, salt marshes host a specialized biodiversity, mostly adapted to stress factors induced by both flooding and salinity. Salt marshes have been reclaimed for a while to establish activities that locally stopped nowadays, especially in small polders. With the objective of restoring biodiversity, but also of adapting to global changes, several restoration projects of small systems are currently undertaken, some with a monitoring of the recovery dynamics of biodiversity of the new habitat.

Monitoring protocols have been set up on several small marshes of the Atlantic coast recently reconnected and located in Normandy, South Vendée and Brittany. These studies were set up within the framework of the DPM (Programmed Depoldering of Small Coastal Marshes) research program and the DPMACC program (Dynamics of Depoldering of Small Coastal Marshes: Crossed Approaches and Implications for Adaptation to Climate Change). The objective is to analyze, in a pluridisciplinary manner, the ecological and social dynamics involved in depoldering processes, as they occur.

Concerning the ecological aspect of the program, on each of the sites studied, a standardized monitoring device, consisting of plots (quadrats) distributed over the entire site, was set up (20 to 30 depending on the surface of the site). These devices are materialized, geolocated and linked by topographic measurements. In each of these quadrats, vegetation surveys are carried out twice a year as well as arthropod sampling by aspiration (DVac). Measurements of sedimentation and salinity evolution are also made as well as samples to observe the seed bank.

The presentation will focus on the recolonization dynamics of plant species a few months after depolderization. Although depoldering is still recent, it is already possible to observe a return of halophilic vegetation on the sites. It can be noticed that this vegetation is already dominated by halophilic species such as *Atriplex hastata* or *Tripolium pannonicum*, but that *Haliomione portucaloides*, a characteristic salt marsh species, is still absent several months after reconnection. This may indicate a eutrophic character of the environment linked to the former agricultural uses of the sites.

## Services provided by ecosystems and biodiversity (1/2) - Salle 11+12 23/11 ; 10:00-12:00

**00592**

### **Rainforest management effects on trade-offs and synergies among multiple ecological and socio-economic functions**

Oral

S. Fiedler <sup>1</sup>, J. Henzler <sup>1</sup>, J. Lay <sup>2</sup>, K. Meyer <sup>1</sup>, J. Salecker <sup>1</sup>, S. Tarigan <sup>3</sup>, K. Wiegand <sup>1</sup>

<sup>1</sup>University Of Göttingen - Göttingen (Germany), <sup>2</sup>Giga German Institute Of Global And Area Studies - Hamburg (Germany), <sup>3</sup>Ipb University, Soil And Natural Resources Management - Bogor (Indonesia)

#### Abstract

Land use changes have dramatically transformed many tropical landscapes from forest-dominated to agricultural landscapes. Agricultural land uses, such as rubber and oil palm plantations, increase the economic benefit at the cost of reduced ecological functions. Questions arise on how to manage these systems in a way that economic benefits are sustained while restoring the ecological integrity. Due to the system's complexity involving different socio-economic and ecological aspects, it is still unclear what combination of management options minimizes trade-offs or improves synergies among functions and thereby optimizes multiple functions simultaneously. Moreover, it is difficult to test more than a few options via field work alone, thus a modelling approach is needed.

To tackle these knowledge gaps, we developed the integrated ecological-economic land-use change model EFForTS-ABM that follows a combined agent- and grid-based approach. The model simulates the impact of land use change decisions made by smallholder farmers on the economic outcomes from oil palm and rubber plantations as well as on ecological functions such as carbon sequestration. EFForTS-ABM is based on socio-economic and ecological field data from the Jambi province in Sumatra (Indonesia). We ran model scenarios on different landscape settings (i.e. different spatial settings of the plantations as well as different environmentally friendly management options). We assessed which setting improved an ensemble of ecological functions and economic functions. Further, we quantified synergies and trade-offs among functions at farm and landscape level.

Here, we will demonstrate the usefulness of ecological-economic models such as EFForTS-ABM for supporting sustainable management of degraded rainforest systems where both socio-economic and ecological functions are the goals. The model is able to assess relationships among functions at different spatial and temporal scales, and identify major trade-offs and synergies. These results are an important basis for identifying management options that minimize losses in ecological functions while still allowing for economic benefits.



00052

## Correlations between ecosystem functions of a grassland are temporally variable and driven by plant diversity and plant community identity

Oral

L. Argens<sup>1</sup>, W.W. Weisser<sup>1</sup>, A. Ebeling<sup>2</sup>, N. Eisenhauer<sup>3</sup>, M. Lange<sup>4</sup>, Y. Oelmann<sup>5</sup>, C. Roscher<sup>6</sup>, H. Schielzeth<sup>7</sup>, B. Schmid<sup>8</sup>, W. Wilcke<sup>9</sup>, S.T. Meyer<sup>1</sup>

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Abstract

Ecosystem management aims at providing many ecosystem services simultaneously. This so-called multifunctionality can be limited by trade-offs and increased by synergies among the underlying ecosystem functions (EF). For developing targeted management, it is essential to understand synergies, trade-offs, and their drivers. Previous studies found differences in the correlation between EFs that may have resulted from methodological differences or different environmental conditions. We hypothesized that correlations among EFs are variable even under the controlled conditions of a field experiment and that seasonal and annual variation, plant diversity, and plant species composition (community identity) are drivers of these correlations. We used data on 31 EFs related to plants, consumers, or physical soil properties, measured over 5 to 19 years, up to four times per year, in a temperate grassland experiment with 76 different plant communities, constituting six different plant diversity levels (1, 2, 4, 8, 16, 60 species). Most EF pairs (259) showed weak correlations ( $-0.3 < r < 0.3$ ), many EF pairs (56) showed medium correlations ( $0.3 < r < 0.5$  or  $-0.5 < r < -0.3$ ), and 26 EF pairs showed strong correlations all of which were positive ( $r > 0.5$  or  $r < -0.5$ ). To determine the drivers of pairwise EF correlations, the covariance between EFs was partitioned into contributions from plant diversity, community identity, and time (including years and seasons). We found that for synergies, most of the covariance was explained by diversity, whereas for trade-offs, most covariance was explained by community identity (about 17% each). Time explained 10% of covariance for trade-offs but little for synergies. Additionally, we found that correlations were variable over repeated measures, ranging from weak to strong correlations or negative to positive correlations for different time points, indicating that correlations between two EFs from single measurements are insufficient for drawing conclusions about trade-offs and synergies. Consequently, more effort is needed in measuring pairs of EF repeatedly under different conditions to derive recommendations for the management of ecosystem functions.

**00067**

## **Eco-evolutionary dynamics of host-parasite systems in complex landscapes.**

Oral

J.N. Deshpande <sup>1</sup>, V. Dakos <sup>1</sup>, O. Kaltz <sup>1</sup>, E.A. Fronhofer <sup>1</sup>

<sup>1</sup>Isem, Université De Montpellier, Cnrs, Ird, Ephe, Montpellier, France - Montpellier (France)

### Abstract

Global anthropogenic change causes disturbances to natural host-parasite systems leading, for example, to the phenomenon of emerging infectious diseases. Particularly, human disturbances such as habitat fragmentation or the rewiring of dispersal networks can change the spatial context of natural host-parasite systems. Therefore, understanding the eco-evolutionary dynamics of spatially explicit host-parasite systems is critical to global change research. While previous studies have addressed how parasite virulence and host-parasite ecological dynamics feed back onto each other when there is heterogeneity in host contact or spatial structure, the central role of host dispersal and dispersal evolution has been ignored. However, the concurrent evolution of host dispersal and parasite virulence can potentially be modulated by host spatial structure and further impact the ecological dynamics of disease prevalence or host population densities, forming an eco-evolutionary feedback. Thus, in the present study, we seek to understand how host-parasite systems evolve in complex landscapes. We develop an individual-based model of a spatially structured host-parasite system in which host dispersal and parasite virulence can co-evolve in complex landscapes. We first establish our baseline expectation of how host dispersal evolution impacts optimal virulence for a classical regular grid host spatial structure. We further extend our analysis to realistic landscapes represented by random geometric graphs (RGGs) for terrestrial and optimal channel networks (OCNs) for riverine host-spatial structures. We find that the feedback between landscape structure, dispersal and host-parasite ecological dynamics together determine optimal virulence, generating empirically testable predictions.

00140

## Crop diversity in the landscape favors bats and biological control of some pests

Oral

A. Tortosa <sup>1</sup>, B. Giffard <sup>2</sup>, L. Barbaro <sup>1,3</sup>, J. Froidevaux <sup>3,4</sup>, S. Ladet <sup>1</sup>, J. Delhommel <sup>1</sup>, A. Vialatte <sup>1</sup>

<sup>1</sup>Université De Toulouse, Inrae, Dynafor - Auzeville-Tolosane (France), <sup>2</sup>Bordeaux Sciences Agro, Inrae, Isvv, Save - Villenave D'ornon (France), <sup>3</sup>CESCO, Muséum national d'Histoire naturelle, CNRS, Sorbonne University - Paris/concarneau (France), <sup>4</sup>University of Stirling, Biological and Environmental Sciences, Faculty of Natural Sciences - Stirling (United Kingdom)

Abstract

Agricultural landscapes mixing crop types can support higher biological pest control, while contributing to maintain farmland biodiversity. In addition to their status of protected species, bats have been recently shown to be efficient predators of many agricultural and forest pests.

In our study, we investigated how diverse agricultural landscapes could promote bat richness, activity and biological pest control. We hypothesised that resource continuity may be ensured in diverse landscapes combining maize, vineyards and pine plantations, which are major crops of South-western France. Indeed, flight peaks of three associated moth pests follow one another in time and are known to be prey of several insectivorous bats. We therefore evaluated whether diverse landscapes with all 3 crops (maize, vineyard and pine, with the proportion of semi-natural habitats controlled) affect bat communities and their biological control activity, by comparing them with simplified landscapes dominated by only one of the three crops.

Our study involved 37 landscapes (vineyards-, maize-, pine plantations-dominated landscapes and diverse landscapes) where abundance of the three lepidopteran pests were measured with specific pheromone baited-traps according to their first generation flight peak. Alternative preys were estimated with food traps. Bat activity was recorded two consecutive nights with passive detectors. Finally, specific damages were observed.

We found that diverse landscapes have positive effects on bat species richness and activity. We also showed that grapevines and pine plantations benefit from a diverse landscape from the point of view of controlling their main pests by bats. Maize-dominated landscapes showed contrasting results, pest abundances and damage were positively related to bat richness and activity; assessing the actual efficiency of their biological control would require longer-term investigations. In addition, more diverse landscapes benefit to a large range of bat species and especially for species of conservation concern activity. This work highlights potential win-win strategies between different crops managed by different producers at the landscape scale.

Overall, our study advocates for promoting the diversity of coexisting crop types within agricultural landscapes to enhance bat species richness, which in turn would sustain higher pest biological control and ultimately bolster biodiversity conservation strategies in farmland.

00151

## Provision of multiple ecosystem services in extensively and intensively managed organic and conventional grasslands in Switzerland

Oral

F. Richter <sup>1</sup>, A. Lüscher <sup>2</sup>, N. El Benni <sup>3</sup>, P. Jan <sup>3</sup>, N. Buchmann <sup>1</sup>, V. Klaus <sup>1,2</sup>

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<sup>3</sup>Agroscope, Tänikon - Ettenhausen (Switzerland)

Abstract

Grasslands can provide a wide range of provisioning, regulating, supporting and cultural ecosystem services (ES) essential for human wellbeing. Increasing management intensity is often hypothesized to decrease the ability of a grassland to provide many ES at a high level, consequently decreasing ES-multifunctionality. Organic agriculture could have a positive effect on ES-multifunctionality, due to the restrictions on mineral fertilizer and pesticide use. In Switzerland, farmers receive direct payments for organic production and extensively managed grasslands in biodiversity programs (Ecological Compensation Areas, ECAs).

The ServiceGrass Project aims to investigate the effect of 1) organic management, 2) land use intensity, and 3) grazing (pasture) vs. mowing (meadow) on ES-multifunctionality of Swiss grasslands. To this end, we measured 22 ES-Indicators on 92 paired grassland sites managed by 36 different organic and conventional farmers. The sites include extensively or intensively managed meadows and pastures. We used generalized linear latent variable models (gllvms) to analyze the effects of the three management variables on the different ES-indicators, as well as on final ES derived from grouping related ES-indicators according to the ES-classification framework CICES.

Organic agriculture affected only two of the 22 ES-Indicators, namely symbiotic arbuscular mycorrhizal Fungi and N-leaching potential. However, management intensity played a much larger role, affecting more than half of the ES-indicators measured, with a similar number of ES-indicators being positively and negatively affected by extensive management. The situation for grazing vs. cutting was similar to management intensity, with two distinct sets of services being favored by grazing or mowing. The weak effect of organic management on ES-indicators could be explained by the fact that differences in grassland management between organic and conventional plots were rather small. Not all conventional farmers used mineral fertilizer or pesticides, and if so, then often only in small amounts. On the other hand, management of extensive vs. intensive sites differed far more – also within farms. Due to the resulting great differences in the ES portfolio of extensive vs. intensive grasslands, we conclude that extensive ECAs play a crucial role for the landscape-level ES-provision, offering those ES that are poorly provided by intensive grasslands.

00197

## Evolutionary changes during experimental epidemic waves and their consequences for disease spread

Oral

G. Zilio <sup>1</sup>, C. Gougat-Barbera <sup>1</sup>, M. Raina <sup>2</sup>, C. Sanchez <sup>2</sup>, O. Kaltz <sup>1</sup>

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### Abstract

Global environmental alterations have increased the risk of disease spread and epidemic outbreaks. These are often accompanied by rapid evolutionary changes, with parasites at the front of an epidemic wave evolving higher transmissibility, thus accelerating their rate of spatial spread. However, the opposite prediction may hold if virulence compromises the capacity of infected hosts to disperse. Moreover, little is known about whether such outcomes are modulated by concurrent host evolution, potentially changing eco-evolutionary feedbacks.

In interconnected microcosms, we investigate the interplay between epidemiology and evolution of the ciliate *Paramecium caudatum* and its bacterial parasite *Holospora undulata*. In two long-term treatments we simulated spatially progressing populations and epidemic waves, where infected and uninfected hosts at the front reach new patches through active swimming (dispersal treatment) or passively in randomly picked groups (pipetting treatment).

First, we assayed evolved parasites and hosts for differences in traits determining the epidemiological potential (parasite  $R_0$ , virulence, resistance) and spatial spread (host growth and dispersal) into linear landscapes. Preliminary results indicate strong parasite effects on spatial host diffusion rates, but also evolved differences in transmissibility and virulence, with marked spatio-temporal patterns of epidemic waves. We will further present a second assay, comparing these epidemiological dynamics for all combinations of evolved parasites and hosts. As simplified abstractions of the real world, such experiments can (i) inform on how different spatial ecological scenarios shape host and parasite trait (co)evolution during an epidemic, and (ii) help to assess the impact of such different (co)evolutionary histories on the spatial spread of disease.

00215

## Vegetation-mediated ecosystem services predicted by plant traits

Oral

M. Kleyer <sup>1</sup>

<sup>1</sup>University Of Oldenburg - Oldenburg (Germany)

### Abstract

Although well recognised in ecology, the concept of ecosystem services is still not widely applied in practical environmental planning. Environmental planning often has to evaluate whole landscapes in a spatially explicit way, including marginal landscape elements for which data on provisional, regulatory, and cultural ecosystem properties and services are not readily available or are costly to provide. On the other hand, many planning schemes include a habitat- or vegetation survey, raising the question whether ecosystem services can be predicted from vegetation properties alone.

I used a large data set of herbaceous plant communities collected across Germany, The Netherlands, and Denmark, as well as additional data, to predict (i) the probability of obtaining a high marginal income from forage production, (ii) the probability of a high conservation value based on the occurrence of regionally rare plants, and (iii) carbon stocks in mineral soils (SOC). The predictions are based on 22 plant traits of 123 common species of reeds and of dry, mesic, wet, and ruderal grasslands. The individual traits were aggregated to trait modules representing major biological functions that affect the provision of services.

High marginal income from forage production was predicted for plant communities functionally composed of intermediate levels of above-ground size and allocation, and an acquisitive leaf economy on the one hand, but little lateral expansion, generative reproduction and root mass on the other. The probability of finding regionally rare plants increased in communities with small-to-intermediate above-ground size, a conservative leaf economy, low C:N ratios, few and large seeds, and little lateral expansion. Communities displaying pronounced lateral expansion and above-ground size were linked to high soil organic-carbon stocks. The models predict trade-offs between these ES that are relevant to environmental planning. Where income from forage production is high, regionally rare plants will not be found, and SOC will be low. Where SOC is high, income from forage production will be low and rare plants infrequent. Where many rare plants are found, neither income from forage production nor SOC will be high.

**00009**

## **Landscape management strategies for multifunctionality and social equity**

Oral

**M. Neyret <sup>1</sup>, S. Peter <sup>2</sup>, G. Le Provost <sup>3</sup>, A.L. Boesing <sup>1</sup>, P. Manning <sup>4</sup>**

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### Abstract

Increasing pressure on land resources necessitates landscape management strategies that simultaneously deliver multiple benefits to multiple stakeholder groups with competing interests. Accordingly, we developed an approach that combines ecological data on all types of ecosystem services with information describing the ecosystem service priorities of multiple stakeholder groups. We identified landscape scenarios that maximise overall ecosystem service supply relative to demand (multifunctionality) for the whole stakeholder community, while maintaining equitable distribution of ecosystem benefits across groups. For rural Germany, we show that the current landscape composition is close to optimal, and that most scenarios that maximise one or a few services increase inequities. This indicates that most major land use changes proposed for Europe (e.g. large-scale tree planting or agricultural intensification) could lead to social conflicts and reduced multifunctionality. However, moderate (4%) gains in multifunctionality and equity can be achieved by expanding and diversifying forests and de-intensifying grasslands. More broadly, our approach provides a tool for quantifying the social impact of land-use changes, and could be applied widely to identify sustainable land-use transformations.

## Services provided by ecosystems and biodiversity (2/2) - Salle 11+12 23/11 ; 14:30-16:15

**00225**

### **Towards the viability of social-ecological system : modeling approach for multiple ecosystem services related to hedgerows in rural landscapes.**

Oral

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#### Abstract

In the context of global changes, local populations face complex challenges for sustaining the provisioning of ecosystem services (ES) essential for their livelihoods. The semi-natural habitats that support such services (or disservices) are not always well known nor taken into account. This work aims to provide a modeling tool to support local stakeholders for the management of semi-natural habitats, like hedgerows, and their ES provision. The framework we develop aims to find the adaptation actions which maintains the viability of a bundle of ES in the long run.

A first challenge depends on how well is the modeling of the dynamics of semi-natural habitats and their interactions with their social-ecological environment. A second challenge depends on the capacity of organization and the maintaining of ES in a complex network of social interactions. Altogether, such social-ecological complexity needs to be well framed to design useful models and decision support tools for planning sustainable management actions.

As a study-case, we considered the viability of ES delivered by hedgerow networks in a rural landscape with suburban populations (in central France). Hedgerows are semi-natural infrastructures that are usually privately owned by farmers, but their governance may be collective or not. We combined three theoretical frameworks to identify viable scenarios that maintain ecosystem services of interest above a given threshold on the long run.: (i) the coupled-infrastructure system (CIS) framework, (ii) Aubin's viability theory, and (iii) the adaptation policy pathways framework.

We first identified hedgerows dynamics by using cartographic data. Then, we identified ES at stake onto this territory, and we tested four scenarios of governance, each defined by a different CIS structure, and associated costs and benefits on the dynamics of the hedgerows network: (A) Business as usual, (B) Payment for ecosystem services provided by external governance structure, (C) Self-organization of neighboring farmers, and (D) A more structured governance combining the benefits of the two previous governance systems. The framework allows us to build a qualitative model of the social-ecological system accounting for a diversity of ecosystem services, paving the way to sustainable policies of ecosystem services delivery.



00326

## Mosquito host-feeding patterns in relation to land use

Oral

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Abstract

Mosquitoes (Diptera: Culicidae) are the most important arthropod vectors of pathogens. Understanding their blood-feeding behavior is an essential element to assess the vectorial capacity of a mosquito population. Therefore, this study aims to analyze mosquito spatial-temporal host-feeding patterns by barcoding blood-fed female mosquitoes. Between 2012 and 2019, mosquitoes were sampled at different sites in Germany, Iran, Moldavia and Romania. Blood-fed specimens were analyzed by PCR with vertebrate specific primers and subsequently processed with Sanger sequencing. The sequences were compared to sequences from GenBank to identify the host species. The host specificity of the mosquitoes was tested by calculating the checkerboard score (C-score). In addition, land use information based on the Copernicus global land cover layers were extracted from each sampling site to analyze its influence on the mosquito-host interaction. In total, we collected 4,827 blood-fed specimens of 48 different mosquito taxa. The molecular biological analysis revealed 82 host taxa, including 3 amphibia, 42 bird, 36 mammal and 1 reptile species. The five dominant host species were domestic cattle (34%), human (18%), wild boar (13%), horse (9%) and roe deer (6%). C-scores indicated a random structure in the host-feeding patterns, i.e. mosquitoes use a broad range of different host species. Nevertheless, most mosquito species preferred certain host groups. Species from the genus *Aedes* predominantly fed on mammals, while we detected a balanced proportion of mammal and bird blood in *Culex* specimens. The analyses showed that the mosquito-host interaction is significantly affected by land use factors, e.g. at forest sites, human blood was predominantly detected in *Aedes* mosquitoes, while at unforested sites, particularly in urban areas or in shrublands, humans are more likely to be bitten by *Culex* mosquitoes. Land use changes can influence the abundance and species composition of mosquitoes and vertebrates affecting vector-host dynamics. This large data with a standardized molecular screening method gives a unique insight in the spatial-temporal host-feeding patterns of mosquitoes and the relevance for mosquito-host interaction on the epidemiology of mosquito-borne diseases.

**00333**

## **Variations of ecosystem services during vegetation succession following agricultural abandonment in the Massif central region (France)**

Oral

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### Abstract

Forest expansion following agricultural abandonment is major land-use and land-cover change in Europe. When agricultural activities are no longer carried on, vegetation succession leads to substantial changes in plant community composition, structure, and functional properties, from herbaceous cover to forest vegetation types.

While the effect of post abandonment succession on plant communities have been well studied, the eventual consequences on ecosystems services or disservices have been much less investigated. Together, it remains unclear how ES varies during succession and which ecosystem features are driving ES changes. To fill this gap, we studied three regulation ES (soil fertility, carbon stock and erosion prevention) in a semi-mountainous zone concerned with forest expansion in the Massif central region of France.

Field measurements were conducted in 30 plots spread amongst five different succession stages after abandonment, from shrubby grasslands to forest more than 70 years old. Carbon stock was determined through aboveground and belowground biomass measures and estimations. Soil fertility was approached by various indicators of soil content, including organic carbon and nutrients, and soil texture. Erosion limitation was approximated through vegetation layer index and erodibility index calculation.

The results obtained showed that, as expected, some ES indicators changed significantly along with the succession run, with in particular aboveground biomass and thus carbon stock. We also show that not all succession stages differentiate themselves regarding ES indicators. The pattern of soil fertility indicators for example was found to vary non-linearly along succession. Surprisingly, some indicators did not vary with succession. This is e.g. the case of soil organic carbon and nitrogen. The relationship of these results with other features than succession stages was then investigated, including dominant plant species and species traits related to productivity and biomass accumulation.

00358

## Evaluation and comparison of pollination service indicators at agricultural landscape level

Oral

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Abstract

The current pollinator decline is a major issue, notably because one-third of the world agricultural production depends on pollination. However, quantifying whether the loss of some pollinators translates into less efficient pollination remains challenging, particularly at the scale of farmland territories, which is a relevant scale for action. On the one hand, clear links have been established between the abundance and diversity of pollinators and pollination efficiency only over relatively small areas, because time-consuming experimental methods prohibit studies over broader areas. On the other hand, nationwide or continentwide indices exist but they either measure potential pollination only or have not been validated against other metrics characterizing pollinators or pollination. The aim of our study was to assess the relevance of two pollination indicators developed at national or broader scale, to characterize pollination over a 950-ha farmland territory of field crops (Fénay platform near Dijon, France). We specifically evaluated the realized pollination service indicator, based on crop yields and their dependence on pollinators, and the potential pollination indicator simulated by the InVEST model, based on land use and landcover as proxies for potential floral and nesting resources. We examined the spatiotemporal variation of these indicators over the Fénay area between 2005 and 2019, their environmental correlates (farming practices, landscape, and weather) and how they were related to each other. Our results suggest that the two indicators designed for large spatial extent can prove useful within farmland territories: both indicators exhibit significant variation across the study area, some of which could be related with environmental variables known to influence pollinators. For example, the spatial variation in the realized pollination service index correlates with farming practices, e.g. less efficient pollination in plots with more herbicide use. No correlation with the distance to the nearest semi-natural element was found, which contradicts results from previous studies at the field scale. The temporal variation in the pollination service index correlates negatively with the duration and intensity of summer heat waves. The potential pollination indicator will be compared with the realized pollination indicator, and in the future with field measurements of pollination efficiency for cross validation.

**00497**

## **Challenges and opportunities for grasslands on river dikes: Reconciling flood security, biodiversity, recreation and management costs**

Oral

J. Kollmann <sup>1</sup>, M. Bauer <sup>1</sup>, M. Moosner <sup>1</sup>, L.H. Teixeira <sup>1</sup>

<sup>1</sup>Technical University Of Munich - Freising (Germany)

### Abstract

River dikes are secondary habitats that can support species-rich grasslands, since they are regularly managed but not fertilised. Dike grasslands provide several ecosystem services and offer interesting opportunities to test new approaches for integrating land use and biodiversity protection. However, restoration and management that try to improve multifunctionality of dike grasslands have to address the trade-offs between ecosystem services. Here, we present a conceptual framework for assessing multifunctionality of dike grassland and some practical implications, based on vegetation surveys and manipulative experiments along the rivers Danube and Inn in southern Germany. We identified flood protection, biodiversity promotion, conservation of rare species and recreation, and biomass production as the main ecosystem services of dike grasslands. These services can be moderated by site preparation, trait-based seeding design and management methods. Nevertheless, spatio-temporal variation of the resulting communities needs to be considered. In conclusion, river dike grasslands reflect current challenges of ecological restoration and nature conservation, since they have a high potential to reconcile ecosystem services, and can be enhanced to maintain these services under increased climatic variability. Restoration and management of river dike grasslands would benefit from more cooperation between conservation and river authorities, and by applying current ecological knowledge on grassland communities, ES, trait-based restoration and adaptive management.

**00500**

# **Impact of enhanced roadside vegetation and urban landscape on pollinators and pollination**

Oral

N.K. Berger <sup>1</sup>, S. Dietzel <sup>1</sup>, J. Kollmann <sup>1</sup>

<sup>1</sup>Technical University Of Munich - Freising (Germany)

## Abstract

Urbanization has increased steeply during the past decades, and this trend will continue, leading to sealing of even more surfaces, fragmentation and loss of habitats, and altered microclimates. In combination with intensification of agriculture in adjacent rural areas, this poses severe risks for biodiversity. Especially pollinating insects, whose ecosystem function is crucial for crops and wild plants, are threatened by poor urban habitat conditions. Roads contribute to this degradation, while recent studies report that roadside vegetation potentially supports plant and insect diversity.

To test the effects of enhanced roadside vegetation on pollinator abundance and pollination, we established species-rich wildflower patches along four urban roads in the city of Munich and monitored flowering plant species and floral density. Abundance of different pollinator groups was sampled with colored pan traps, while pollination was monitored with three phytometer species, i.e. *Fragaria x ananassa*, *Ranunculus acris* and *Trifolium pratense* that differ in reproductive traits and interact with different sets of pollinators. Nearby species-poor roadside lawns were used as control. We also identified land-use types within a 500-m radius around the study sites, accounting for impervious surfaces, vegetated and agricultural areas, and water bodies, and measured the distance to the city center.

Some phytometer flowers were insufficiently pollinated due to low numbers of pollinators in structurally homogenous urban landscapes. Pollinator abundance was positively correlated with local flowering species richness and floral density. At the landscape scale, pollinator abundance was positively correlated to the proportion of impervious surface, and negatively to edge density. Moreover, there were plant-specific responses in pollination to landscape characteristics: Fruit weight of *F. x ananassa* was highest in the inner city, while in *R. acris*, fruit number was lower in heterogeneous landscapes and fruit weight was positively correlated with flowering species richness, and negatively with proportion of impervious surface. In *T. pratense*, fruit number increased in heterogeneous landscapes and with increasing wildflower species richness, while fruit number and weight were negatively correlated with sealed surface area.

We conclude that enhancing local vegetation is beneficial for pollinators, but that the urban environment at a landscape scale has strong effects on pollination.

00458

## Decomposition of organic matter of farming origins by woodlice *Armadillidium vulgare* (Latreille, 1804), and quality of fecal pellets for agrosystems

Oral

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Abstract

To face issues such as soil erosion, carbon sequestration and plant production, farmers are encouraged to use organic inputs to limit carbon emissions and to improve soil structure and fertility. Various organic matters are used: animal and green manures, composts, residues of methanization, etc. Yet, there values differ at improving soil structure or fertility. Their effect on soil organisms may also differ, as well as on associated processes such as organic matter decomposition. Among soil detritivores, woodlice are known fragmenters of litter. Their population is bound to increase with changes in farming practices (e.g. no-till), and they could play a critical role in the decomposition of organic matter and improved topsoil quality. Yet, their ability to fragment organic matter of farming origins (OMFO) has not been studied, nor the fertilizing or structuring effect of their feces. In a mesocosm study, we tested the ingestion of five OMFO by a common woodlouse *Armadillidium vulgare*, after one, two, three and four weeks. The five OMFO were cattle manure, residues of methanization, faba bean (100 %, no herbicide), faba bean (100%, glyphosate), faba bean mix with Phacelia, daikon and oat. The loss of matter in boxes with/without woodlice was measured, the feces produced were weighed and counted, and their consumption and assimilation rates were calculated. Preliminary results showed that the consumption rate on manure was high the first week and decreased the following weeks, and the consumption of residues of methanization was low on week 1, increased on week 2, and decreased again. This pattern could be explained by a respective early and delayed satiety, linked with the quality of the ingested matter. The faba bean mix was highly consumed on weeks 1 and 2, after which the values dropped; the consumption of pure faba bean was heterogeneous to low; and faba bean with glyphosate was surprisingly highly consumed on week 1 and 2, after which woodlice mortality increased. This result suggests an effect of glyphosate on woodlice physiology. A visible change in faba bean quality could explain the overall drop of green manure consumption after two weeks.

00095

## Interactive effects of soil moisture, air temperature and litter nutrient concentrations on soil microbial and collembolan population

Oral

C. Biryol<sup>1</sup>, A. Aupic-Samain<sup>1</sup>, C. Lecareux<sup>1</sup>, T. Gauquelin<sup>1</sup>, V. Baldy<sup>1</sup>, M. Santonja<sup>1</sup>

<sup>1</sup>Imbe-Mediterranean Institute Of Marine And Terrestrial Biodiversity And Ecology - Marseille (France)

### Abstract

Soil organisms play an eminent role on carbon and nutrient cycling in forest ecosystems. These organisms are known to be strongly influenced by litter quantity but our knowledge about their responses to litter chemistry is still limited. Moreover, as they are strongly sensitive to climatic conditions, the ongoing climate change might directly affect their demographic parameters but also indirectly by altering litter chemistry. To fill this gap, we designed a 10-week microcosm experiment to study the relationships between litter nutrient concentration, microbial biomass, Collembola demographic parameters, and litter mass loss and evaluate how simulated climate change could impact these relationships (i.e., increasing air temperature or decreasing soil moisture). We used six tree litter mixtures between *Quercus pubescens* and its companion species characterised by an increase in litter nutrient concentration. As expected, decreasing soil moisture negatively affected soil organisms and litter decomposition. Increasing temperature increased bacterial biomass while, on the opposite, decreased fungal biomass and Collembola abundance. We observed that bacterial biomass, Collembola abundance and litter mass loss increased with increasing litter nutrient concentration and particularly Ca and Mg litter contents. However, the positive effect of increased litter nutrient concentration was not maintained under low soil moisture or high air temperature conditions. For example, the relationships between Collembola abundance and Ca and Mg litter contents were weakened under warmer and totally disappeared under drier conditions. To conclude, our study points out that the ongoing climate change, in addition to affect directly soil organisms, could also strongly alter the relationships between litter nutrients and soil organisms. In addition, we highlighted that nutrient-rich resources could be potentially more impacted by the ongoing climate change than nutrient-poor resources.

**00223**

## **On the phenology of soil organisms: current knowledge and future steps**

Oral

A.E. Bonato Asato <sup>1</sup>, C. Wirth <sup>1</sup>, N. Eisenhauer <sup>1</sup>, J. Hines <sup>1</sup>

<sup>1</sup>German Center For Integrative Biodiversity Research - Leipzig (Germany)

### Abstract

Phenology is the study of timing of periodic activities in biological life cycles. It defines an inherent component of ecosystem dynamics and has been increasingly recognized as an indicator of global change. Although phenology is mainly studied in plants, major ecosystem processes, such as decomposition, mineralization, and nutrient cycling, are soildependent, indicating that the phenology of soil organisms is a crucial aspect for the functioning of terrestrial ecosystems. We performed a systematic review of 94 studies, which reported 226 phenological observations, to evaluate the current knowledge of soil microbial and animal phenology. Despite the increasing number of soil phenology reports, most research is still concentrated in few countries (centered in the Northern Hemisphere) and taxa (microbiota), with significant gaps in the most diverse regions of the globe (i.e., tropics) and important taxa (e.g., ants, termites, and earthworms). Also, biotic predictors (e.g., biodiversity and species interactions) mainly were ignored as possible drivers of soil organisms' phenology. We then build a guide on soil phenology research based on an extensive discussion on the found geographical, taxonomic and methodologic trends and biases for soil phenology research. First, we highlight leading papers that currently depict good soil phenology practice, either regarding the research foci, methodological approaches, or results reporting. Then, we discuss the gaps, challenges and opportunities for future research. Overall, we advocate that focusing on highly diverse ecosystems and key soil organisms, together with testing for the direct and indirect effects of biodiversity loss and climatic stressors, could be decisive to increasing our knowledge of soil functioning and predicting the effects of global change on terrestrial ecosystem functioning as a whole.



**00245**

## **Effect of soil structure on trophic interactions: a modelling approach**

Oral

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### Abstract

Trophic interactions play a vital role in soil functioning and are important drivers of the soil microbiome and biogeochemical cycles. However, what determines trophic interactions in soil remains largely unknown. Small scale soil physical structure, namely pore geometry, connectivity and the soil hydration status could play a determinant role but was little investigated. For soil organisms unable to deform the soil structure, such as bacteria, fungi, nematodes and microarthropods (micro-foodweb), the soil physical structure determines their habitat and mobility. It can affect their accessibility to food resources/prey, due to (i) the size segregation of prey and consumers in pores of different sizes, (ii) the modulation of prey and consumer's mobility due to changes in the connectivity of the pores and water film, and (iii) variations related to heterogeneous resources distribution. We developed a 2D spatially-explicit multi-agent simulation model that aims to quantify how changes in soil physical structure ( $\mu\text{m}$  to  $\text{cm}$  scale) affect trophic interactions (encounter probabilities), population abundances, and mineralization rates. The soil structure was defined by porosity, including pore size distribution and micro- and macro-connectivity, soil moisture, through the volumetric water content, and the distribution of organic matter and rhizosphere hotspots. Parameters obtained experimentally were used to create a parametrized random soil matrix. Then, for each type of soil organisms (i.e bacteria, fungi, nematodes and microarthropods), rules for movement, reproduction and life duration, feeding preferences and metabolism were defined according to the literature. Preliminary results showed that variations in pore size, soil moisture and organic matter distribution induce changes in trophic interactions and mineralization rates.

00284

## Effects of summer drought and soil organic carbon content on biotic communities and ecosystem services in agricultural soils across Europe

Oral

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Abstract

Future levels of agricultural production in Europe will be altered by extended periods of summer drought and severe negative effects on soil biodiversity and associated ecosystem services that will threaten food security. It is therefore crucial to address the question how extreme drought conditions will affect communities in agricultural soils and to understand if management of soil organic carbon can contribute to a mitigation of such effects across regions with different levels of ambient precipitation. We experimentally reduced ambient precipitation by 65% in paired wheat fields with high and low soil organic carbon content in Sweden, Germany and Spain over the crop growing seasons. As expected, simulated drought affected soil water content (SWC) most under relatively high ambient precipitation levels. Nitrogen mineralisation was highest and abundances of foliage-living natural enemies were lowest under simulated drought. Microbial respiration increased with increasing SWC in Sweden and Germany and bacteria, nematodes and soil mesofauna were most sensitive to shifts in SWC. Total organic carbon content (TOC) generally affected levels of biodiversity and ecosystem service proxies positively, with microbial respiration being positively related to TOC across all countries. Ecosystem multifunctionality was positively related to TOC in Sweden and Spain, while multidiversity was only positively related to TOC in Sweden. However, SWC was not significantly related to multifunctionality or multidiversity. Simulated drought reduced the number of significant relationships between biodiversity components and ecosystem service proxies by more than 20% compared to control plots. Responses of biodiversity and ecosystem services and disservices to simulated drought often depended on ambient levels of precipitation. However, some overarching patterns were observed across countries: summer droughts reduced the abundance of natural enemies, and selected bacteria and soil animals with consequences for wheat yields. In addition, relationships between biodiversity and ecosystem service proxies were considerably weakened by summer drought conditions. Soils with relatively high TOC generally had higher levels of biodiversity and ecosystem service proxies, but not of disservice proxies. Management of soil organic carbon hold the potential to contribute to the mitigation of negative consequences of future summer droughts.

**00447**

## **Impact of interactions among earthworms species on soil functioning**

Oral

J.H.R. Araujo <sup>1</sup>, L. Dupont <sup>2</sup>, Y. Capowiez <sup>3</sup>, C. Hartmann <sup>1</sup>, T.Z. Lerch <sup>2</sup>

<sup>1</sup>Ird - Bondy (France), <sup>2</sup>Upec - Créteil (France), <sup>3</sup>Inrae - Avignon (France)

### Abstract

Earthworms are implicated in the regulation of many soil ecosystem services, including water regulation, nutrient cycling, primary production, carbon storage and contaminants degradation. Their communities are often composed of several species but the functional role of each species is still a matter of debate as they may change their behavior according to different environmental contexts. It has been shown that the diversity of plants or microorganisms plays an important role in the soil functioning. However, this question has not yet been clearly addressed with respect to earthworms. The aim of this study was to test the hypothesis that the higher the earthworm diversity, the stronger the effect on soil processes. A second assumption relied on the fact that earthworm effects depend on soil texture. To test our hypotheses, a laboratory controlled experiment was conducted on 72 mesocosms (5 L) filled with 3 different grassland soils with different textures (from sandy to loamy), covered by a layer of green waste compost (2 cm). In each soil, 8 combinations of 3 different species of earthworms (*Lumbricus terrestris*, *Lumbricus castaneus*, and *Allolobophora chlorotica*) were tested. The experiment lasted about 14 months in a room where air temperature, air humidity and light were controlled. Irrigation of all samples was made every month and the evolution of the amount of water retained in each sample was recorded. Every two weeks, the soil respiration was analyzed using a LI-COR chamber. At the end of the experiment, analyses of soil structure by X-ray-tomography were performed. Finally, *Lolium perenne* were grown during 6 months in order to assess the effects of earthworms on plant growth. The periodic analyses of the soil respiration and its capacity to retain water suggest that the assembly of the 3 species had the strongest effects on compost mineralization and hydric properties, depending on the soil texture. The analyses of the soil structure revealed that interactions between earthworm species lead to changes in the soil porosity profiles. Ongoing plant cultivation experiments will determine whether the demonstrated changes in soil properties result in changes in plant growth and physiology.

**00463**

## **Different approaches to grasp multi-trophic ecology using network methods: models, assumptions and applications on soil eDNA data**

Oral

**M. Ohlmann <sup>1</sup>**

<sup>1</sup>Laboratoire D'ecologie Alpine, Leca, Umr Uga-Usmb-Cnrs 5553 - Grenoble (France)

### Abstract

Since a large part of terrestrial biodiversity is hidden in the soil, understanding quantitatively soil multi-trophic ecology would consist in a major step forward. This is all the more crucial for biodiversity conservation in a context of land-use intensification and global changes. With the rise of eDNA soil data, soil is no more a black box. We can then quantitatively grasp soil multi-trophic ecology; from millions of sequences across kingdoms to the outcomes of statistical models that allow ecological conclusions to be drawn.

In this talk, we propose an overview of few recent methodological developments to better grasp soil ecology using network methods, with several applications on soil eDNA data.

We will start by providing meaningful representations of trophic networks using a diffusion-based layout algorithm. We will describe the structure of a soil expert-knowledge network using this method with interpretation in terms of energetic channels. We will then see how variation of network structure through space can be assessed using network diversity indices. We will present applications on soil eDNA data using an expert-knowledge network. As expert-knowledge networks only represent potential interactions, we will see how association networks offer additional perspectives to comprehend soil interaction networks from eDNA data. To conclude, we will contrast ecological assumptions and methods around potential networks reconstruction and association network inference using eDNA data.

**00445**

## **Differential effects of soil trophic networks on microbial decomposition activity in mountain ecosystems**

Oral

C. Martinez Almoyna<sup>1</sup>, A. Saillard<sup>2</sup>, L. Zinger<sup>3</sup>, C. Lionnet<sup>1</sup>, C. Arnoldi<sup>1</sup>, A. Foulquier<sup>1</sup>, L. Gielly<sup>1</sup>, G. Piton<sup>4</sup>, T. Muenkemueller<sup>1</sup>, W. Thuiller<sup>1</sup>

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Abstract

Soil food webs are crucial for biogeochemical cycles and in particular for decomposition. However, few studies have quantified how microbial decomposition activity is influenced by both the composition of bacterial and fungal communities and their respective consumers, conditionally on environmental variation. Here, we measured and compared these effects between forests and open habitats, using several altitude gradients in the French Alps.

We found that while the response of microbial decomposition activity to abiotic conditions varied little between the two habitats, it was determined by the composition of fungal communities in forests, and by the composition of bacterial communities in open habitats. We also identified indirect effects of consumer communities that suggest the existence of trophic regulation of microbial decomposition activity. The effect of trophic regulation differed between habitats: minor in forests, it was however strong in open habitats.

The hierarchical integration of the environment and the soil food web to quantify indirect and direct pathways effects on decomposition highlights the need to better assess the importance of trophic regulation to predict ecosystem functioning.

## Theoretical ecology and ecological modelling - Salle 5 22/11 ; 13:45-15:45

00106

### Modeling the stoichiometry of N and P fluxes in socio-agroecosystems: prospective scenarios for a sustainable French agriculture.

Oral

A.S. Lafuite <sup>1</sup>, I. Gounand <sup>2</sup>, S. Barot <sup>3</sup>, T. Daufresne <sup>4</sup>

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Abstract

Nitrogen (N) and phosphorus (P) are both essential elements for plant growth that are absorbed under stoichiometric constraints. In the dominant model of conventional agriculture, N and P are mostly supplied to plants through chemical fertilizers, the use and production of which are unsustainable, as illustrated by the recent rise of gas and fertilizer prices: not only are they a significant source of environmental pollution, they are also produced from limited and nonrenewable resources (gas, phosphate rocks), thus posing serious threats to global food security.

Moreover, harvesting and exportation of agricultural products have generated more and more net spatial flows of nutrients from cultivated soils to importer regions which, combined with very low local recycling, have resulted in the gradual opening of the biogeochemical cycles of N and P. If not compensated by organic and inorganic fertilizer inputs, nutrient depletion could lead in the long term to a decrease in soil fertility and nutritional quality of food, adding to the other threats on food security. However, despite their crucial role in long-term food production, available forecasts do not explicitly account for nutrient dynamics nor N:P stoichiometry.

Using existing published or open data, our model investigates the long-term risks for soil fertility of these nutrient transfers, and thus aims at assessing the sustainability of current intensive agricultural practices in France by estimating the temporal scale of soil nutrient depletion in a business-as-usual scenario. We then simulate alternative scenarios by varying agricultural factors (crop types, soil, agricultural practices and specialization, N:P ratios) and/or socio-economic factors (food demand, dietary preferences, environmental norms, production costs, importations and rate of waste recycling). Confrontation of our results to other published prospective scenarios emphasizes the importance of accounting for nutrient dynamics and stoichiometry when generating scenarios in this field. Finally, we suggest agricultural schemes that would help reconcile potentially antagonistic but fundamental targets: reducing nutrient soil depletion and pollution while maximizing food security and quality.

00141

# Modelling the Geometric and Demographic Effects of Fragmentation on Biodiversity Across Spatial Scales

Oral

S. Gelber <sup>1</sup>, F. May <sup>1</sup>

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## Abstract

Anthropogenic land-use change is recognized as a major driver of biodiversity loss. Typically, land-use change results in simultaneous loss of habitat, habitat degradation, and habitat fragmentation. While previous studies have demonstrated the negative effects of habitat loss and habitat degradation on biodiversity, the effects of habitat fragmentation per se on biodiversity are still intensely debated. A more comprehensive understanding of the effects of fragmentation on biodiversity is crucial for meaningful conservation efforts and informed policymaking. Results from previous fragmentation studies are diverse, showing positive, negative, or neutral effects on biodiversity. One explanation for these seemingly contradicting results is that some studies implicitly extrapolate from fragment to landscape-scale while others simply confounded different spatial scales, despite fragmentation being a landscape-scale phenomenon. In this study, we strive to reconcile these contradictions by explicitly considering fragmentation effects on different spatial scales. We aim to isolate and disentangle the scale-dependent effects of fragmentation by utilizing a conceptual approach that distinguishes two types of fragmentation effects – geometric and demographic effects. Geometric effects arise from the spatial distribution of biota prior to fragmentation and the spatial configuration of land-use change, whereas demographic effects refer to changes in species birth, death, and migration rates due to land-use change. In order to demonstrate the interplay between the two types of effects, we designed a dynamic agent-based simulation model. This spatially explicit model simulates fragmented and auto-correlated landscapes where geometric, as well as demographic processes, emerge from the interactions between agents and their environment, such as habitat filtering and dispersal limitation. By simulating different scenarios with varying degrees of fragmentation, habitat heterogeneity, and dispersal distances, we were able to: (i) distinguish between geometric and demographic effects; and (ii) demonstrate the scale-dependence of fragmentation effects. With this explicit consideration of different scales, we reconcile previous apparent contrasting results and illustrate an approach for advancing the debate on fragmentation and biodiversity.

00309

## Interactions between foraging and dispersal scales drive the emergence of spatial heterogeneity in abiotic resources in plant-herbivore systems

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.

Meta-ecosystem; spatial ecology

Oral

I. Gounand <sup>1</sup>, N. Loeuille <sup>2</sup>, C.J. Little <sup>3</sup>, S. Charberet <sup>2</sup>, E. Fronhofer <sup>4</sup>, E. Harvey <sup>5</sup>, S. Kéfi <sup>4</sup>, S.L. Leroux <sup>6</sup>, C. Saade <sup>7</sup>, F. Massol <sup>8</sup>

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Abstract

Spatial heterogeneity of abiotic resources is essential for species coexistence. Ecological theory often assumes predefined heterogeneity of resources and assesses its consequences at various ecological scales. However, the recent development of the meta-ecosystem framework highlights how resource patterns should not be construed as an external constraint, but rather as the result of interactions between the activity and movement of organisms and their abiotic environment. For instance, nutrient uptake by plants and plant consumption by herbivores is leading to the redistribution of nutrients in space through the foraging movement of herbivores and recycling processes. Dispersal success of organisms is likely to be constrained by this resource redistribution, and to further feed back on it through consumption by the dispersed populations.

We investigated how dispersal and foraging scales of organisms drive the emergence of resource heterogeneity in a spatially explicit nutrient-plant-herbivore occupancy model. We found plant dispersal range to be the main driver of resource spatial autocorrelation, with higher heterogeneity occurring at lower ranges; whereas herbivore dispersal range has very low effects on resource redistribution. Conversely, increasing ranges of herbivore foraging favored resource heterogeneity, leading to higher heterogeneity than expected by chance but only at large foraging ranges and strong recycling rates. We discuss the mechanisms underlying these results, which set bases to better understand how the movement of organisms contribute to create dynamical landscapes of hot and cold spots of abiotic resources.



**00399**

## **A multi-species grassland model for analysing the response of the cover composition to various management regimes and climate**

Oral

T. Moulin <sup>1</sup>, P. Calanca <sup>2</sup>, B. Tietjen <sup>1</sup>

<sup>1</sup>Freie Universität Berlin - Berlin (Germany), <sup>2</sup>Agroscope - Zurich (Switzerland)

### Abstract

European permanent grasslands represent a backbone for dairy and meat production, and are hotspots of biodiversity, providing important ecosystem services to society. Understanding how the form of land use and climate variability affect the botanical composition of these grasslands is therefore essential for adequate management adaptations to target sustainable development goals. It is also a key requirement for gauging climate change effects on forage quality, an aspect often overlooked in impact assessments. Here, we present results of the DynaGraM modelling approach to understand short- and long-term changes in grassland biodiversity in response to various forms of land use and climatic variations. DynaGraM is a process-based model for simulating seasonal aboveground vegetation dynamics of semi-natural grasslands for plant communities containing any number of species. It has been shown to be capable to reproduce the composition of permanent grasslands in the French Jura Mountains, inferred from floristic relevés.

Here, we show that the model predicts highest, resp. lowest vegetation diversity for extensive grazing, resp. extensive mowing. We further find that the time scales of responses to external perturbations largely dependent on management, with shorter time scales (of the order of 5 to 10 years) under grazing than under mowing (of the order of 50 years). We highlight which mechanisms or processes could explain those differences in the time of response. We apply the model to examine how increasing summer aridity affects the species composition of pastures in the same geographic area. The results underline that management intensity modulates the impact of summer drought on both yield as well as botanical diversity, with largest changes over time in the latter under extensive grazing.

Overall, this model introduces a novel and relatively simple approach to represent competition and adaptation processes in plant community dynamics, thus providing a response to the key challenge of modeling multi-species grasslands.

00522

## Modelling age-class dependent response of the epiphytic lichen *Lobaria pulmonaria* to climate

Oral

L. Di Nuzzo <sup>1</sup>, G. Canali <sup>2</sup>, P. Giordani <sup>3</sup>, J. Nascimbene <sup>4</sup>, R. Benesperi <sup>1</sup>, A. Papini <sup>1</sup>, E. Bianchi <sup>1</sup>, P. Porada <sup>5</sup>

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### Abstract

Lichens are poikilohydric organisms, whose internal water content tends to reflect external humidity conditions. After drying, they can reactivate their metabolic activity through water vapor uptake or liquid water input. In spite of this flexibility, however, multiple studies suggest negative impacts of future warmer and drier climatic conditions on survival, in particular for epiphytic lichens of the Mediterranean region, such as the old-growth forest lichen *Lobaria pulmonaria*. Thereby, models predicting the effect of environmental conditions on lichens are based mainly on the presence or absence of adult thalli. Environmental factors which affect lichen survival, however, might vary during their life cycle, for example during propagule establishment or in the first stages of thallus development. Little is known about the different ecological requirements at the different development stages in lichens. In this work, we measured key functional traits, such as water holding capacity (WHC) and specific thallus mass (STM), of adult and recruit thalli of the model species *Lobaria pulmonaria* along a climatic gradient to constrain the trait-based non-vascular vegetation model LiBry. The LiBry model represents environmental filtering of the potential trait space of non-vascular vegetation by simulating a large number of strategies differing in their physiology and morphology. We simulated the productivity, activity and performance of adult and recruit thalli in 9 regions of Italy and Corsica. The model was used to test if adult thalli of *L. pulmonaria* have a higher survival probability due to their higher aerodynamic resistance. In current climatic conditions, the LiBry model predicts a higher survival probability of adults with decreasing absolute survival rates of both age classes with increasing temperature. We discuss the main implications of our simulation outputs, provide future perspectives and possible implementations of the LiBry model.

00616

## Impact of fecundity-immunity trade-off on host eco-evolutionary dynamics.

Oral

E. Djahoui <sup>1</sup>, N. Loeuille <sup>2</sup>, R. Rohr <sup>1</sup>

<sup>1</sup>University of Fribourg - Fribourg (Switzerland), <sup>2</sup>Sorbonne Université - Paris (France)

### Abstract

Evolutionary outcomes are largely determined by resource allocation trade-offs. For instance, empirical works have shown that in host-pathogen systems, hosts exhibit an allocation trade-off between fecundity and immunity toward the pathogen. Here, we explore the possible evolutionary outcome of such a trade-off. To do so, we implement an SIR (Susceptible - Infected - Recovered) model where the host alone follows a logistic growth. We assume that host fecundity is submitted to a resource allocation trade-off that affects various aspects of host immunity (transmission, virulence, recovery). For each of these components, we introduce a parameter defining the strength of the trade-off and explore systematically its effects on the host evolutionary outcomes. For low and extreme trade-offs, we show that evolutionary outcomes are simple and evolution tend to maximize fecundity. For intermediate trade-off, evolution can lead to multiple and complex outcomes. The outcomes depend also on the immunity component considered. For instance, when the trade-off acts on the virulence, evolution tends to select the host that maximizes the basic production number ( $R_0$ ) of the pathogen. While for transmission and recovery, evolution favors the host whose pathogen has the smallest  $R_0$ . In these two cases, the host can undergo a branching point, which may eventually result in the coexistence of two hosts (one investing in fecundity and one investing in immunity). This branching occurs even when there is no ecological niche difference. That is, the pathogen induces host diversification.

Keywords: eco-evolutionary dynamics, adaptive dynamics, immunity, trade-off, fecundity, host-pathogen dynamics.

**00564**

**IESR: a novel method to analyze species introduction effects in space-time on species range dynamics, and prioritize conservation efforts.**

Oral

A. Callebaut <sup>1,2</sup>, J. Serra Diaz <sup>1</sup>, J. Gegout <sup>1</sup>

<sup>1</sup>Agroparistech - Nancy (France), <sup>2</sup>Université de Lorraine - Nancy (France)

Abstract

Under the context of a current massive climatic change, the outcome for species has been summarized as either resist new environmental conditions, adapt, or move. Empirical and modeling studies suggest that the pace of climate change is faster than species ability to migrate. Assisted migration (AM) could be an effective strategy to compensate for the slow movement of some species, to prevent their decline or extinction, but raise also a lot of questions. Part of the issue in assessing potential AM plans is that we lack tools able to identify where and when it is more effective to perform AM given species characteristics, and balance these against several risks.

Current tools allow modeling species distribution shifts either using correlative approaches at large scales, or based on mechanistic shifts involving migration, succession, disturbances, and species interactions. While these offer a toolbox for projecting future species distributions, they either fast but do not consider temporal scales of dispersal, or they imply are often too computationally intensive to consider a spatial and temporal optimization of conservation choices. The need to understand the large-scale effects of intended or unintended of assisted migration effects on biodiversity and species distributions calls for the construction of dedicated models that combine species range dynamics models and optimization of systematic conservation algorithms, which to our knowledge do not exist yet.

Here, we bridge this gap by presenting a novel mathematical framework capable of determining, with a minimum of computation load, the effect of establishing a population at a given location at a given time on species distribution dynamics. In order to identify the potential consequences of introductions on range dynamics, and explore the solutions space of the theoretical problem efficiently. We then use this framework to optimize our choices, by means of metaheuristic algorithms. The method can be used as an AM framework, but also in the study of invasive species and more generally in any potentially colonizing system.

**00641**

## **Hibernation niche modelling across 200 years of global warming.**

Oral

K. Kravchenko <sup>1</sup>, C. Voigt <sup>2</sup>, S. Lange <sup>3</sup>, J. Klar <sup>3</sup>, A. Courtiol <sup>2</sup>, S. Currie <sup>4</sup>

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<sup>3</sup>Potsdam Institute for Climate Impact Research (PIK) - Potsdam (Germany), <sup>4</sup>Universität Hamburg - Hamburg (Germany)

### Abstract

The ability of an individual to persist in an environment is constrained by the interplay between its thermoregulatory physiology and ambient temperatures. A key question is, therefore, how does climate change reshape the geographical areas that meet the physiological needs of species? We developed an integrative ecophysiological approach to answer this question in hibernating endotherms. Our framework aims to model the hibernation niche of any hibernator. We define such a niche as the geographic area where energy stored in fat reserves should meet the energy requirements for an average individual during hibernation. Conversely, an individual located outside its hibernation niche would not survive even if all other species requirements were met. We applied this approach to a widespread migratory bat species (*Nyctalus noctula*) from Europe by combining empirical physiological measurements with past and future predictions of daily winter temperatures (1900-2100) from 20 different climate projections. Our approach revealed hibernation periods to become shorter and warmer over time, and energy storage to become less depleted for the hibernating bat. It also predicts the median latitude of areas suitable for hibernation to shift northward by at least 200 km over 200 years. We discuss the relationship between hibernation niche modelling and actual species distribution, and how this framework could be applied to other species.

# Trait-based approaches: from microbes to plants and animals (1/2) - Salle 3 24/11 ; 10:00-12:15

00155

## Effect of environment and management on *Arnica montana* traits of economic importance

Oral

J. Locqueville<sup>1</sup>, S. Caillon<sup>1</sup>, C. Violle<sup>1</sup>, D. Mckey<sup>1</sup>, S. Coq<sup>1</sup>

<sup>1</sup>Cefe, Cnrs - Montpellier (France)

### Abstract

Managing wild populations of *Arnica montana* L., one of the major wild collected medicinal plants in Europe, is both an economical and ecological stake. We aimed at bridging the gap between the ecology of the plant and the benefits for harvesters. Specifically, we explored to what extent the management of the rangeland that constitutes the habitat of this plant leads to intraspecific variation in its phenotype, with potential implications for pickers.

Indeed, when the flower heads alone are picked, only reproductive traits are of interest, but when the whole plant is collected, the vegetative biomass is also of interest for pickers. We asked whether tree shade and management practices such as grazing and mowing impacted the vegetative and reproductive functional traits of interest for picking. For this we measured 10 traits of *A. montana* in 27 sites in the Monts d'Ardèche region in France, in June 2021, and recorded the management practices performed on the sites and various ecological variables, including vegetation height and composition.

We found that shade was associated with a lower flowering and a higher leaf mass, while mowing and grazing were associated with a lower leaf mass but surprisingly did not impact flowering. A path analysis suggested that the effect of management practices on vegetative development was mediated by vegetation height. The correlation between vegetative traits reproduces the foliar economic spectrum at the intraspecific level at the local scale, a result that does not support the common assumption that the foliar economic spectrum is only found at the regional and global scale. The observed decorrelation between vegetative and reproductive traits of *A. montana* is worth noticing, in relation with classical hypothesis in ecology.

For pickers, these results suggest that shaded environments are beneficial for whole plant picking as individual plants yield more under shade. However they tend to flower less, therefore for the picking of the flower heads open environments are preferable. *Arnica montana* is thus an excellent model for disentangling the drivers of intraspecific variation in plant phenotype (in our case in a trait-based approach).

**00175**

## **Linking the root economics space to rhizosphere fungal communities in grasslands**

Oral

J. Hennecke <sup>1</sup>

<sup>1</sup>Leipzig University & German Centre For Integrative Biodiversity Research (div) Halle-Jena-Leipzig - Leipzig (Germany)

### Abstract

Root traits are organized along two orthogonal axes: the conservation gradient, analogous to the leaf economics space, and the recently described collaboration gradient. The conservation gradient ranges from 'fast' (high nitrogen content) to 'slow' turnover times (high tissue density). The collaboration gradient ranges from an 'outsourcing' strategy in plants with short and thick roots, that trade photoassimilates for nutrient acquisition with mycorrhizal fungi, to a 'do-it-yourself' strategy in plants that invest in long and thin roots to acquire resources themselves. This trait variation along the two axes is described in the so-called Root Economics Space (RES). The RES therefore explicitly links plant functional strategies to belowground fungal communities. Accordingly, we expect that different fungal guilds will associate differently with the different root trait axes. We expect that there will be a higher relative abundance of mycorrhizal fungi in the rhizosphere of 'outsourcing' plants than in the rhizosphere of 'DIY' plants. Additionally, we expect pathogenic fungi to be more closely linked to collaboration traits, whereas saprotrophic fungi should be more closely linked to conservation traits, due to their dependency on litter quality.

To test the predictive power of the RES framework on rhizosphere fungal guilds, we sampled roots and soil in monocultures of the Jena Experiment. We measured root traits from individual plants and sequenced the fungal community in the rhizosphere soil. Fungal taxa were then assigned a functional guild (arbuscular mycorrhiza, pathogens and saprotrophs) and we analysed their proportion, diversity and community composition. We found that the conservation gradient of root traits is indeed a main driver of the saprotrophic fungal community, even though the proportion of saprotrophs does not change strongly along the axis. Surprisingly, we found no change of arbuscular mycorrhiza proportion along the collaboration gradient, while pathogen proportion was not affected by any of the axes.

Overall, we show that root traits and the root economics space can be a driver of rhizosphere fungal community structure but effects on the proportion of fungal guilds are less clear and abiotic conditions have stronger effects than root traits in monocultures.

00196

## Copepods true colors: astaxanthin pigmentation as an indicator of fitness

If you have chosen the theme "free topic" please indicate 1 or 2 keywords here.

aquatic ecology

Oral

L. Vilgrain <sup>1,2</sup>, F. Maps <sup>2</sup>, S.L. Basedow <sup>3</sup>, E. Trudnowska <sup>4</sup>, A. Madoui <sup>5</sup>, B. Niehoff <sup>6</sup>, S.D. Ayata <sup>7,1</sup>

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Abstract

Pigmentation is often overlooked in zooplankton, since organisms are mostly colorless to fit the translucent water medium. However, one of the dominant zooplankton taxa in aquatic ecosystems, i.e. copepods, often show a red-orange coloration owing to the accumulation of carotenoid pigments in some parts of their bodies. Even though there are many traits describing copepod performance (e.g. size, feeding and reproductive modes), it is surprising that the role of such a simple and visible trait as coloration has not gained enough attention yet. Here, by reviewing 82 studies, we demonstrate that carotenoid-induced pigmentation (mainly caused by astaxanthin molecules) is a widespread copepod functional trait in freshwater and marine ecosystems. We propose an initiative to disentangle the complex, and thus intriguing purposes of pigment expression along latitudinal and altitudinal gradients, addressing its relation to diet quality and quantity, temperature, ultraviolet radiation stress, predation pressure, lipid metabolism, and reproduction. We also show that large scale variations in pigmentation are difficult to tackle because copepod coloration is fundamentally plastic and can change at short time scales (ie. hours, days), regulated by finely-tuned molecular processes. The most recent information about carotenoid bioconversion (genes and enzyme identification, influence of microbiota) are addressed. From this meta-analysis, we hypothesized that astaxanthin can play a "swiss-army knife" role for copepod fitness, useful in various ecosystem conditions, by means of the strong antioxidant power provided by the long conjugated carbon chains of astaxanthin molecules. With larger antioxidant capacities (survival), higher metabolisms (growth) and more abundant/better offspring (reproduction), red morphs are more successful than their uncolored siblings. Also, the potential camouflage strategies allowed by color changes are broadly discussed. Beyond the advantages that carotenoids provide for copepods, these pigments could be beneficial to the entire aquatic trophic network by the transfer of antioxidants, up to fish and humans. Ubiquitous quantifications of copepod pigmentation through trait-based approaches could thus be useful (i) to obtain an accurate copepod fitness indicator, (ii) to better estimate antioxidant transfer and its role in ecosystem functioning, and (iii) to monitor aquatic ecosystem health.



00429

# Stoichiometric plasticity of aquatic hyphomycetes and its functional consequences on decomposition and nutrient cycling

Oral

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Abstract

Aquatic hyphomycetes (AH), one of the important plant litter decomposers in freshwater ecosystems, require various essential elements [including carbon (C), nitrogen (N) and phosphorus (P)] in different proportions for their development. Each strain has an optimal ratio below and beyond which its growth could be affected. Consequently, such imbalance between elements availabilities and demand for organisms (the “stoichiometric constraints”) could greatly disrupt ecological processes, like the decomposition of plant litter in streams. Ecological stoichiometry theory (Sterner & Elser, 2002) states the elemental compositions of organisms reflect at least partially their demands. It has been shown that AH’s elemental composition could be highly variable (Danger & Chauvet, 2013), but the ecological consequences of this non-homeostasis are still not well understood. We have grown 4 AH strains on NP-rich, NP-depleted and N- or P-depleted agar plates with glucose. We measured colony sizes each week until the whole surface was covered. We have then divided the mycelium into 3 age categories to analyse their CNP content. The results should hint to an optimal growth NP ratio for each strain and highlight any difference in NP content between mycelium ages. Each strain should have its preferential NP ratio for growth, and the colony sizes would be strain- and ratio-dependent. First results indicate that younger mycelium has a higher P content than older ones because active growth requires more P-rich rRNA. Colonies grown on N-depleted plates also have a higher P content. In a separate independent setup, 5 AH strains were grown together on alder leaves on gradients of 8 N:P ratios, where we analysed the relative abundances by strain-specific Taq-Man qPCR, measured ergosterol content and the leaves mass losses and at 3 different times over a 40-day period. First results showed negative correlations between the N:P ratios and the total abundance, ergosterol content and leaf mass loss. The imbalance between AH nutrient requirements and dissolved N:P impacted nutrient mineralization, but most nutrients were quickly immobilized whatever the amount of nutrients available. Further analyses in detail of both experiments should give us insight into the AH homeostasis and their function as decomposers.

00346

## Mediterranean plant trait response to fire gradient

Oral

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### Abstract

The current composition of the Mediterranean vegetation is the result of long-lasting effects of fire, and land use. For the next decades, climate in Mediterranean region is expected to be 25% warmer over the year than the rest of the planet with up to 40% warming peak in summer. These increasing heatwaves in combination with drought and land-use change (decrease of grazing or protected lands, both increasing tree connectivity) are likely to cause higher fire risks, longer fire seasons and more frequent, large, and severe fires

Understanding the processes shaping plant communities under fire is a core challenge in ecology and conservation science in this area. Recent advances in the application of species traits, to assess the functional structure of communities, have provided an alternative approach that responds rapidly and consistently across taxa and ecosystems to disturbances. Plant functional uniqueness characterises Mediterranean ecosystems, yet the gradient response of critical plant traits and functional diversity to fire activity is still understudy despite the recent and ongoing increase of fire frequency and size.

The Provence Alpes Cote d'Azur region this unique opportunity to records of both fire parameters (date and size) from Prométhée database, and vegetation surveys from Silene database, to answer ecological key question: Is there a scheme of plant trait distribution and functional diversity in response to a gradient fire number and size in a Mediterranean ecosystem?

The focus is on six functional traits determining plant fitness, which represent major axes of ecological strategy for growth, survival, reproduction and fire resistance (SLA, LDMC, max Height, wood density, LNC and seed mass) derived from the TRY database and the BROT database. To reduce the kurtosis shape of trait distributions we will log<sub>10</sub> transform the values.

The results show no direct significant relationship between fire parameters and plant species. At the community level, however, the trait values narrowed to maximizing the efficiency of traits in a highly fire prone systems. In addition, seed mass, and wood density are closer to fire parameters in bidimensional PCA analysis than LNC and SLA variables. We now stress the need to extend this finding in Mediterranean.

00373

## Plant functional traits and species distribution determine the spatio-temporal variability of phenological events in herbaceous species

Oral

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Abstract

In recent years there has been a growing interest in research on plant phenology and its responses to biotic and abiotic factors. Numerous studies have shown that climate warming has led to shifts in phenology – mostly indicated by advanced spring phenology and delays in autumn events. However, global climate change is not only characterised by (region-specific) increases in temperature and changes in precipitation, also the magnitude of their variability has changed and differs on spatial and temporal scales. For this reason, there is a need for studying how the variation in environmental factors affects the variability of plant species' phenology to predict their responses to future climate.

To get deeper insights, we analysed phenology records of 230 herbaceous species, which were collected by members of the PhenObs network ([www.idiv.de/phenobs](http://www.idiv.de/phenobs)) in 12 botanical gardens between 2019 and 2021. We used boosted regressions trees including the standard deviation of the different phenological events within one species to capture its spatio-temporal variability as response variable. Abiotic factors (i.e., climate data) and species' characteristics (distributional range and functional traits) as well as species' phylogeny were included as explanatory variables.

We found that the relative contribution of each explanatory variable differed between the different phenological events. However, species' phylogeny always contributed a large portion (between 43 and 72%), whereas abiotic factors and species' characteristics were less important. In regard to the species' distribution and functional traits our results suggested some comprehensible patterns: species' distributional range was the most important predictor of flowering peak and species with a large range showed a higher variation in time. Furthermore, seed mass, (negatively related to dispersal capacity) contributed the most to predict the variability in flowering duration and the day of leaf unfolding; species with small seeds were more variable.

In general, our findings indicate that the timing of phenological events is more scattered in species originating from a broad distributional range. Furthermore, this work showed the importance of including species' phylogeny and characteristics (e.g. distribution and functional traits) as well as abiotic factors when aiming to understand and eventually predict the responses of species to climate change.

00391

# Morphological overdispersion patterns support the role of competitive interactions driving community assembly of dragonflies

Oral

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Abstract

The contribution of biotic processes driving animal community assembly is a controversial topic in ecology with major predictive and conservation implications. The recent increasing availability of large-extent diversity data together with more mechanistic functional approaches promises novel insights across taxa. Odonata (dragonflies and damselflies) constitute a unique but overlooked system to understand the operation of competition in ecology due to their strong territoriality for reproductive aquatic territories. We departed with 1+ million observational records of Odonata to build 10,339 and 6,103 ecologically meaningful and representatively sampled dragonfly and damselfly assemblages across 3 independent European study regions (UK, Bavaria, Catalonia). Using a functional approach based on patterns of morphological overdispersion, we (1) infer the role of competition driving dragonfly and damselfly community assembly, and (2) test whether, as expected based on ecological theory, competition effects increase with reduced strength of abiotic stressors. Results support our first expectations by showing that dragonfly— but not damselfly – assemblages exhibit clear patterns of morphological overdispersion based on the traits expected to promote interspecific territoriality (either body size alone or in combination with body shape and body colour). These results were highly consistent across study regions. Morphological overdispersion often, but not always, increased with decreased strength of abiotic stressors related to thermoregulation, i.e. temperature and precipitation, partially supporting our second expectation. Moreover, morphological overdispersion showed a clear phenological pattern increasing over the season. These results constitute a striking example for a consistent support of competitive interactions driving community assembly in a group of insects, which may be triggered by the unique combination of strong territoriality, high resource limitation and reduced possibility of resource partitioning of Anisoptera. Based on our results, Odonata may constitute a valuable model system to better understand the operation of biotic interactions in ecology and their role mediating future global change effects.

**00424**

## **A bacterial trait-based approach using BactoTraits to evaluate the impact of physico-chemistry and pollutants on shaping soil functional diversity**

Oral

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### Abstract

The microbial diversity is influenced by abiotic, biotic and anthropogenic factors that act as filters to select microorganisms best adapted to local conditions. A key question is to understand the impact of these filters on bacterial assemblages. To characterise these bacterial assemblages a new approach based on morphological, physiological and genomic traits has been developed to compare a wide range of ecosystems with different bacterial diversities.

The BactoTraits database was created, based on the attributes (19 traits including for example: oxygen preference, size and shape of bacteria, motility, optimum and ranges of pH and temperature, genome GC percent and trophic type) of 19,455 bacterial strains. Moreover, five functional groups (i.e. mesophiles, competitors, colonizers, stress-sensitives and stress-tolerants) gathering strains with quite similar trait profile combinations, were also defined.

BactoTraits was used to characterize the traits of the bacterial communities identified through high-throughput sequencing of 16S rDNA of 30 soil samples from 10 different sites having various physico-chemical properties and contamination (metal and polycyclic aromatic hydrocarbon, PAH) levels. If intuitively predictable results were found, as the acidic soil pH selecting for bacteria with low pH optimum, many other suites of traits were non predictable such as increase of non-motile, ovoid and anaerobic bacteria. Soil texture, dissolved organic carbon, Na, N, and P<sub>2</sub>O<sub>5</sub> contents also influenced the trait profiles of the bacterial communities, such as an increase in bacteria belonging to the "competitors" functional group in soil with the highest N and P contents. Metals and PAHs selected bacteria with specific traits (e.g. for metals: filament shape, microaerophile and temperature optimum higher than 40°C, and for PAHs: spherical shape, facultative anaerobe/aerobe, no spore production, pH optimum ≥ 8, low temperature optimum but high temperature variation tolerance).

This approach that consists of inferring trait values from a list of taxa and their abundances within a bacterial assemblage, can be extended readily to almost all microbial systems and contexts. It has the potential to facilitate understanding of adaptation or tolerance mechanisms to environmental stressors, by relating bacteria community diversity to trait assembly.

00246

## Leaf Metal Exclusion or Accumulation is Related to Soil Resource Exploitation Strategy in European Calamine Species: Evidence for a Leaf Elemental and Economic Spectrum?

Oral

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Abstract

Functional traits related to plant growth, survival and reproduction vary along two independent axes: the leaf economic spectrum opposing fast-growing nutrient-exploitative species and slow-growing nutrient-conservative species; and plant stature opposing short and tall plants. This work aimed at characterizing the unknown position of calamine species along these two functional axes in relation with leaf metal accumulation or exclusion. We assumed that species growing in highly polluted environments should be positioned similarly to species growing in other harsh ecosystems where both plant size and growth rate are limited. We studied height functional traits related to the leaf economic spectrum (Leaf Mass Area, Specific Stem Density, leaf Nitrogen concentration, Leaf Dry Matter Content, Twigg Dry Matter Content) and plant stature (Height, Leaf Area, Seed Mass) in 44 dominant species in nine calamine grasslands (Northern plain and Pyrenean range in France) and 42 dominant species in nine non-calamine grasslands as control. Leaves and roots Zn, Cd and Pb concentrations were characterized for 9 out of the 44 calamine species. Regarding plant stature, calamine species had small size like those observed for non-calamine species growing in harsh environments. However, calamine species showed an important variability for traits related to the leaf economic spectrum. This variability was strongly correlated with metal accumulation, fast growing species showing lower metal sequestration in roots and higher leaf metal concentrations. Fast-growing species exploiting soil resources are likely more exposed to soil contamination. In that case, metal exclusion from leaves and sequestration in roots may be less efficient than translocation to leaves procuring defense against herbivores, and leading to the observed Leaf Elemental and Economic Spectrum. Screening of plant traits including those related to metal accumulation in more diverse metalliferous plant communities is necessary to assess the generalization of this trade off coupling leaf metal accumulation/exclusion with soil resource exploitation/conservation.

## Trait-based approaches: from microbes to plants and animals (2/2) - Salle 3 24/11 ; 13:45-15:45

00436

### Stocking shape the functional characteristics of fish communities in small lakes

Oral

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Abstract

Gravel pit lakes are increasingly common and represent a valuable and attractive environment for recreational activities. They also represent substitute habitats for the conservation of freshwater biodiversity in altered floodplains. Gravel pit lakes are often disconnected from the hydrographic network, causing a slow natural colonization by fish that primarily relies on human-mediated introductions through stocking. Stocking is a widespread practice that covers a large range of management purposes and that is also strongly modulated by the socio-ecological context, but little is known on its effects on the functional characteristics of recipient fish communities. Here, we assessed how community structure responded to stocking intensity and stocked species in a network of 34 geographically-closed gravel pit lakes located in the Garonne floodplain (France). Using a survey-based approach, stocking practices by stakeholders were assessed and fish communities were sampled using a standardized protocol to quantify two important functional features: functional diversity and body size-spectrum. Our results showed that stocking is frequently used by stakeholders (50%) and is highly variable in terms of intensity (ranging from 2 to 907 kg.yr<sup>-1</sup>.ha<sup>-1</sup>, average of 128 kg.yr<sup>-1</sup>.ha<sup>-1</sup> ± 239 SD) and species stocked between stakeholders. A total of 14 fish species (six native and eight non-native) were used for stocking and six species accounted for 99% of the total stocked biomass. Stocking intensity and the stocked species were primarily driven by the management objective and lake size, respectively. Stocking intensity is significantly associated to changes in functional diversity and community size-spectrum, with an increase in functional richness and non-linear changes in the community size-spectrum. Moreover, stocked species exhibited significantly different functional traits than the other species. Recreational fishery management contributed to increase fish functional diversity, but the repeated stocking with a specific pool of species could lead to a biotic homogenization among lakes. This study confirms the urgent need to better understand the effects of human practices on the functional attributes of fish communities and the subsequent consequences on ecosystem functioning. This could promote a more integrative and sustainable management of recreational fisheries in a context of declining biodiversity.

00444

## Shining a light on bumblebee foraging strategies: bumblebee species niche partitioning is related to visual sensory traits

Oral

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Abstract

Coexistence of bee species has been explained by resource partitioning between flower species that require different morphological adaptation for efficient foraging. However, bumblebee species often coexist despite large overlap in flower use. In this study, we investigated microhabitat niche separation as an alternative but overlooked mechanism underlying bee species coexistence. In particular, we investigated if bumblebee species exploit different light-temperature microhabitat niches, thereby avoiding competition over a homogeneous resource – bilberry (*Vaccinium myrtillus*) flowers – in a heterogeneous light and temperature environment (hemiboreal forests). We expected species with higher eye parameter – indicator of a higher investment in light sensitivity compared to visual resolution – to be able to forage in lower light environment. We expected small bees to be restricted to lighter environment given their smaller and thus less-sensitive eyes. We found that bumblebee communities segregated against a light intensity gradient. A Fourth corner analysis showed that bumblebee eye parameter, not body size, was correlated to light intensity. As hypothesised, community weighted mean of the eye parameter increased in darker environment – indicating a higher light sensitivity while, against our hypothesis, smaller bumblebees were not restricted to higher light intensities. Bumblebee species differed in their response to a light intensity gradient. HOF models based on species occurrence showed the differences of shape of light niches. Light niche of all species with a low eye parameter – indicating an investment in visual resolution – increased unimodally with light intensity. Bumblebee species with a higher eye parameter displayed bell-shaped or decreasing niche with light intensity. Consistently, the optimal of the light niches decreased with the value of species' eye parameter. Given a correlation between light intensity and temperature ( $R^2=0.33$ ), it is possible that relationships are partly driven by bees surface to volume ratios as determined by size. Further investigations are therefore needed to disentangle the effects of light and temperature on bumblebees' microhabitat use. This study highlights microhabitat niche partitioning as a potential mechanism underlying bumblebee species coexistence and indicates the importance of considering sensory traits when studying insect pollinator habitat use and their capability to adapt to rapid habitat changes.



**00462**

# **Rules of Size and Colour: Responses of Forest Insect communities to Temperature and Solar Radiation**

Oral

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## Abstract

The Heat Conservation Hypothesis and the Thermal Melanism Hypothesis predict the specific response of colour lightness and body size of insects to climate, while the Heat Transfer Theory and Bogert's Rule predict responses of those traits to solar radiation. To show effects of climate and radiation on forest insect communities with different activity periods, we tested the response of colour lightness and body size of Coleoptera, Heteroptera, and nocturnal Lepidoptera communities from 503 forest sites to mean annual temperature and canopy cover as surrogates for macroclimate and microclimate respectively, and to canopy cover, skyview and direct solar radiation as surrogates for solar radiation. We show for the first combination of hypotheses with linear mixed effect models that regardless of the communities' activity period, the body sizes decrease with an increase of both climatic variables. An increase of mean annual temperature leads to an increase in colour lightness. In line with our predictions, the insect communities show different reactions of colour lightness to canopy openness depending on their activity period. With regard to the second combination of hypotheses, we could not find a consistent line with our predictions. Following the Heat Transfer Theory, the insect communities became smaller with increasing solar radiation; we can confirm Bogert's Rule only for Coleoptera and Lepidoptera communities; their colour lightness decreases with increasing skyview and canopy openness respectively. Our results indicate that climate and solar radiation are important characteristics for forest insect communities with rather consistent responses in nocturnal and diurnal taxa. The high importance of canopy cover suggests that canopy cover should receive more attention in climate-biodiversity studies.

00561

## The ECOLOPES plant-animal-soil community model

Oral

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Abstract

Urbanization is a major contributor to natural habitat loss. Urban areas are extreme habitats in comparison to their natural counterparts, including non-natural soils, frequent drought and flood risk, and human disturbances. Yet, well-planned architecture can also provide rich habitat for microbes, plants and animals alike, allowing for human-nature interactions that increase human wellbeing and the quality of life in the city.

In the EU-project ECOLOPES, we propose a radical change for city development: instead of minimizing the negative impact of urbanization on nature, we aim at urbanization to be planned and designed such that nature –including humans– can co-inhabit the city. A cornerstone of our approach is a computational design workflow, in which the interaction of architecture with plants, animals and microbes is incorporated into the evaluation of an architectural design.

We develop an ecological model which incorporates a spatially and temporally explicit simulation of plant, animal and microbe communities. Using existing code from FATE-HD and Buchmann's allometric home range formation model, we develop a Functional Group - based plant-animal-soil model in which plant succession is affected by architecture, soil and herbivory; animal home ranges are affected by architecture, soil and plant resources; and soil develops depending on animal and plant activity. Furthermore, the immigration of animals and plants depends on their occurrence on a regional scale. Our model simulates community succession on microhabitat scale (1m<sup>2</sup>), and includes microenvironmental parameters such as shading as well as management plans, thus making it applicable to an urban context. We envision that our ecological model and its integration into ECOLOPES will transform architectural design and increase the quality of life for humans, microbes, plants and animals alike.

**00617**

## **Trait based approaches: e -science tools and new perspectives.**

Oral

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### Abstract

Trait-based approaches have been used in community ecology for several decades and to date, a tremendous amount of trait-based data have been produced. However, the inconsistencies in the current usage of terms in trait-based approaches together with the lack of common guidelines for standardized measurements of various traits pose challenges in finding a consistent and common way to describe trait-based data among researchers of the same discipline and beyond. The heterogeneity due to the lack of standards for acquiring, organizing and describing data and more specifically trait-based data hamper the findability, accessibility, interoperability, and reusability of such data (fairness) and their potential use to increase our understanding of ecosystem functioning and to be able to face global challenges. In this sense, the Research Infrastructure LifeWatch Italy aims to support the scientific community providing e-science tools in order to facilitate the research lifecycle. Here, we present the research lifecycle related to trait-based approaches on phytoplankton. In this case study we provide services through a virtual working environment (Phytoplankton Virtual Research Environment) i) to facilitate the identification of the species, shape, size and the calculation of morphological traits; ii) to provide harmonised data and metadata using specific semantic resources such as meta(data) schema, controlled vocabularies and thesauri and iii) to execute phytoplankton traits analyses at different levels of data aggregation (i.e. individual, taxonomical, spatial and temporal levels). The final goal is to reduce the barriers to data discovery, integration, and exchange and to allow final users to investigate phytoplankton community dynamics under global change by using a user friendly and open research environment.

**00630**

**Grassland root traits respond rapidly to climate change, while functional type composition explains differences in biomass allocation.**

Oral

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Abstract

Climate change is pervasive and have serious implications for biodiversity and ecosystem processes. While current research aims to understand ecosystems responses and feedback to climate change, multifactorial studies experimentally testing different components of climate change are needed to refine predictions about ecosystem responses. Besides well-known impacts on aboveground compartments, multiple components of climate change combined may have greater influence belowground, especially in grasslands, whereby absorptive roots largely control soil C allocation and water and nutrient acquisition. Therefore, we analyzed the responses of biomass and root traits in designed grasslands to climate change, while controlling for community composition of functional types. Using mesocosms in climate chambers, we simulated recently established urban grasslands that increase biodiversity and deliver urban ecosystem functions under challenging environmental conditions. With the objective to test biomass allocation and root traits responses to climate change, and based on the question whether functional type composition influences the responses of grasslands to climate change, we simulated two contrasting IPCC climate change scenarios for CO<sub>2</sub> and temperature, and used two precipitation treatments, i.e. normal vs. reduced precipitation during early summer in C Europe. Moreover, we controlled grassland composition by varying the evenness between grasses and forbs. We quantified above- and belowground biomass, root diameter, root tissue density, specific root length and root length density in 64 mesocosm grasslands. We found that belowground responses of grasslands to climate change did not translate rapidly into changes in biomass allocation but rather leads to changed root trait values. While the responses aboveground were clear early in the development of the grasslands, we highlight that root traits can better explain belowground adjustments of grasslands to climate change. Furthermore, functional types and intra-functional trait diversity modulate C allocation in grasslands. Hence, functional and taxonomical composition of grasslands should be considered in climate change experiments.

00632

## Allometric scaling of sustained dispersal speed in flying, running, and swimming animals

Oral

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### Abstract

Understanding the ecological consequences of landscape connectivity for biodiversity requires trait-based animal dispersal models that are both sufficiently general and biologically realistic. A central component of animals' capacity to disperse is their sustained speed, which fundamentally depends on the locomotion mode, body mass and temperature. While allometric scaling relationships have achieved generality in relating body mass to the mechanical- and metabolic energy cost of locomotion, there is considerable variation in the allometric exponents reported by models that predict the sustained speeds of different groups of flying, running, and swimming animals.

We derive a general allometric model which considers how fundamental biophysical constraints associated with the utilisation and dissipation of energy limit the sustained speeds of flying, running, and swimming animals during their transient phase of dispersal. Our model builds on previous biomechanical and energetic approaches by considering the body-mass dependence of (1) aerobic metabolism and (2) the minimum energy cost of locomotion. Unlike previous models, however, we also consider how (3) the dissipation of heat - a by-product of muscular contractions - limits animals' capacity for sustained locomotion. To tease apart how body mass mediates these fundamental biophysical constraints we answered three specific questions: (i) Does the new heat-dissipation model provides more accurate predictions of animal dispersal speeds than conventional power-law models? (ii) Does accounting for the allometric scaling of an animal's maximum heat-dissipation capacity further improve the accuracy of predictions? (iii) Are there systematic differences between flying, running, and swimming animals?

Using Bayesian parameter estimation and an extensive empirical dataset of sustained dispersal speeds, we show that an allometric movement model that includes allometric constraints on maximum heat-dissipation capacity best captures hump-shaped trends in the empirical dispersal speeds of running, flying, and swimming animals (533 species). Our body mass-dependent heat-dissipation model suggests that the inability to dissipate metabolic heat leads to the saturation and eventual decrease in sustained speeds with increasing body mass, especially among flying animals. Our model provides mechanistic predictions of animal dispersal speed that can be generalised across species, even when the details of an individual species' biology are unknown.

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## Plant functional groups to model vegetation dynamics in urban ecosystems: the ECOLOPES project approach

Oral

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Abstract

Urban contexts are complex and fragmented ecosystems, subjected to different anthropic disturbances. These disturbances, together with other ecological factors, act as filters on the selection of species: only species that present functional traits adapted to the urban environment can settle and spread.

Functional traits play a pivotal role within the H2020 FET-Open ECOLOPES project. This project aims to develop a new design approach of building envelopes, that considers ecological and architectural aspects, to realize regenerative urban ecosystems. One of the key elements is the spatially explicit ecological model that works with functional groups to simulate the temporal and spatial dynamics of different natural components (soil-microbiota, plant, and animal) as a function of abiotic conditions and biotic interactions, including human management.

Relevant species traits were used to obtain plant functional groups (PFG) with an innovative methodology. The traits were extracted from the global database of plant functional traits TRY according to seven ecological dimensions, and an aesthetic filter chosen by the user of the model. The intersection of all the dimensions potentially defines the ecological niche space of every plant species of the world: species that occupy a different niche belong to a different PFG. The validation of the PFG building methodology is being done through field data in the form of a green roof, subjected to different level of human management, and urban plots subjected to different level of anthropic pressures. The lists of spontaneous species collected on the two sites are being analysed with TRY database to define traits that are associated with typical urban anthropic pressures and maintenance. The list of plant functional traits collected are being processed to obtain PFG. These will later be checked against the theoretical PFG to check the effectiveness of the current PFG method.

The final output of the ecological model will be a map showing the distribution of animal and plant functional groups in different time step on the base of the architect design, i.e., geometry of the buildings, local abiotic conditions, soil characteristics, human management, interactions with the other biological components, and the natural evolution of the ecological systems.

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