34th Plant Population Biology Conference (POPBIO)
"All facets of diversity"

BOOK OF ABSTRACTS

Bolzano-Bozen (Italy)
2022

34th Plant Population Biology Conference (POPBIO)

May 19-21, 2022 Bolzano-Bozen (Italy)

All facets of diversity

Book of abstracts

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Dear PopBio participants,

Welcome to PopBio 2022, finally an in-person meeting in the wonderful city of Bozen/ Bolzano! This 34st meeting of our Specialist Group Plant Population Biology of the Ecological Society of Germany, Austria and Switzerland (GfÖ) is the first offline meeting of PopBio "after" Covid-19, where we could not meet at all in 2020 and had to reschedule our meeting to an online conference hosted by our colleagues in Prague in 2021. This year, our annual meeting is hosted by Camilla Wellstein and her working group at the Free University of Bozen-Bolzano, for which we are very grateful.

We also thank the keynote speakers – Emiliano Trucchi, Niek Scheepens, Claus Bässler, Anna Bucharova and Florian Jansen – for their upcoming contributions in five sessions covering a broad range of themes and for their flexibility to contribute to our conference both in person and as online lectures. In addition to that, a total of 30 oral and 19 poster presentations, will be presented at our conference, which will hopefully be inspiring and generate lively discussions which are the basis of our vivid PopBio community. As every year, many presenters are young scientists, for whom this conference aims to provide a welcoming stage.

This conference is indebted to its sponsors, in particular the directorate of the GfÖ for their financial support as well as the Free University of Bozen-Bolzano, allowing us to realize this PopBio meeting.

Enjoy!

Solveig Franziska Bucher and Sergey Rosbakh – Speaker and vice-speaker of the Specialist Group Plant Population Biology of the Ecological Society of Germany, Austria and Switzerland

P O P B I O 2 0 2 2 P R O G R A M

May 19th (Thursday) Aula Magna UNIBZ

08:00 Registration

09:00 Welcome Johann Gamper, Vice-Rector for Research UNIBZ
Camilla Wellstein, organizer of the conference UNIBZ
Solveig Franziska Bucher and Sergey Rosbakh, speakers of the Specialist Group POPBIO/GFOE

SESSION 1 chair Camilla Wellstein GENETICS & EVOLUTION

09:15 Keynote Emiliano Trucchi Common bean domestication genomics and implications

10:00 1 Sandner, Tobias Continuous inbreeding affects genetic variation, phenology and reproductive strategy in ex situ cultivated Digitalis lutea

10:15 2 Wellstein, Camilla Genetic and functional variation of *Vaccinium vitis-idaea* (Ericaceae) in ice holes microrefugia

10:30 3 Baric, Sanja Genetic diversity of European chestnut trees in South Tyrol (northern Italy)

10:45 coffee break

11:15 poster session I (genetics & evolution) 7 posters, 1 hour

12:30 lunch

14:00 Keynote Niek Scheepens The resurrection approach: case studies and general aspects

14:45 4 Karitter, Pascal A resurrection study reveals evolutionary changes in *Leontodon hispidus* after two decades of increasing temperatures and water scarcity

15:00 5 Münzbergová, Zuzana Rapid evolution in populations of a long-lived dominant grass species *Festuca rubra*

15:15 6 Lukic, Natasa Antioxidative mechanisms in transgenerational drought and waterlogging stress memory

15:30 coffee break including group photo outdoors

16:00 poster session II (all other sessions) 12 posters, 2 hours

19:00 conference dinner at Franziskaner Stuben at the historic city centre of Bozen-Bolzano

May 20th (Friday) Aula D 1.03 UNIBZ

SESSION 2 chair Sergey Rosbakh INTERACTION

09:00 Keynote Claus Bässler ONLINE Fungal functional ecology - towards a deeper understanding of fungal diversity

09:45 7 Herol, Lior The effect of ectomycorrhizal fungi on the response of Aleppo pine seedlings to drought and competition by a grass

10:00 8 Livne-Luzon, Stav The ectomycorrhizal community composition of *Pinus halepensis* and *Cedrus deodara* and how it changes with host age

10:15 9 Moncalvillo, Belén Host age strongly affects the performance of the root hemiparasitic plant *Rhinanthus alectorolophus*

10:30 10 Salman, Ibrahim Bumblebee attraction to *Matthiola livida* flowers is altered by combined water stress and insect herbivory

10:45 coffee break

SESSION 3 chair Solveig Franziska Bucher ENVIRONMENTAL HETEROGENEITY, PLANT DIVERSITY AND ADAPTATION

11:15 11 Tielbörger, Katja Habitat heterogeneity does not affect species diversity - a rigorous experimental approach

11:30 12 Fischer, Felicia Seasonal beta-diversity of dry grassland vegetation: divergent peaks of biomass and species richness

11:45 13 Franke, Luise Promoting functional plant diversity in agricultural landscape
12:00 14 Seifan, Merav I never promised you a rose garden – coping with hyper-arid conditions in the True Rose of Jericho (*Anastatica hierochuntica*)

12:30 lunch

SESSION 4 chair Jitka Klimešová PLANT TRAITS

14:00 keynote Anna Bucharova Seeding the future: Evolutionary perspective on seed based ecological restoration

14:45 15 Rosbakh, Sergey Machine learning algorithms predict soil seed bank persistence from easily available traits
15:00 16 Zhu, Jinlei Density-dependence of fecundity and seed dispersal profoundly alters the spread of plant populations
15:15 17 Koubek, Tomas Shoot senescence in herbaceous perennials of the temperate zone

15:30 coffee break

16:00 18 Millan, Mathieu Plant architecture can improve predictions of flowering thresholds in savanna woody species
16:15 19 Rauschkolb, Robert Flowering leaf phenology are more variable and stronger associated to traits in herbaceous compared to tree species
16:30 20 Ferenc, Viktoria Legume presence affects how traits determine fitness responses
16:45 21 Harris, Timothy Herbs´ hidden biomass: rhizome size and its environmental correlates
17:00 22 Klimešová, Jitka Is root-sprouting ability enabled by a low auxin to cytokinin ratio?

SESSION 3 continued ENVIRONMENTAL HETEROGENEITY, PLANT DIVERSITY AND INVASION

17:15 23 Wei, Guanwen Soil heterogeneity tends to promote the growth of naturalized aliens when competing with native plant communities
17:30 24 Chen, Duo Plant-soil-feedback-mediated invasional meltdown may depend on community diversity

18:00 - 20:00 meet the keynote

May 21th (Saturday) Aula Magna UNIBZ

SESSION 5 chairStefan Zerbe ENVIRONMENTAL POLLUTION, RESTORATION AND CONSERVATION

09:00 Keynote Florian Jansen Changes of species distribution and abundance in Germany derived from legacy observational data

09:45 25 Shemesh, Hagai Doing more harm than good: when short-term responses don't predict the long-term consequences of a conservation management action
10:00 26 Bucher, Solveig Franziska Plant ecophysiology as a tool to judge the success of ex situ conservation — a case study of *Minuartia smejkalii*
10:15 27 March Salas, Martí Climbing affects cliff-plant communities by reducing species diversity and altering species coexistence patterns

10:30 coffee break

11:00 28 Iberl, Katerina Restoration of calcareous grasslands by recolonization after forest clearing and its impact on the genetic variation of three common herb species
11:15 29 Wang, Min Dynamics of plant diversity during restoration of roadside slopes following large-scale construction work in the Western Sichuan Plateau
11:30 30 Tomiolo, Sara Effects of plastic fragment size and concentration on plant performance are mediated by soil properties and water availability

11:45 farewell, prizes
12:15 lunch
13:00 - 19:00 excursion Inneralpine Vinschgau Valley - Val Venosta

POSTERS

poster session I (genetics and evolution)

1 Büse, Silas Evolutionary responses in *Onobrychis viciifolia* to four generations of contrasting precipitation predictability: shifts in mean traits and inter-individual variation

2 Latzel, Vít The role of DNA methylation in transgenerational adaptation of (a)sexual offspring of *Fragaria vesca* to future climatic conditions

3 Lampei, Christian *Epilobium angustifolium* shows increasing maladaptation to south-western common garden with increasing latitude and longitude of origin

4 Voisin, Camille From idiosyncratic to general phylogeographic patterns in the Eastern Alps. A comparative study of beech forest understorey species

5 Höfner, Johannes Effects of sampling design on patterns of genetic variation of grassland plants across seed transfer zones in Germany

6 Durka, Walter RegioDiv: Assessment of plant genetic variation as a basis for seed zone design in Germany

7 Iberl, Katerina Restoring populations of the endangered plant species *Myricaria germanica* by reintroduction – is there an impact on genetic variation?

poster session II (all other sessions)

8 Klimešová, Jitka How belowground traits may affect ecosystem function

9 Schnablová, Renáta Vegetative preformation of overwintering buds as a potential source of phenology variation of temperate herbs

10 Thakur, Dinesh Are climatic effects on twig economic traits similar to leaf economic traits?

11 Guo, Yaolin Large-scale geographic variation in litter chemistry and palatability to detritivores in a widespread invasive plant versus its native competitor

12 Dostálek, Tomáš Spatial variability in plant-soil feedback

13 Canessa, Rafaella Plant responses to nutrient and drought limitation across a climate gradient in Chile

14 Bucher, Solveig Franziska Artificial Light pollution at night (ALAN) affects plant performance and abundance

15 Bhatt, Tarun Role of jasmonate in plant-microbe interactions and plant stress resistance

16 Amputu, Vistorina Mapping rangeland condition indicators in arid savannahs using drone technology

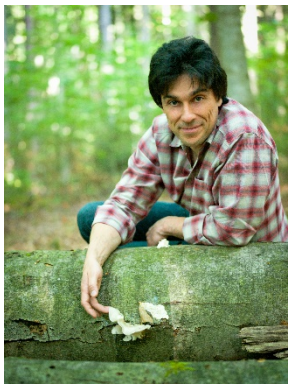
17 Wódkiewicz, Maciej Evaluating eradication feasibility with USEF

18 Riemenschneider, Adriana Spatio-temporal variation of natural pest control in pesticide-free winter wheat compared to conventional and organic cropping systems

19 Rathore, Nikita Variation in root exudation is linked to phylogeny and explained by plant root traits

KEYNOTE SPEAKERS

***Bässler Claus** - Fungal functional ecology - towards a deeper understanding of fungal diversity



Compared to the plant and animal kingdom, fungi were the forgotten organisms in macroecology for a long time. However, due to recent efforts to compile large-scale citizen science data and metabarcoding approaches, data are now available to address pressing macroecological questions. Further, recent efforts to assign fungal life-history traits to thousands of species and the availability of mega-phylogenies allows approaching the question, “what are the underlying mechanisms that explain large scale fungal diversity pattern.” However, well-selected lab and real-world experiments are complementarily needed to improve our understanding of species diversity patterns. In this talk, I will highlight the state-of-the-art of fungal diversity patterns at different spatial scales and how trait and phylogenetic information of species could help to increase our mechanistic understanding of fungal diversity patterns. These models finally aim to predict the consequences of fungal diversity patterns and related ecosystem processes in times of land use and climate change. Finally, I will provide an outlook on the next consequent steps to learn more about fungal diversity in a rapidly changing world.

***Bucharova Anna** - Seeding the future: Evolutionary perspective on seed based ecological restoration

Restoration of degraded habitats is an indispensable tool for combatting the current biodiversity crisis. As degraded habitats often lack plant diaspores, successful terrestrial restoration commonly requires introduction of plant seeds from other sources. During the seed production and restoration seeding, plants repeatedly face novel environments, which provides an excellent opportunity to study rapid adaptation.

Restoration seeds are collected in the wild and either directly used in restoration, or propagated on seed farms to increase their amount. However, agricultural propagation imposes a specific selection pressure which shifts plant trait distributions towards larger size and synchronized flowering – in parallel with domestication syndrome in crops. Fortunately, these changes are rather small, affect only fraction of cultivated species, and do not reduce plant adaptation to stress. The plants from farm-produced seeds even show signs of regional adaptation, suggesting that their natural integrity is largely maintained through the cultivation process.

Restoration seeds are sown to degraded or destroyed habitats whose soils, water regime or management typically differ from the conditions at natural sites. We have shown that some species adapt to such new conditions; for example, plants from restored grassland flower earlier and have stronger clonal propagation than conspecifics from natural grasslands that served as the seed source for the given restoration project. Such rapid adaptations may contribute to species persistence at restored sites and ultimately to restoration success.

***Jansen Florian** - Changes of species distribution and abundance in Germany derived from legacy observational data

Despite a lot of evidence from ecological experiments and case studies as well as a long tradition of expert knowledge (Red Lists) regarding regional and supra-regional species trends and threads, spatially explicit data about the development of distribution and abundance of biota in Central Europe is rare. This is based not least on the fact that national biodiversity monitoring programs started late (Switzerland and others) or not at all (Germany). We started a project in 2017 to explore the possibilities to derive quantitative biodiversity trends from heterogeneous legacy data available in Germany. The talk will inform about results, methodological approaches, and remaining difficulties, as well as our efforts to correlate the trends with drivers, not at least to inform the policy.

***Scheepens Niek** - The resurrection approach: case studies and general aspects

Climate change may cause rapid evolutionary changes in plant populations. The resurrection approach, in which plants raised from ancestral seeds are compared with plants raised from descendants of the same population, is a powerful and direct method to reveal evolutionary changes over time and can therefore be used to investigate how recent environmental dynamics affect rapid evolution. I will show that conventional seed banks are a valuable source of ancestral propagules for resurrection studies. Furthermore, I will provide evidence from resurrection studies that rapid evolutionary changes took place in various plant species across Europe, possibly as adaptive response to climate-change related environmental changes. Finally, I will show how resurrection ecology can adopt classical methods from experimental plant ecology and modern molecular techniques to increase our understanding of rapid evolutionary processes.

***Trucchi Emiliano** - Common bean domestication genomics and implication

Since the early onset of domestication of crops, farmers selected desirable phenotypic traits while leading domesticated populations through several more or less gradual demographic contractions. As a collateral effect, wild genetic variation is typically lost in modern cultivars, making them highly susceptible to pathogens, pests and environmental change. However, this perspective is now being challenged by recent insights from genomics of modern and ancient crop samples suggesting a different and more complex process. Analysing the temporal dynamics of genetic variation and selection during the domestication of the common bean in the southern Andes, we show that most domestic traits were selected for before 2,500 years ago, with no or only minor loss of whole-genome diversity. A plausible explanation of this decoupling of selection and genetic erosion is that early farmers applied a relatively weak selection pressure by using, as parents, genetically diverse individuals showing some phenotypic traits of interest in common. Similar results in other crops support such an alternative scenario during ancient domestication, while indicating that more recent selection strategies (during the past few centuries) more intensively reduced genetic variation within cultivars and produced further improvements by focusing on a few plants carrying the traits of interest at the cost of marked genetic erosion.

SPEAKERS

Baric Sanja - Genetic diversity of European chestnut trees in South Tyrol (northern Italy)

Scaiattolini, Federico; Free University of Bozen-Bolzano (Master's student)

Baric, Sanja; Free University of Bozen-Bolzano (presenting author)

The European chestnut (*Castanea sativa* Mill.) is the third frequent permanent culture in South Tyrol (Autonomous Province of Bozen-Bolzano, Italy) that provides vital ecosystem services and an important additional income to many farmers. Despite the growing interest for chestnut tree cultivation, there is no data available about the genetic diversity of *C. sativa* in this region. The objective of the present study was to perform a molecular genetic characterization of chestnut trees planted over different centuries in South Tyrol. Leaf samples of 115 *C. sativa* trees were collected all over the chestnut growing area and microsatellite DNA analysis was performed at eleven loci. A total of 86 genotypes were found among the analyzed chestnut trees and the geographical districts of Eisacktal-Valle Isarco and Vinschgau-Val Venosta harbored the highest degrees of genetic variability. A Bayesian structure analysis revealed the presence of two major groups of genotypes, which can be assigned to the highly diverse chestnut cluster and the rather homogeneous Marroni cluster. The presence of intermediate genotypes pointed to the admixture between the two clusters, which was further supported by parentage analysis. The study provided an insight into the temporal and spatial genetic diversity of *C. sativa* in South Tyrol, which can be regarded an important resource for the development of conservation strategies for this tree species.

Bucher Solveig Franziska - Plant ecophysiology as a tool to judge the success of ex situ conservation — a case study of *Minuartia smejkalii*

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Münzbergová, Zuzana and Pánková, Hanka, Institute of Botany, Academy of Sciences of the Czech Republic

Minuartia smejkalii is a serpentinophyte species which is endemic to Czech Republic. Currently, there are to occurrences remaining in the wild and ex situ conservation efforts are being made via cultivating the plant species in private gardens in the vicinity of the occurrences. However, plants growing in ex-situ cultivation may adapt to the ex-situ condition, and thus lose adaptations to the original sites. We attempted to reduce such efforts by cultivating the plants on artificial serpentine rocks created in the gardens. Still, other conditions may differ between the gardens and natural sites. Thus, in this project we aimed to monitor the fitness and adaptations of the ex situ conservation sites of *M. smejkalii* as well as the populations still occurring in the wild. We studied 21 ex situ conservation sites as well as the two sites where *M. smejkalii* is still occurring in nature. Specifically, we studied plant functional traits linked to ecophysiology of the species, which pose a minimum disturbance for the plant individual including plant height, specific leaf area, chlorophyll fluorescence (Fv/Fm, a measure of plant stress and PIabs, a measure of plant performance) as well as chlorophyll content. We also monitored the abiotic site conditions, as the sites strongly differed in terms of habitat characteristics. We found that the plant populations differed between gardens and natural populations. The plants in the natural sites were bigger, indicating a competitive advantage, they had a higher chlorophyll content and were less stressed (as seen by a higher Fv/Fm) and had a higher performance (assessed via PIabs) than plants growing in gardens. The natural populations were much more stressed than garden populations and therefore light availability was lower, which might affect the performance. Assessing ecophysiological performance of plants in ex situ conservation can be a tool to predict the establishment success, develop and fine-tune management plans and thus to improve plant vitality in the gardens to ensue the survival of endangered plants like *M. smejkalii* in the long term.

Chen Duo - Plant-soil-feedback-mediated invasional meltdown may depend on community diversity

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It has been suggested that establishment of one invader might promote further invasions. Not only alien but also native plants can expand their populations and invade new locations within their native range. However, whether this might be mediated by soil-legacy effects has not been explored yet. Here, we conducted a two-phase plant-soil-feedback experiment. In a soil-conditioning phase, we grew five alien and five native species as invaders in 21 communities of one, two or four species. In the subsequent test phase, we grew five alien and five native invaders on the conditioned soils. We found that growth of these invaders was negatively affected by soils conditioned by both a community and an invader, and particularly if the previous invader was a conspecific (i.e. negative plant-soil feedback). Subsequent alien invaders benefited from previous allospecific alien invaders through soil-legacy effects, but this benefit decreased when the soil had been co-conditioned by a multi-species community. Our findings suggest that plant-soil-feedback-mediated invasional meltdown may depend on community diversity, which provide some evidence that diverse communities could increase resistance against subsequent alien invasions.

Keywords

alien species, coexistence, diversity-invasibility, native invader, soil legacy, subsequent invasion

Ferenc Viktoria - Legume presence affects how traits determine fitness responses

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Brendel, Marco R.; Sheppard, Christine S. University of Hohenheim, Institute of Landscape and Plant Ecology

Facilitation has been a long-neglected type of species interaction but received more attention recently. A functional group well-known for facilitative interactions are legumes, as one of their key traits—nitrogen fixation—makes them an important group to consider in the context of species interactions. Facilitative interactions may also be an important factor for biological invasions, and thus should receive more attention especially in the light of increasing numbers of alien species. We set up a common garden experiment using 30 alien Asteraceae species in communities with or without legume presence. We measured functional traits, performance, nitrogen concentration and δ15N in Asteraceae and two native community species (phytometer). Thus, we investigated 1) how Asteraceae performance can be explained by functional traits; 2) how functional traits and performance relate to nitrogen concentration of Asteraceae; and 3) whether legume presence affects native phytometer, neophyte and archaeophyte Asteraceae differently. We found SLA to have a negative effect on aboveground biomass and seed production, with a stronger effect in communities without legumes. Nitrogen concentration in leaves (as an approximation of nutrient uptake) was positively correlated with biomass in both communities and could be explained by height and SLA. Considering nitrogen concentrations and δ15N, we could not detect any effects of legume facilitation across the 30 alien focal species. However, in the leguminous community, we found increased nitrogen concentration and showed direct legume facilitation in native phytometer species but only when growing with archaeophyte focal species, not in the presence of neophytes. This hints at varied mechanisms of competition for nitrogen between natives and alien species of different residence time and deepens the understanding of facilitative leguminous effects in alien species presence.

Keywords

Facilitation, legumes, alien species, functional traits, common garden pot experiment

Fischer Felicia - Seasonal beta-diversity of dry grassland vegetation: divergent peaks of biomass and species richness

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Chytrý, Kryštof, Prokešová, Helena, Chytrý, Milan, Těšitel, Jakub

Question: Temperate grasslands are known for high plant diversity and a marked seasonality. However, the intra-annual community dynamics are still largely overlooked by community ecologists. Therefore, we explored the pattern of seasonal alpha- and beta-diversity and their relationships to primary productivity in temperate dry grassland.

Location: Pavlov Hills, SE Czech Republic.

Methods: We monitored the species composition of a rocky steppe vegetation (*Festucion valesiacae*) in monthly intervals for one year using 42 permanent plots of 0.25 m2. We explored the community seasonal beta-diversity based on species presence/absence and biomass-estimate data. The beta-diversity was partitioned into the turnover and nestedness components and their quantitative counterparts: balanced changes and abundance gradients.

Results: We identified a pronounced seasonal pattern of biomass, species richness, and composition. The total community biomass was highest in June, with its peak accounting for only 60% of the total annual productivity. However, the peak of species richness occurred in March (80% of the total annual species number). Accordingly, nestedness and abundance-gradient patterns differed in the spring months, while seasonal turnover and balanced changes in abundance were generally congruent. Annual, short-lived, and perennial species displayed different seasonal patterns of species richness and biomass production, although a strong increase in abundance and a peak in species richness in spring were universal across the community.

Conclusions: Seasonal climatic constraints of plant growth represent the main determinants of primary productivity dynamics. Plants adapt to these constraints by adjusting their life cycles in different ways. In dry grasslands, the complexity of plant responses to climatic seasonality can result in seasonal beta-diversity pattern with divergent peaks of species richness and standing-crop biomass.

Keywords

beta-diversity, biomass, dry grassland, permanent plots, plant community, primary productivity

Franke Luise - Promoting functional plant diversity in agricultural landscape

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Arable ecosystems, and especially arable plants, have experienced a drastic loss of diversity in the past years due to intensification of agriculture. Facing those problems, agricultural areas have moved into the focus of conservation measures. This led to the establishment of agro-environmental schemes, aiming to provide habitat and resources for farmland biodiversity. While their effects on faunal diversity are well researched, their potential to promote rare agricultural flora is poorly investigated. The Hohenheim Biodiversity Experiment (HoBE) explores the conservation value of diversifying field margins by applying management practices with different disturbance intensity and timing of disturbance. In a blocked experimental design, six treatments (Control, Flower Strips, Early Tillage, Late Tillage, Sand) are applied at two spatial scales. Here, we investigate the temporal dynamics of functional diversity and functional community composition of the field margin vegetation in the first two years of the HoBE experiment. We characterize community dynamics based on 12 functional traits, indicating competitive ability and response to disturbance: Grimes CSR strategy, life span, phenological traits (start of flowering and flower duration), Ellenberg's indicator values for nitrogen, moisture and light requirement, SLA, plant height and seed mass. Treatments were expected to act as environmental filters on functional diversity, resulting in changes of community weighted mean trait values (CWM) and trait variability, measured as community weighted standard deviations (CWSD). We investigate how the temporal dynamics of functional diversity and functional community composition (CWM and CWSD of functional traits) depend on treatment and scale. The temporal dynamics of functional richness at plot-level (alpha diversity) depended on treatment. In most treatments, alpha diversity decreased over time. Looking at the temporal dynamics of individual traits, generally, CWM trait values became more similar between treatments over time, while trait variability (CWSD) increased. Consequently, functional dissimilarity between plots (beta diversity) and functional richness at the block scale (gamma diversity) decreased over time. Functional diversity indices did not depend on the scale of treatment application. This suggests that external drivers and processes of early community assembly act more strongly on functional community composition than the filters applied by the treatments. We conclude that treatment and time are the main determinants of functional community composition, while scale plays a minor role. Our experiment thus yields new insights into the potential of agri-environmental schemes to promote the functional diversity of arable plants while highlighting the crucial role of effective management regimes.

Keywords
arable plants, community composition, functional diversity, functional traits

Harris Timothy - Herbs´ hidden biomass: rhizome size and its environmental correlates

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Across the diversity of angiosperms, plant size and plant ecological strategy both influence the proportion of total plant biomass allocated to different organs. Effect of plant size on biomass allocation is well studied and multiple explanations have been given for discontinuities in the corresponding scaling relationships. However, explanations have rarely referred to the effects of herbaceous perennation strategies or perennating organs on biomass allocation. To begin filling this evidence gap, we consider biomass allocated by perennial herbs to rhizomes – the most common perennating organ in temperate herbs and an organ that can be reliably distinguished. For rhizomatous herbaceous plants we ask: i) what is the proportion of total biomass allocated to rhizomes and ii) what are the potential drivers of interspecific and intraspecific variation in allocation to rhizomes. We refer to the few existing studies that have measured biomass allocation to all organs of rhizomatous herbs when considering our first question. To elucidate interspecific differences, we refer both to published literature and our own experimental data. Intraspecific variation in biomass allocation is identified using our measurements of wild-collected rhizomatous herbs from the Czech Republic. We observe that, on average, rhizomes make up 30% plant biomass. We find plants experimentally grown from seed to have a lower rhizome biomass than wild collected plants. We identify soil moisture as a potential driver of intraspecific differences amongst plants collected in the wild. Our interpretation considers the multiple functions performed by rhizomes: storage, horizontal expansion and connection of aboveground stems to fine roots. The substantial biomass allocated to this organ indicates its importance, but measurements from a greater range of species are required to elucidate the full effect of perennial ecological strategies on biomass allocation.

Keywords

perennial, clonal organ, allometry, ecological gradient, belowground

Herol Lior - The effect of ectomycorrhizal fungi on the response of Aleppo pine seedlings to drought and competition by a grass

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Tree seedling establishment is a crucial stage in forest dynamics. Establishing seedlings need to cope with challenges such as competition from herbaceous vegetation and drought. Since many forest ecosystems rely on mutualistic relationships, the effect of drought and competition on such interactions can play a key role in forest response to climate change. Stressful conditions can alter mutual relationships, resulting in new interactions along the continuum between mutualism and parasitism. We carried out a greenhouse experiment testing the effect of drought conditions and competition with grasses on the obligate mutualism between ectomycorrhizal fungi and Aleppo pine seedlings. As expected, pines that germinated in the presence of the ectomycorrhizal fungal spores had greater biomass. However, we found that under drought and/or competition, the positive effect of the ectomycorrhizal fungi on biomass was eliminated. Ectomycorrhiza also had a positive effect on the number of side branches. Unlike biomass, this positive effect was maintained under single stress conditions and was eliminated only under the combination of competition and drought. It therefore seems, that the value of the mutualistic interaction for the pine seedlings, is dependent on external ecological conditions. These results highlight the importance of examining the role of mycorrhizal mutualisms under ecologically relevant conditions.

Keywords

drought, competition, Mycorrhiza

Iberl Katerina - Restoration of calcareous grasslands by recolonization after forest clearing and its impact on the genetic variation of three common herb species

Katerina Iberl & Christoph Reisch

Species-rich calcareous grasslands strongly declined during the 20th century due to drastic land use changes. Many grasslands were converted into more productive pastures or are covered by shrubs or forests today, since they were overgrown after abandonment or afforested. Restoration of calcareous grasslands by shrub or forest clearing and subsequent recolonization of grassland species from adjacent grasslands is, therefore, an important conservation approach. Restored populations of calcareous grassland species may, however, differ from their source populations in genetic diversity and differentiation due to potential founder and bottleneck effects.

In our study we analysed, therefore, the impact of restoration by forest clearing and natural recolonization on the genetic variation of three common calcareous grassland species without persistent seed bank (*Agrimonia eupatoria*, *Campanula rotundifolia*, and *Knautia arvensis*) in South-Western Germany. We used molecular markers (AFLPs) to compare genetic diversity within and differentiation among historically old source populations and restored populations, which have been re-established during the 1990ies.

Molecular markers revealed broadly similar levels of genetic diversity in source and restored populations of the study species. Only *Agrimonia eupatoria* exhibited higher diversity in restored populations. Genetic differentiation among source and restored populations was not significant, indicating strong gene flow among the populations. Our study underlines, therefore, that restoration of calcareous grasslands by natural recolonization after forest clearing is an efficient method to re-establish genetically variable populations comparable to their source populations.

Karitter Pascal - A resurrection study reveals evolutionary changes in *Leontodon hispidus* after two decades of increasing temperatures and water scarcity

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Due to climate change, plant populations are facing increasing temperatures and water scarcity. To avoid extinction, populations must adapt to these novel conditions either plastically or through rapid evolutionary changes. In this study, we applied the resurrection approach to investigate evolutionary changes in ecologically important phenotypic traits and trait plasticity in a population of the perennial herb *Leontodon hispidus*. We revived ancestors from stored seeds and descendants sampled 23 years apart from the same population. After a refresher generation to reduce maternal effects, we germinated seeds under high (control) and low water potential to simulate strong water scarcity during this important life cycle stage. Subsequently, we cultivated the seedlings under 25°C and 30°C ambient temperatures respectively and measured morphological traits as well as flowering phenology. During the flowering stage, we ceased irrigation and recorded the time until wilting. Generally, descendants flowered earlier than ancestors and responded plastically to the water scarcity treatment during germination with an even earlier flowering compared to ancestors which tended to delay their onset of flowering. Descendants also survived the irrigation withdrawal during flowering longer than ancestors in the 30°C treatment, but survived as long as the ancestors in the 25°C treatment. Our results provide strong evidence that the study population of *L. hispidus* has evolved over the last 23 years in ecologically important phenotypic traits and their plasticity, including the persistence under extreme drought conditions. Earlier flowering is very likely a strategy to accelerate the life cycle to escape increasingly unfavourable environmental conditions. This study also provides valuable insights into the effects of water scarcity during germination on later life cycle stages and their interactions with ambient temperatures and on evolutionary processes. Finally, we demonstrate that the resurrection approach is also a suitable method to study rapid evolution in perennials and can be combined with multiple treatments to provide new insights into evolutionary change and plant responses.

Keywords

Climate change; Common garden experiment; Drought stress; Phenotypic plastic; Rapid evolution

Koubek Tomas - Shoot senescence in herbaceous perennials of the temperate zone

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Perennial herbaceous species form their aboveground parts every year anew and discard them before the advent of winter. The senescence of aboveground structures is thus an inevitable part of their life cycle. This is also a key process that determines photosynthetic gain late in the season and the economy of soil-borne nutrients.

Here we address patterns and drivers of the shoot senescence of perennial herbaceous plants. We present a comparative study of 231 temperate species, ranging from spring ephemeroids to species senescing in late autumn, in a common botanical garden collection. We assessed senescence by measuring size decline in the autumn part of the season.

There were two main directions of variation in senescence trajectories: the pace-date axis, separating early and fast senescing species from late and slowly senescing species, and the shape- asynchrony axis, separating species with accelerating and synchronised senescence from constant senescence asynchronous among individual shoots. While accelerating senescence late in the season can be due to passive effects of the environment (e.g. frost), accelerating senescence early in the season is likely to be an indication of an active process driven by the enzymatic activity of the plant.

The pace and shape of shoot senescence were associated with both leaf- and shoot-level traits. Species having leaves with high dry matter content senesced linearly and with higher asynchrony. Species with a larger specific leaf area senesced earlier and faster, while tall plants and plants with monocyclic shoots senesced later and in a more synchronous and accelerating manner.

Species from different habitats varied in their senescence patterns. Forest species postpone their senescence relative to open-habitat species, presumably to boost their photosynthetic balance. We did not confirm the hypothesis that plants from nutrient-poor habitats senesce earlier to retain soil-borne nutrients before the winter.

Shoot senescence in herbaceous plants is a neglected phenomenon in its own right, which bears only superficial similarity to autumn leaf shedding in trees. Individual species differ strongly in the pace, shape and synchrony of their senescence trajectories, with a potential bearing on the carbon and nutrient dynamics of their habitats.

Keywords

senescence pace and shape, SLA, LDMC, habitat productivity, disturbance frequency

Livne-Luzon Stav - The ectomycorrhizal community composition of *Pinus halepensis* and *Cedrus deodara* and how it changes with host age

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The mutualistic interaction between trees and ectomycorrhizal fungi (EMF) can have a major effect on forest development, especially on the establishment of young seedlings. Both the age of the host tree and its identity are known to separately affect its EMF community richness and composition. Here, we compared the EMF community composition associated with the roots of young saplings and mature trees of co-habiting *Pinus halepensis* and *Cedrus deodara* using advanced molecular identification of fungal species. We found that host age had a major effect on EMF community richness, while host identity mostly affected community composition. Young cedars and pines were associated with similar EMF communities, while mature trees tended to have more distinct EMF communities. Moreover, we found that the proximity to a specific host species had a significant effect on the community composition of young saplings, suggesting that the dynamics of the EMF community are greatly determined by the current distribution of mature trees in the forest.

Keywords
Community composition; Fungal community; Fungal traits; Host diversity; Host traits

Lukic Natasa - Antioxidative mechanisms in transgenerational drought and waterlogging stress memory

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Drought and waterlogging can induce changes in the abundance and distribution of plant species, which may cause shifts in plant community and composition. A transgenerational stress memory transmitted from parents to offspring plants might be a key strategy for plants to rapidly adapt to changing environmental conditions. However, transgenerational adaptive effects and underlying mechanisms in response to waterlogging are still unclear. Further, research on transgenerational cross-stress tolerance, pre-adapting offspring to any stress when maternal plants experience stress, is largely missing. We conducted a full-factorial pot experiment over two generations, using four perennial plant species (*Plantago lanceolata* L., *Bellis perennis* L., *Alopecurus pratensis* L. and *Trifolium pratensis* L.). Maternal and offspring plants were subjected to waterlogging, drought and mesic (control) conditions. We hypothesized that offspring experiencing the same type of water stress (irrespective of stress type) as their mother, perform better. We found increases in offspring fitness, such as biomass, leaf number and reproductive output in offspring experiencing the same stress conditions as their mothers (transgenerational adaptive effects). On the other hand, we did not detect cross-stress memory. Transgenerational adaptive effects were strongly linked to an upregulation of antioxidative enzymes (superoxide dismutase, peroxidase and catalase) and non-enzymes (phenolic compounds) in offspring experiencing the same water conditions as their mothers, reducing the oxidative injury in offspring. Our research provides evidence for a transgenerational waterlogging and drought memory and links this to underlying photosynthesis- and redox-related mechanisms. Transgenerational adaptive effects acting on the antioxidative system might therefore contribute to “rapid evolution” in the face of environmental change.

March-Salas Martí - Climbing affects cliff-plant communities by reducing species diversity and altering species coexistence patterns

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Cliffs are unique ecosystems with an outstanding but relatively unknown plant diversity, harboring rare and endemic species, including threatened species, but also dominant species. Historically, cliffs have been highly inaccessible to humans but the rising popularity of climbing represents an increasing threat to cliff biota, potentially diminishing diversity and species associations, which may ultimately affect the community composition. We used a closely paired sampling design to differentiate plant species abundance, cover, diversity, associations and community composition in climbed and unclimbed plots. To do so, we established a case-control sampling quadrat at different heights of the cliff face along twelve routes with different climbing intensities in Potrero Chico (Nueva León, Mexico). Diversity indices on the sampled cliffs show high diversity, even greater to that in other regional ecosystems. We found reduced abundance, cover, and diversity in climbed plots, irrespective of the climbing intensity. In terms of abundance, dominant species were greatly negatively affected by climbing, but some locally rare species, comprising endemics and endangered species, were entirely absent from climbed plots, anticipating a potential species loss due to climbing. Co-occurrence analysis showed that the number of associations between pairs of species were greatly reduced in climbed plots, and that positive associations between locally rare species existed in unclimbed plots but not in climbed plots. Finally, NDMS analysis revealed that the community composition significantly changed due to climbing. This indicates that climbing alters the cliff-vegetation assemblage and reduces the number of positive associations, especially between pairs of dominant and pairs of rare species, which may contribute to the disappearance of endemic and threatened species. Our study thus shows that cliff species diversity and species coexistence are disturbed by climbing activities, potentially affecting ecosystem stability and functioning. Therefore, under increasing human pressures, conservation actions to preserve cliffs' biodiversity should focus on all species, whether dominant, common or rare.

Keywords

Cliff ecosystems; Dominant & rare species; Human disturbance; Species co-occurrence

Martínková Jana - Is root-sprouting ability enabled by a low auxin to cytokinin ratio?

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There are two independent evolutionary pathways to clonality. The first pathway is based on stem derived clonal growth organs, e.g. stolons and rhizomes, the second one on adventitious sprouting from roots. Adventitious sprouting from roots is rare and often triggered by injury. It was hypothesised that sprouting from roots is enabled by hormonal imbalance, specifically by a low auxin to cytokinin ratio. Auxin is produced by aboveground plant parts and when a plant loses them due to disturbance remaining plant fragment contains a relatively higher concentration of cytokinin than auxin. Nevertheless, there are root-sprouting plants that sprout from roots spontaneously without being injured and we tested question whether it is enabled by naturally low auxin to cytokinin ratio. In a greenhouse pot experiment, we analysed growth parameters, root-bud development, aerobic root respiration and phytohormone profiles of two closely related clonal herbs that differ in root-sprouting ability (root-sprouting *Inula britannica* and rhizomatous non-root-sprouting *Inula salicina*) either exposed to severe biomass removal or not. We confirmed root-sprouting ability only in the previously reported root-sprouting species *I. britannica*. Phytohormones differed between root-sprouting and non-root-sprouting species significantly even in control non-injury conditions. In root-sprouting species, the auxin to cytokinin ratio was low and injury further decreased it. Root sprouting species also produced root buds before it was injured and injury did not affect this ability. Our results suggest that intrinsic phytohormone regulation is behind the ability of root-sprouting. Injury is less important, at least in the spontaneously root-sprouting species *I. britannica*.

Keywords

auxin/cytokinin ratio, biomass, buds, disturbance, phytohormones, root respiration

Millan Mathieu - Plant architecture can improve predictions of flowering thresholds in savanna woody species

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Assessing plant reproductive onset is essential to better understand and predict population structure and dynamics. Reproductive onset of woody plants can be estimated using plant size measures (e.g., height-diameter scaling relationships). While this method is reliable in forests, it underperforms in disturbance-prone biomes, such as savannas. Therefore, there is a need to identify trait(s) that could allow the estimation of flowering thresholds (e.g., onset and large amount of reproductive structures) tailored for savanna woody species to be incorporated in population analyses. Plant architectural traits, e.g., the number of forks, that are used in forestry for evaluating life stages, can constitute an effective tool. However, despite the potential relevance of forking, it has been neglected in ecology and has never been related to the production of flowers. Here, we explored this avenue by analysing 1) scaling relationships between forking, flowering, resprouting and size-related traits (height and basal diameter) in a common and abundant savanna woody species, and 2) general significance of forking in modulating flowering thresholds in eight of the most common savanna woody species. We studied scaling relationships for 200 individuals of *Senegalia nigrescens* in one savanna site within Kruger National Park using linear regressions. We then tested the general application of forking by expanding to 1546 individuals belonging to eight woody species, across multiple sites within and surrounding Kruger National Park. For this multi-species analysis, we examined correlations between forks and flowering using logistic regressions.

We revealed that *S. nigrescens* individuals need at least one fork before they can start flowering, and that there are no sterile individuals having three or more forks. We also found that a minimum of three forks is required before individuals can start producing large amount of reproductive structures. These results were confirmed by the multi-species analysis. Indeed, the logistic regressions indicated that flowering thresholds could be reliably predicted using the number of forks. For the eight savanna species, the flowering onset averagely initiated at four forks, and at five forks individuals could start producing large amount of reproductive structures. The identified forking thresholds in woody species' structure before flowering may indicate 1) decreasing in apical dominance required by the branched system to release flowering shoots, and 2) increasing number of receptive meristems sensitive to signals necessary for flower initiation. Forking represents an easy-to-measure trait yet able to convey key ecological information which can facilitate predictions of population dynamics in disturbance-prone biomes.

Keywords

Flowering onset; Flowering thresholds; Forking; Plant architecture; Savanna; Scaling relationships

Moncalvillo Belén - Host age strongly affects the performance of the root hemiparasitic plant *Rhinanthus alectorolophus*

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Root hemiparasitic plants are generalist parasites that can use a wide range of plant species as hosts by invading their roots and extracting nutrients from them. Some hemiparasites are noxious weeds in crops while others are ecosystem engineers which can promote biodiversity in grassland communities. Large differences have been reported in hemiparasite performance depending on host species identity, but the concrete traits underlying host quality are still little understood. Host age and size could be important determinants of host quality, as they influence the amount of resources that might be extracted by the parasite and the strength of competition for light between parasite and host. We grew the annual hemiparasite *Rhinanthus alectorolophus* with five different hosts planted at six different times: ten, four and two weeks before the parasite, at the same time as the parasite and two and four weeks after the parasite. Hemiparasites and hosts were separated in half of the pots to exclude competition for light. *R. alectorolophus* grew best with hosts planted at the same time or slightly earlier, while growth was much poorer with older hosts or those planted later. Growth of very young hosts was strongly suppressed by the hemiparasites, indicating successful parasitism, although the parasite did not profit from growing with them. These small hosts apparently provided few resources to the parasites. The final performance of the parasites was negatively related to the size of the hosts two weeks after parasite planting, while above-ground separation did not influence parasite growth. The low quality of old hosts could thus not be explained by light competition. Possible factors preventing the successful use of older hosts by the parasites include restricted space for the growth of parasite roots, more strongly defended host roots, or increased competition by the hosts shoots for resources taken up by host roots. Our findings show that interactions between hemiparasitic plants and their hosts depend not only on host species identity but also on the phenological state and vigour of the host, which could also influence the role of hemiparasites as ecosystem engineers.

Keywords

plant-plant interactions, host selectivity, host quality, light competition

Münzbergová Zuzana - Rapid evolution in populations of a long-lived dominant grass species *Festuca rubra*

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Rapid evolution in response to climate change is an important mechanism helping organisms to adapt to changing climate. While such a potential has been repeatedly demonstrated in short lived organisms such as various microbes, to what extend we can observe it in long-lived species is largely unknown.

We used long-lived clonal hexaploid grass Festuca rubra growing along precipitation and temperature gradients in Norway as a model. We transplanted seed mixtures produced at single localities to original localities and to localities with climate changing in the direction and degree of predicted climate change for the region (to warmer, wetter and warmer-wetter sites). All localities received seeds originating from the same maternal plants in identical proportions. We assessed trait and genetic composition of established plants after 3 years.

The traits of plants which established in the given conditions have converged towards traits of plants which originate in the given environment. Similarly, the genetic data indicated that genotypes established in the same conditions have specific sets of genes independent of seed origin. Both these datasets indicate that environment can select genotypes best suited to local conditions. This suggests that even long-lived organisms can undergo rapid evolution allowing them to adapt to novel climates. Such rapid adaptation was possible thanks to high genetic diversity of populations of the species, providing sufficiently large pool of genotypes from which to select.

Keywords

rapid evolution, climate change, alpine grasslands, plant physiology, genotype selection

Rauschkolb Robert - Flowering leaf phenology are more variable and stronger associated to traits in herbaceous compared to tree species

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We present a case study of the PhenObs network that focuses on the phenology of herbaceous species, which are largely underrepresented in phenology research as it is mainly focused on trees and shrubs so far. More specifically, the aim of this network is to link phenology and traits for a better understanding of phenological events and shifts in response to environmental conditions and climate change. In this study we investigated how different phenological events during the annual life-cycle of plants from leaf-out to senescence differ between herbaceous and woody species and how they interact with functional traits.

To answer these questions, we recorded multiple generative and vegetative phenological stages of 21 herbaceous and 19 woody species in the Botanical Garden of Jena during the growth period in 2021 following the protocol of the PhenObs network. We further measured several functional traits for which relationships to flowering phenology have been found in comparable studies (vegetative height, specific leaf area, leaf dry matter content, leaf thickness, leaf chlorophyll content and stomatal pore area). To assess whether herbaceous and woody species differ in the timing of phenological stages, we used Welch's two-sample t-test and Bartlett's test. To investigate whether the relationship between phenology and traits are consistent between the growth forms, we ran linear models with the phenological stage as the dependent and traits as explanatory variables; growth forms were included as covariates.

We found evidence that the studied herbaceous species in comparison to the woody species showed a larger variability in phenology. Furthermore, we were able to confirm known relationships between functional traits and phenology, whereby the LDMC was particularly suitable for predicting phenological events. However, species-specific patterns of the phenology could be mainly explained by the measured functional traits for the herbaceous species, whereas trees showed only weak correlations between phenology and functional traits.

This work is a clear example of how useful phenological observations in botanical gardens can be to study and understand the complex relationships between plants' phenology and functional traits. However, further research is needed to investigate avenues to use widely available trait data to predict species-specific phenology.

Keywords

Botanical garden, Functional traits, Generative phenology, PhenObs, Vegetative phenology

Rosbakh Sergey - Machine learning algorithms predict soil seed bank persistence from easily available traits

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Question: Soil seed banks (SSB), i.e., pools of viable seeds in the soil and its surface, play a crucial role in plant biology and ecology. Information on seed persistence in soil is of great importance for fundamental and applied research, yet compiling datasets on this trait still requires enormous efforts. We asked whether the machine learning (ML) approach could be used to infer and predict SSB properties of a regional flora based on easily available data.

Location: Eighteen calcareous grasslands located along an elevational gradient of almost 2000 m in the Bavarian Alps, Germany.

Methods: We compared a commonly used ML model (random forest) with a conventional model (linear regression model) as to their ability to predict SSB presence/absence and density using empirical data on SSB characteristics (environmental, seed traits and phylogenetic predictors). Further, we identified the most important determinants of seed persistence in soil for predicting qualitative and quantitative SSB characteristics using the ML approach.

Results: We demonstrated that the ML model predicts SSB characteristics significantly better than the linear regression model. A single set of predictors (either environment, or seed traits, or phylogenetic eigenvectors) was sufficient

Keywords

artificial intelligence, predictive modeling, persistence, random forest, seed, soil, trait

Salman Ibrahim - Bumblebee attraction to *Matthiola livida* flowers is altered by combined water stress and insect herbivory

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The emission of floral volatiles is one of the well-known cues which mediates plant-pollinator interactions. Understanding plant-pollinator interactions is especially important in arid regions, where the low abundance of pollinators limits their visiting frequency and thus, constraints the reproductive success of many plant species. From the perspective of the foraging pollinators in such arid habitats, it will be beneficial to identify the level of stress experienced by plants and consequently, to direct visits to less stressed plants. Similarly, it will be beneficial for pollinators to identify whether plants are suffering from other forms of stress, such as insect herbivory. To explore this general hypothesis, we used as a model the species *Matthiola livida* (Brassicaceae), a common native plant species in arid regions of the Middle East. We first tested whether water shortage and insect herbivory, inflicted by whiteflies, caused stress in *M. livida*, based on the change in carbohydrates and starch content, and examined whether the plants produced distinct volatile composition in response to these stressors. Then, we tested if bumblebees, a common pollinator of *M. livida*, were able to differentiate between plants suffering from water shortage and insect herbivory based only on volatile emission. We found that both water shortage and insect herbivory caused stress in the plants. We also found that the plants produced a distinct volatile composition in relation to the specific stress they were exposed to. Specifically, in comparison to control plants, insect herbivory induced the amounts of alkanes, aldehydes and alcohols volatile and reduced the amounts of esters, benzenoids and phenylpropanoids. Water shortage reduced the amount of aldehyde volatiles and induced the amount of alcohol volatiles. Moreover, using choice experiments, we found that bumblebees differentiated between stressed and non-stressed plants based on their volatile compositions, and preferred less stressed ones. Our study indicated that pollinators rely on floral volatiles in their foraging decisions and are highly sensitive to variation in the plant conditions. This suggests that volatile cues may create a constraint on the ability of the plants to secure their reproductive success in arid habitats, that are added to the direct stress created by the arid conditions themselves.

Keywords

plant volatiles, whitefly, *Bemisia tabaci*, olfactometer, pollinators, insect herbivores, *Bombus terrestris*

Sandner Tobias - Continuous inbreeding affects genetic variation, phenology and reproductive strategy in ex situ cultivated *Digitalis lutea*

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Ex situ cultivation is a central element of plant conservation strategies, but cultivation in small populations may result in genetic changes by drift, inbreeding or unconscious selection. Inbreeding over several generations potentially influences not only plant fitness, but also floral traits and interactions with pollinators. These effects have hardly been studied. We studied the molecular genetic variation of *Digitalis lutea* L. from a botanic garden population cultivated ex situ for 30 years, a frozen seed bank conserving the original genetic structure, and two current wild populations including the source population. In addition, we studied the effects of experimental inbreeding and between-population crosses on performance, reproductive traits and flower visitation of plants from the garden and a wild population in a common garden. Significant genetic differentiation was found between the garden population and its original source. After experimental selfing, inbreeding depression (ID) was only found in early traits of plants from the wild population, indicating a history of inbreeding in the smaller garden population. Moreover, garden plants flowered earlier than wild plants and showed floral traits related to selfing, whereas wild plants showed traits related to attracting pollinators. Bumblebees visited more flowers of outbred than inbred plants and of wild than garden plants. To conclude, our results show that in addition to the effects of genetic erosion and unconscious selection, high levels of inbreeding during ex situ cultivation can influence reproductive traits and thus interactions with pollinators, which may affect the population dynamics of plants after reintroduction into natural habitats.

Keywords

Inbreeding depression; ex situ cultivation; selfing syndrome; pollinator visitation; rapid evolution

Seifan Merav - I never promised you a rose garden – coping with hyper-arid conditions in the True Rose of Jericho (*Anastatica hierochuntica*)

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Desert plants need to cope with extreme habitat conditions such as water shortage, high soil salinity and high temperatures. Moreover, plants in such habitats need to cope not only with the harsh conditions, but also with strong, and often unpredictable, fluctuations in the local conditions. The True Rose of Jericho, *Anastatica hierochuntica* (Brassicaceae) is an annual plant that has a large geographical distribution throughout the deserts of the old world. It is also well known for its aerial seed bank, with seeds remaining on the skeleton of the mother plant for many years and dispersing only during rainfall events. The wide distribution and clear adaptation to deserts make *A. hierochuntic*a a convenient model plant to study the potential strategies that allow plants to adapt to harsh conditions. We have used a set of field observations and controlled experiments to show that the success of this species mainly depends on its ability to respond fast to the local conditions experienced by the individual plant. These immediate and changing responses to habitat conditions can be detected in several functional traits of the species, and in relation to several aspects of the desert habitat, including soil salinity, water shortage and neighbor identity. Overall, based on the results of our studies, we suggest that maintaining flexible responses is the leading strategy that allows *A. hierochuntica* to prosper in desert conditions, and may be crucial for the ability of plants to succeed in harsh conditions in general.

Keywords

adaptation, annuals, arid conditions, functional traits, phenotypic plasticity, trait variation

Shemesh Hagai - Doing more harm than good: when short-term responses don't predict the long-term consequences of a conservation management action

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The survival of endangered species often depends on active conservation interventions. Lack of correlation between short- and long-term effects can result in the implementation of erroneous conservation management plans that look good in the short run but cause long term damage. We present an example of the locally endangered plant *Paeonia mascula* (L.) Mill., in plots that were cleared from trees ~20 years ago, and in plots whose canopies remained intact. The short-term responses (obtained 4 years after clearing) suggested that clearing increases the percent of *P. mascula* flowering plants, while not changing plant density. In contrast to these positive short-term effects, the long-term (20 years) consequences were negative, with percent flowering, plant density and soil seed bank all being lower in the cleared compared to the control plots. This study is a unique example of a (probably more common) scenario in which conservation decisions based on short-term data can result in actual long-term damage to the species we are trying to protect.

Keywords

Conservation, Long-term

Tielbörger Katja - Habitat heterogeneity does not affect species diversity - a rigorous experimental approach

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Habitat heterogeneity is assumed to have positive effects on species diversity, because different habitats allow species with different niches to coexist. However, when there are many habitats in a given area, the habitat fragments are small and the probability of stochastic extinction increases. Therefore, the area-heterogeneity trade-off theory (AHTO) predicts a unimodal relationship between habitat heterogeneity and species richness along a habitat heterogeneity gradient. However, this theory awaits rigorous experimental testing. Here, we tested the AHTO in artificial grassland plant communities by means of a large common garden experiment. We monitored plant species richness, community structure and extinction probabilities for five years across a habitat heterogeneity gradient. Habitat conditions were manipulated in microcosms with combinations of two levels each of soil depth, fertilization, mowing and trampling, resulting in one, two, four, eight or 16 habitats per microcosm, respectively. Surprisingly, there was no change in diversity nor overall extinction probability across the five heterogeneity levels. However, a closer look indicated that gradients of extinction probabilities across heterogeneity levels depended on habitat conditions. Namely, niche-based processes did operate, especially under homogeneous and productive conditions, and deterministic extinction could be observed. Vice-versa, stochastic extinction operated mainly under heterogeneous conditions, i.e. when habitat patches were small. Overall, our findings indicate that while the basic assumptions of the AHTO seem to hold, deterministic and stochastic extinction operate simultaneously such that the predicted unimodal relationship between habitat heterogeneity and diversity may be masked.

Keywords

grassland, common garden experiment, habitat heterogeneity, biodiversity

Tomiolo Sara - Effects of plastic fragment size and concentration on plant performance are mediated by soil properties and water availability

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Although plastic contamination has been recently recognized as a global stressor, its effects on soil properties and plant performance have received little attention. Because plastic contamination can affect soil water content, it may interact with known climate change factors, such as drought. In addition, the combined effects of plastic contamination and drought on soil may be mediated by soil texture. We hypothesized that 1) the effects of plastic on soil water content are stronger in high concentration and size of plastic fragments, and under low water availability; additionally, soil texture mediates such effects; 2) plants attain higher growth in soil where the negative effects of drought and plastic are small. We tested the joint effects of water availability, soil texture, and plastic fragments (varying in concentration and size), on soil water content and growth of the model plant *Arabidopsis thaliana*. Low concentration and size of plastic fragments increased soil water content, and this declined in higher levels of plastic contamination. Such responses where stronger in low water availability, and soil texture influenced the shape of the response. Plastic fragments' concentration and size had a positive effect on plant growth. Soil texture and water treatment affected the strength and direction of soil and plant responses. While increasing concentrations and size of plastic negatively affected soil water content, likely by favoring the formation of fractures within soil aggregates, they positively affected plant growth, likely by increasing soil porosity and facilitating root growth. In low water availability such responses were generally stronger, while soil texture mediated the response of soil water content. Our study offers a proof of concept of the combined effects of plastic contamination and water availability on soil and plants. We argue for the necessity of further studies to investigate the potential combined effects of climate change-induced drought and plastic contamination on plant and soil systems.

Wang Min - Dynamics of plant diversity during restoration of roadside slopes following large-scale construction work in the Western Sichuan Plateau

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Restoration of road-side habitats is challenging at high altitudes, and it depends on further progress in ecological theory and practical knowledge. Thus, this topic was investigated on degraded slopes of a highway in the highlands of the Western Sichuan Plateau at 3100, 3300, 3500 and 3800 m elevation. By adopting a space-for-time approach, the changes in species diversity of herbs, shrubs and trees were studied in the years 1–3 since restoration. The results indicate that the species diversity gradually decreased, while plant cover, height and density increased with time. In the herbaceous layer, we did not detect significantly differences in species diversity and herb cover among the four elevation gradients, while plant height decreased with altitude. In the shrub layer, the Shannon-Wiener, Simpson and Pielou indices increased with decreasing plant cover and height along the elevational gradient, while we found a rebound of species diversity at 3500 m. In the tree layer, plant cover and height significantly decreased with declining species diversity. Furthermore, the persistence of the shrub species was most pronounced compared with herbs and trees. Finally, restoration must be site-specific and maintenance of species diversity is one of the most important goals. The results should be used as reference for practitioners during the process of road planning, construction and operation in mountain areas.

Keywords

Ecological restoration; High altitude; Roadside slope; Species diversity; Sustainability

Wei Guanwen - Soil heterogeneity tends to promote the growth of naturalized aliens when competing with native plant communities

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Elton's diversity-invasibility hypothesis predicts that diverse communities are more resistant against alien invaders. However, observational studies frequently find positive relationships between the numbers of alien and native species. It has been suggested, but rarely tested, that environmental heterogeneity may cause such positive relationships. Here, we experimentally tested the effects of soil heterogeneity and diversity (species richness) on the invasibility of native communities. We first filled mesocosm pots with either a heterogeneous soil, consisting of one patch of sand, one patch of peat and one patch of an equal mixture of both substrates, or a homogeneous soil, consisting of the mixture only. Then, we planted those pots with 29 native communities consisting of one, four or eight species, and invaded them with populations of four individuals of one of five alien species. In the heterogeneous soils, individual alien plants benefited more strongly from the resource-rich peat soil than the native communities did. Moreover, in the mixture soil of the heterogeneous treatment, individual alien plant over-proportionally produced more biomass than in the mixture soil of the homogeneous treatment. Consequently, the populations of naturalized alien plants in each pot benefited from heterogeneous soil conditions, and this tended to be particularly the case when a native community was present. The native communities did not respond to soil heterogeneity, but they had a negative effect on the naturalized plants, irrespective of their diversity. Our results indicate that soil heterogeneity might alleviate the competitive effects of native communities on the alien invaders, as the latter took more advantage of the high resource patches than the natives did. The beneficial effect of heterogeneity on invasion success could thus explain why observational studies usually find positive relationships between the numbers of alien and native species.

Keywords

biodiversity, biological invasion, community, competition, environmental heterogeneity, invasibility, invasion ecology

Wellstein Camilla - Genetic and functional variation of Vaccinium vitis-idaea (Ericaceae) in ice holes microrefugia

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Ice holes are montane cold microrefugia that preserve plant species of higher elevation probably over thousands of years under extra-zonal conditions. We hypothesized that (i) populations within these microhabitats would show genetic differentiation from other populations; (ii) these extrazonal populations would also show high functional trait distinctiveness, in agreement with genetic patterns.

In this study, we assessed genetic and functional trait variation in the species *Vaccinium vitis-idaea* (Ericaceae) within and between three ice hole populations and three nearby subalpine populations on siliceous and calcareous bedrock. We genotyped almost 30.000 single nucleotide polymorphisms using restriction site-associated DNA sequencing. On the same individuals we measured eight functional traits indicative of individual performance and ecological strategies.

Genetic results revealed high differentiation among the six populations suggesting isolation. On siliceous bedrock, ice hole individuals exhibited higher levels of admixture than those from subalpine populations which could have experienced more bottlenecks during demographic fluctuations related to glacial cycles. Ice hole and subalpine calcareous populations clearly separated from siliceous populations, indicating a possible effect of bedrock in shaping genetic patterns. Trait analysis reflected this bedrock effect. The significant correlation between trait and genetic distances highlights the genetic contribution in shaping intraspecific functional differentiation. In conclusion, genetic and phenotypic differentiation of extra-zonal populations determined by history and ecological contingency can contribute to the overall variability of the species, enhancing its resilience to upcoming environmental challenges.

Keywords

microrefugia, RADSeq, intraspecific functional variability

Zhu Jinlei - Density-dependence of fecundity and seed dispersal profoundly alters the spread of plant populations

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Plant population spread is a fundamental process of vital ecological and evolutionary importance. Plant population spread depends on fecundity and seed dispersal. Although both fecundity and seed dispersal are density-dependent, it is poorly understood how density-dependence of fecundity and seed dispersal impacts plant population spread.

We address this question by incorporating an analytical mechanistic model for wind-driven seed dispersal into a temporally and spatially explicit process-based cellular model for population spread. To parameterise the models, we conducted a common garden experiment in which we grew five wind-dispersed plant species (*Hypochaeris glabra*, *Chenopodium album*, *Crepis sancta*, *H. radicata*, *Bellis perennis*) at three population densities and measured how density affects fecundity, dispersal traits, and dispersal environments. We simulated the spread of plant populations in a homogeneous landscape and quantified the population spread rate, distance to the range front (the distance between the range edge of the last generation and the mother plant of the seeds that land at the current range edge), as well as range continuity (the ratio of occupied cells from range core to range edge).

Fecundity decreased with population density in all study species. Seed dispersal distance decreased with population density in three species but increased in two species. Negative density-dependence of both fecundity and seed dispersal reduced population spread rate, the distance to range front, and range continuity. In contrast, positive density-dependent seed dispersal increased spread rate and the distance to range front but decreased range continuity.

This study provides experimental evidence for density-dependent fecundity and seed dispersal and shows that density-dependence of fecundity and seed dispersal profoundly alters plant population spread. Our findings should help to improve the prediction of whether plants can track climate change and management strategies for controlling plant invasions and conserving endangered plants species.

Keywords

Common garden experiment, coupled map lattice model, invasion by extremes, WALD model

POSTERS

Amputu Vistorina - Mapping rangeland condition indicators in arid savannahs using drone technology

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Ecosystem degradation remains a major environmental concern, particularly in drylands where primary productivity is already constrained by limited moisture availability. This requires that monitoring methods are easy to apply and provide reliable and repeatable results at various spatial and temporal scales to improve management and answer ecological questions. However, the usual methods applied for assessing the status of rangelands at global and local levels through satellite data and field observations, respectively, provide limited information to detect degradation in its early stages. Fortunately, newly emerging techniques such as unmanned aerial vehicles (UAVs), better known as drones, associated miniaturized sensors and improving digital photogrammetric software allow us to transcend these limitations. However, calibration of any remotely sensed data with direct field observations is compulsory before they are integrated for long-term monitoring, and this is still lacking in arid savannahs. Hence, the aim of our study was to test the efficacy of drone-based assessment of rangeland condition in a Namibian arid savannah. Here, the two common indicators of rangeland condition, vegetation cover and forage biomass, were observed directly in the field and compared to those estimated from high resolution multispectral drone imagery. We obtained very good agreements between drone-and field-based estimates of bare cover ($r = 0.96$, $p < .001$), total vegetation cover ($r = 0.96$, $p < .001$), herbaceous cover ($r = 0.89$, $p < .001$) and woody cover ($r = 0.82$, $p < .001$). Similarly, a significant positive linear relationship (adjusted $R2 = 0.80$, $p < .001$) between drone and field estimated forage biomass was also found. Our findings demonstrate the applicability of drone technology to evaluate vegetation parameters even in highly heterogeneous systems. This offers an opportunity to survey broader spatial areas more rapidly allowing for landscape level assessment of rangeland resources. Therefore, integrating drone-based observations for monitoring could greatly improve climate-adapted rangeland management to prevent further degradation and associated threats to biodiversity and human livelihoods.

Keywords

arid savannah, forage biomass, ground-truthing, rangeland functional attributes, UAV

Bhatt Tarun - Role of jasmonate in plant-microbe interactions and plant stress resistance

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Abiotic stresses represent a prime challenge for all organisms. Plants are sessile organisms, exposed to a constant influx of abiotic stressors. Environmental conditions such as heat and drought hamper plant growth and development. An important mechanism that allows plants to deal with stress is by associating their roots with beneficial soil microbiota, which can help plants to overcome environmental stress conditions. The structure and variety of microbiota differs between plant and soil compartments. It was shown that microbial communities in these compartments are not constant but are regulated by the environment as well as inter-microbial and plant–microbe communication. Plant hormones play a vital role in assembly of plant microbiome. In previous studies on biotic stress and annual plants it has been observed that plant hormones regulate plant microbiome and root exudates during stress. However, the role of plant hormones during abiotic stress in the plant microbiome assembly and the root exudates composition has not been clearly elucidated. Also, in past studies the focus was on observing the role of plant hormones only during stress conditions which makes it difficult understanding the function of plant hormones fully during recurrent stress. As there is lack of understanding about their role in recovery phase of plants. In our study we will explore the effects of jasmonate (JA) because of the multifunction of JA both in plant development and functioning during environmental stress phase and recovery phase. The aim of study is two-fold 1) Study the changes jasmonate brings to plant performance during stress and recovery phase and how are these changes mediated by changes in the community of microbes in rhizosphere, 2) Study the changes in the formulation of root exudates caused by the exogenous supply of jasmonate to rhizosphere and how do these correlate with microbial communities and plant performance under stress. The project is ongoing, so I will be presenting the outline of my project.

Keywords

Abiotic stress, root exudates, jasmonate, microbiome

Bucher Solveig Franziska - Artificial Light pollution at night (ALAN) affects plant performance and abundance

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Plants use light as a source of energy and information. Artificial light at night (ALAN) is increasing and affects global biodiversity as it affects organisms in their physiology and behaviour. However, we know very little about how these effects impact ecosystem processes and higher levels of biological organization.
We experimentally tested plant community-level responses as well as animal movement and belowground processes to ALAN using grassland communities assembled in the iDiv Ecotron facility. We found diverse effects on animal movement, predation and plant biomass and performance. We additionally chose three focal species (*Bromus hordeaceus*, *Plantago lanceolata* and *Trifolium repens*) and measured eight plant functional traits to assess the performance under the different levels of ALAN. More specifically, we studied the biomass and plant height to assess productivity and competitive strength, specific leaf area (SLA), leaf dry matter content (LDMC) to capture growth rates and resistance, hairiness of the leaves as well as wettability to assess the light stress as well as chlorophyll fluorescence (PI_{abs} and F_v/F_m) and the SPAD value to assess stress physiology and photosynthetic performance.
We found changes of plant biomass, which decreased with increasing ALAN, plant abundance and selected plant functional traits for which e.g. SLA decreased and LDMC increased with increasing ALAN. This research gives insight for the prediction of biodiversity patterns and plant performance under ongoing increase of ALAN.

Büse Silas - Evolutionary responses in *Onobrychis viciifolia* to four generations of contrasting precipitation predictability: shifts in mean traits and inter-individual variation

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Plants can respond to rapid climatic changes through migration, phenotypic plasticity and adaptive evolution. Previous studies showed that evolutionary responses can occur not only to changes in precipitation means but also to changes in precipitation predictability. This is important because, although annual global mean precipitation is forecasted to remain rather constant, the distribution of precipitation events over the year is becoming more variable both temporally and spatially, leading to decreased predictability of precipitation. Since studies investigating plant adaptation to changes in environmental predictability are still scarce, additional experiments are needed to better understand how plants will respond evolutionarily. We used seeds of the Fabaceae fodder crop *Onobrychis viciifolia* whose progenitors were subjected over four consecutive generations to four different precipitation predictability treatments: low vs high predictability both during early and late plant life stages. We grew plants from these four generations under common garden conditions, which allowed us to observe evolutionary changes in germination time, seedling height, and above-ground biomass in response to the past predictability treatments. Moreover, we investigated whether past predictability treatments affected inter-individual variation in these traits – possibly reflecting ecological diversification – by calculating the coefficient of variation across all offspring per seed family. Our main results show that plants experiencing low precipitation predictability during the progenitors' early plant life stages increased above-ground biomass and had greater inter-individual variation. Furthermore, evolutionary responses to the predictability treatments increased over the first three generations but disappeared in the fourth generation, which may be explained by an increased level of gene flow in the fourth generation. Finally, the results from this common garden experiment are in line with measurements on the progenitor plants which were directly subjected to the four generations of the precipitation predictability treatments. This suggests that evolutionary responses to the treatments constitute the dominant responses whereas phenotypic plasticity played a minor role. Overall, our study demonstrates that precipitation predictability can cause evolutionary responses in only few generations in both mean traits and inter-individual variation.

Keywords

precipitation predictability, adaptive evolution, inter-individual variation, common garden

Canessa Rafaella - Plant responses to nutrient and drought limitation across a climate gradient in Chile

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Nitrogen (N) and phosphorus (P) are two essential macronutrients that often limit plant performance. As N must be fixed from the atmosphere and P is derived from rock weathering, soil development and weathering rates define the availability of these nutrients. Studies along chronosequences suggest a N limitation in young soils and a P limitation with advanced pedogenesis. However, this hypothesis has rarely been tested in other systems, limiting our understanding of plant nutrient constraints in natural soils. Moreover, it is not well understood how nutrient limitation interacts with water limitation in natural ecosystems.

We tested this nutrient limitation hypothesis along a steep climate and vegetation gradient in Chile, ranging from the Atacama Desert to temperate rainforests. We hypothesized that plants will be limited by N in the less-developed soils of the desert, plants from the temperate site will be P-limited due to increased leaching, whereas along the gradient, semi-arid and mediterranean sites will show a co-limitation by N and P. Using a greenhouse experiment with soil from these four ecosystems, we grew local (native) species and two phytometer species under well-watered and drought conditions for nine weeks, in which either N, P or N+P or just water was added during the fourth and fifth weeks. At the end of the experiment, we measured plant biomass, specific leaf area and leaf turgor loss point for each individual, and analyzed the data for each species using linear mixed models to test the interactive effects of soil origin, nutrient and water treatments.

Overall, plants grew larger in the semi-arid and mediterranean soils than in the arid and temperate soils, although species-specific differences were also observed. Independent of soil origin and of species, plants grew larger under well-watered than under drought treatments, and no interaction with nutrient treatments was observed. Phytometer species differed in their response to the nutrient treatment, as Triticum sp. grew better under N+P treatments only in the arid soil, whereas Lupinus sp. grew better under N+P treatments only in the mediterranean and temperate soils.

These preliminary results suggest a strong control of water availability for plant growth even in the wettest sites, and mainly N and P co-limitations along our climate gradient, indicating an intermediate pedogenesis state. Local soil characteristics, such as salinity, pH and metals content, likely explain the low plant growth in the arid and temperate sites. Further results of plant functional responses are expected to be shown.

Keywords

nitrogen limitation, nutrient co-limitation, phosphorus limitation, functional traits, water stress

Dostálek Tomáš - Spatial variability in plant-soil feedback

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Spatial variability in plant-soil feedback

A recently proposed explanation of plant coexistence is based on a reciprocal relationship between plant and soil, plant-soil feedback (PSF). Components of the PSF may have different spatial patterns based on the distance from the plant. Moreover, they may differ depending on the plant species or soil type. We thus explored spatial variability in PSF components in soil cultivated with four plant species in two contrasting soil types. We present the results on spatial variability in soil chemical properties, soil microbial composition (based on ITS sequencing and PLFA/NLFA analyses) and nematode composition.

Keywords

plant-soil feedback, plant competition, soil chemistry, soil biota, soil nematodes

Durka Walter - RegioDiv: Assessment of plant genetic variation as a basis for seed zone design in Germany

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RegioDiv: Assessment of plant genetic variation as a basis for seed zone design in Germany

In Germany, a system of seed zones exists for seed production for grassland restoration purposes. A total number of 22 seed zones (regions of origin) were defined based on predefined natural areas derived from geology, soil and climate. However, no empirical data on adaptedness or genetic variation was used in the demarcation of seed zones. The project RegioDiv aims to assess the patterns of genetic variation across Germany of multiple plant species that are frequently propagated as regional seed and used in restoration and to draw conclusions from the patterns of genetic variation for seed zones.
We present the structure of the project, rationale of sampling, SNP marker analysis and present first results.

Keywords

seed zone, restoration, ddRAD, SNP markers, multiple species

Guo Yaolin - Large-scale geographic variation in litter chemistry and palatability to detritivores in a widespread invasive plant versus its native competitor

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Latitudinal clines in biotic interactions often differ between invasive plants and co-occurring natives, which may drive geographic variation in invasion success. An important type of biotic interaction that has hardly been considered in this context is litter detritivory. We combined field surveys with laboratory experiments to compare latitudinal variation in leaf litter chemistry and palatability to detritivores between the widespread invasive plant *Spartina alterniflora* and its native competitor *Phragmites australis* across their co-occurring range (20.9–40.7°N, ~2200 km) on the coast of China. In five out of nine litter traits we found latitudinal clines, with little differences between the two plant species. Litter palatability decreased with increasing latitude, but was generally higher in *Spartina* than *Phragmites*. Two litter traits (C:P ratio and flavonoid content) driven by temperature of origin crucially affected litter palatability. Our study demonstrates latitudinal clines in litter traits and litter palatability both of the invasive and native plants, with strong links between climate, leaf chemistry and detritivory. The litter of *Spartina*, however, appears to be more rapidly decomposed through detritivores, which could create a positive feedback, and contribute to successful *Spartina* invasion along the coast of China, suggesting the importance of its whole-country control.

Keywords

Biogeography; Biotic interactions; Biological invasion; Detritivory; Litter palatability

Höfner Johannes - Effects of sampling design on patterns of genetic variation of grassland plants across seed transfer zones in Germany

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The last decades have seen an increasing use of regional seeds in ecological restoration. Like in many countries, seed transfer is based on a seed zone system in Germany. Even though there are numerous regional or species-specific studies, the degree and spatial distribution of genetic differentiation across species and zones has never been investigated comprehensively. With genetic marker data from 'RegioDiv' (see the eponymous poster), a project that aims to close this gap, we characterise the sensitivity of various descriptors of genetic variation to sampling design and discuss the implications for the deduction of seed transfer guidelines.

Keywords

seed zone - genetic differentiation - restoration - ddRAD - SNP markers - multispecies - grassland

Iberl Katerina - Restoring populations of the endangered plant species *Myricaria germanica* by reintroduction – is there an impact on genetic variation?

Katerina Iberl & Christoph Reisch

The vegetation along alpine rivers belongs to the most endangered habitats in the Alps. Many species occurring on gravel banks drastically declined due to hydrologic changes related to anthropogenic regulation. In the recent decade strong restoration efforts have been made to prevent the alpine river key stone plant species *Myricaria germanica* from extinction. The impact of reintroduction on genetic variation has, however, not been investigated so far, although potential founder and bottleneck effects may have an impact on restoration success.

In our study we analysed, therefore, genetic diversity and differentiation within and among natural and restored populations of *Myricaria germanica* along the alpine rivers Isar and Lech in South-eastern Germany using molecular markers. Genetic diversity and differentiation of natural Myricaria germanica populations varied strongly and we observed no isolation by distance, as to be expected for a species from a highly dynamic river habitat. Moreover, genetic diversity of restored populations was comparable to genetic diversity of natural populations and genetic differentiation among restored and natural populations was not significant. Genetic diversity and differentiation of the restored populations reflected, hence, the natural genetic pattern of *Myricaria germanica*.

Consequently, our study demonstrates that genetically variable populations of the endangered *Myricaria germanica* can successfully be created, even from small seed source populations, without the negative impact of founder or bottleneck effects. Further populations should, therefore, be restored to counteract the ongoing decline of this iconic alpine river plant species.

Klimesova Jitka - How belowground traits may affect ecosystem function

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Plant traits may be considered response traits, i.e. traits that to respond to environment. For example, a high leaf dry matter content is typical for plants preferring dry and/or nutrient-poor conditions, where long-lived, nutrient-poor and not very photosynthetically efficient leaves enable a plant to conserve limited resources. However, the same trait - a high leaf dry matter content - affects also ecosystem functions (and may be considered effect trait) as such leaves are not easily decomposed and they slow down carbon and nutrient cycling. While aboveground plant traits are frequently used on the ecosystem level, belowground plant traits, e.g. clonal and bud bank traits, have been used on this level only rarely and we have only a limited number of studies using them to evaluate their ecosystem function. We will present an overview of how traits of belowground organs may affect ecosystem functions along an aridity gradient in grasslands. Effect traits of belowground organs include depth versus breadth of rooting that determines water niche; density of rooting and the existence of rhizomes determining sensitivity to soil erosion; production of belowground litter determining pace of the soil carbon cycle; and source of diaspores determining vegetative regeneration. On the basis of the overview, we call for considering the effect traits of belowground organs in future studies.

Keywords

Effect traits, Belowground organs, Aridity gradient, Bud bank, Water niche, Erosion, Carbon cycle

Latzel Vít - The role of DNA methylation in transgenerational adaptation of (a)sexual offspring of *Fragaria vesca* to future climatic conditions

Vít Latzel, Iris Sammarco and Zuzana Münzbergová

Environmentally induced epigenetic variation (DNA methylation in particular) that is passed to the offspring might enable transgenerational adaptation of plants to changing environment. However, solid evidence is still scarce. Moreover, meiosis resets most of the environmentally induced DNA methylation across sexual generations, thus acting as a barrier reducing the role of DNA methylation in transgenerational adaptation. However, plants can also reproduce by means of vegetative propagation, i.e. by clonal reproduction that lacks meiosis. We test the ability of a clonal herb *Fragaria vesca* to adapt to climatic conditions predicted to be prevalent at the end of this century (increased mean temperature for 4 ^{o}C, CO_2 level for 800ppm, drought periods) via transgenerational effects. By using an isogenic inbred line of *F. vesca*, we compare transgenerational adaptation at the level of phenotypic variation to future climatic conditions between sexual and clonal (asexual) offspring. Moreover, we compare the role of DNA methylation variation in the observed transgenerational adaptation between clonal and sexual offspring by whole genome bisulfite sequencing. Our study is the first study directly evaluating the role of heritable epigenetic variation among clonal and sexual offspring in transgenerational adaptation of plants to novel climatic conditions.

Lampei Christian - *Epilobium angustifolium* shows increasing maladaptation to south-western common garden with increasing latitude and longitude of origin

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Latitudinal gradients have been suggested as natural laboratories to infer the response of species to global temperature changes. Here we raised 34 populations of *Epilobium angustifolium* originating from sites between the 50th and 67th latitude in a common garden in Muenster (Germany). We found that the plants produced less biomass, had a lower probability flower and a higher probability to wither early, and in the second year a shorter length of the infructescence, with increasing latitude or longitude of origin. Reasons may be that northern plants flowered later, and showed a different growth-rhythm that may be connected to day length differences. Eastern plants had on average larger leaves, which might point towards a lower water-use efficiency. These results suggest that even outcrossing plants with very high mobility may show strong adaptations to their latitude of origin. This means that they likely will have to adapt to changing temperatures, which may require geneflow from southern populations, if the standing genetic variation is not sufficient. However, our data also point towards the importance of adaptation to the local photoperiod, which does not change with changing temperatures. Therefore, both local and southern alleles may be required for keeping track with local climate.

Keywords

adaptation, climate change, fireweed, common garden

Rathore Nikita - Variation in root exudation is linked to phylogeny and explained by plant root traits

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Root exudation is an important chemical process determining plant interactions with the soil environment. Different plant species vary in their root exudation, however, there is limited understanding of the phylogenetic controls and plant characteristics that drive these differences. We measured various plant functional traits (aboveground and belowground) along with root exudates for 65 plant species. Here, we aimed to: (a) determine whether variation in root traits, root exudates and aboveground traits is constrained by phylogenetic background; (b) to test to what extent the variation in root exudates were determined by plant functional traits. We found that most of the traits showed significant phylogenetic signals, as evidenced by both Abouheif's Cmean and Pagel's lambda. In particular, belowground biomass, root volume, specific root length (SRL), root length density (RLD), root tissue density (RTD) and phenol content (in both exudates and plant belowground biomass) exhibited phylogenetic signals. However, certain traits such as plant aboveground biomass and phenol content in aboveground biomass did not reflect phylogenetic conservatism. Further, the phenol content in root exudates was positively related to plant functional traits (i.e., plant aboveground and belowground biomass, root length, root surface area and root volume) among species and these inter-specific relationships were stronger ($p < 0.001$), when estimated using phylogenetic independent contrasts. Also, it was observed that the positive relationship of phenol content in exudates with RTD and biomass [both aboveground and belowground] appeared after the phylogenetic influence was eliminated. Overall, the findings provide support for phylogenetic conservatism in root traits. These findings improve understanding of species-specific differences in root exudation and identify plant functional traits that might underlie these differences.

Keywords

Phylogenetic conservatism; Phylogenetic independent contrasts; Root exudation; Root traits

Riemenschneider Adriana - Spatio-temporal variation of natural pest control in pesticide-free winter wheat compared to conventional and organic cropping systems

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Conventional cropping systems achieve the high yields demanded by a growing global population, but the requisite chemical-synthetic plant protection products are detrimental to life on Earth. Organic agriculture would be the ideal environmentally sustainable alternative, promoting natural pest control and greater insect biodiversity, but shortcomings in biomass production hinder its implementation. With this in mind, we are investigating a pesticide-free cropping system, also characterized by optimized mineral fertilization and innovative management practices, that could potentially bridge existing gaps between the conventional and organic systems, fostering international sustainability goals such as reversing the decline of insect biodiversity. We study the spatio-temporal abundance variations of functional groups of insects found in winter wheat crops (*Triticum aestivum*) both in a plot experiment comparing different cropping systems and on pesticide-free winter wheat fields at various locations in the State of Baden-Württemberg, Germany. The plot experiment at the Heidfeldhof Experimental Station (University of Hoheheim, in Stuttgart) consists of four blocks of seven cropping systems each (one organic, two variations of the conventional system and four variations of the pesticide-free system) implemented for a six-year crop rotation. In addition to the sampled 14 winter wheat plots per block, trial crop rotations include maize, soybean, triticale, spring barley, clover-grass mix and grass. The field scale samplings took place along 79 transects on pesticide-free winter wheat fields, where insects were sampled in the field margin habitat and at 2.5, 5, 10, 20 and 40 meters into the field. In both the experimental and field scale study, we used an insect vacuum sampler to collect insects on 1 m^2 plots in three visits between May and July 2021. First-year results from the ongoing plot experiment show that the cropping systems have an effect on aphid abundance (suborder Sternorrhyncha), an important pest in winter wheat. There were significantly more aphids captured in the conventional plots as in either organic or pesticide-free plots. A potential explanation for this result is that pesticides affect aphid predators, therefore hindering natural pest control. Furthermore, preliminary field sampling results show a trend of higher ladybug larvae (Coccinellidae) biomass and abundance closer to the field edge. The abundance ratio of predator to pest functional groups showed a similar trend. Such observations highlight the importance of semi-natural habitats for natural pest control.

Keywords

cropping systems, biological control, insect biodiversity

Schnablová Renáta - Vegetative preformation of overwintering buds as a potential source of phenology variation of temperate herbs

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Perennial herbs of temperate regions have to cope with seasonal climate. Due to freezing temperatures, they reduce their aboveground body before winter. Therefore, their maintenance is ensured, besides production of seeds, by resprouting from protected overwintering buds in the spring. These buds may start to develop already during the flowering time of the previous season. Thus, the right strategy balancing the previous year phyotosynthetic gain with the expected demand of the next-year shoot is essential. Plants must invest into the growth and maintenance of photosynthetic and generative organs as much as possible, and on the other hand, they must invest into bud development and storage of compounds for the next season as the bud size and development determine the fate of the next generation.

Bud preformation means that plant organs, either vegetative or generative, are pre-developed before the growth season. Inflorescence preformation is the most frequently reported type of preformation in herbs. It has been known for quite a long time especially from habitats with short vegetative season, like arid and alpine habitats. Recently, it has also been shown to be quite frequent in temperate regions. On the other hand, vegetative preformation is completely unexplored and its links to plant phenology and other ecological functions are completely unknown.

Here, we have analysed vegetative preformation in overwintering buds of a large set of phylogenetically representative herbs growing in different temperate habitats. The vegetative preformation has been analysed in connection to species phenology, morphological traits and growth type in order to identify its importance for plant growth strategy.

Keywords

overwintering buds, phenology, temperate perennial herbs, vegetative preformation

Thakur Dinesh - Are climatic effects on twig economic traits similar to leaf economic traits?

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Variation in leaf and twig economic traits is important to understand resource allocation strategies and trade-offs in plants. Leaves are the most important photosynthetic organs of plants, and twigs reflect physical support and transport functions to leaves. Therefore, it can be expected that the variation in twig economic traits due to climate and trait trade-offs are similar to those of leaf economic traits. However, we have limited understanding if twig and leaf traits vary similarly in response to climatic conditions. We also have limited understanding if trait trade-offs in leaves and twigs are consistent. Therefore, this study is aimed to test if the climatic effects on twig economic traits are similar to the effects on leaf economic traits; and if the trait trade-offs among twig and leaf traits are similar. We collected leaf and twig samples from different populations of two high elevation dwarf-shrubs of Himalaya (*Salix lindliyana* and *Rhododendron anthopogon*) along gradients of elevation (proxy for temperature) and precipitation. From the collected samples, we measured leaf economic traits [leaf area, leaf thickness, specific leaf area (SLA) and leaf dry matter content (LDMC)] and twig economic traits [twig increment, twig diameter, specific twig length (STL), and twig dry matter content (TDMC)]. Data were analysed using mixed effects models and regression analyses. We found that all the studied traits were significantly affected by the individual effects of temperature (elevation) and precipitation. The interactive effects of precipitation and temperature were stronger on leaf traits than the twig traits indicating that the effect of temperature on traits is precipitation dependent. The interaction among precipitation and species was insignificant in case of twig traits but significant in leaf traits indicating that the effect of precipitation is consistent among both the species for twig traits but inconsistent for leaf traits. The triple interaction between temperature:precipitation:species was also significant for all the traits but stronger in leaf traits. In trait bivariate relationships, we found that per unit leaf construction cost (SLA) was strongly and negatively related to LDMC. However, in twigs, the per unit construction cost (STL) was strongly and negatively related to stem diameter rather than TDMC. Overall, results suggest that the effects of climate are different on twig economic traits than leaf economic traits. The effect of climate on traits was also species specific, and this specificity was stronger in leaf traits. Results also suggest differential trait trade-offs in leaves versus twig traits.

Keywords

Climatic gradients; Dwarf-shrubs; Himalaya: trait variation; construction cost; Trait trade-offs

Voisin Camille - From idiosyncratic to general phylogeographic patterns in the Eastern Alps. A comparative study of beech forest understorey species

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During cold stages of the Pleistocene, temperate forests were restricted to small favourable areas. To date, refugia were identified in southern, central and southeastern Europe. Triggered by Holocene climatic warming, post-glacial re-colonization shaped the current genetic diversity and structure. However, while tree and alpine species were intensively studied, only little is known about the phylogeography of forest understory herbs. This is due to the low number of available studies, the low resolution of the used markers, and a focus on a few species.The scarce available studies suggest refugia to be mostly congruent with those of their associated tree species, but also unraveled a high level of idiosyncrasy in terms of current geographical distribution. Here, we reconstruct the glacial and postglacial biogeographic history of *Aposeris foetida*, *Cardamine trifolia* and *Hacquetia epipactis*, three forest herbs strongly associated with beech, the most abundant deciduous tree of temperate Europe. The ranges of these three species are characterised by geographic disjunctions; further, they only cover a fraction of the distribution range of beech, which can be explained by incomplete range filling due to lower migration rates and/or narrower ecological amplitudes as compared to the associated tree species. Our study is based on highly resolving Restriction associated DNA sequencing, which enabled us to work with thousands of SNPs, and to explore the genetic structure of these three beech forest understory species with spatially and temporally explicit demographic models. Our data suggest that beech forests and associated plants have survived the last glaciation in multiple Southern Alpine refugia, but also at the northeastern margin of the Eastern Alps and in the Carpathian mountains.

Keywords

beech understorey plants, glacial refugia, Alps, phylogeography, RAD sequencing

Wódkiewicz Maciej - Evaluating eradication feasibility with USEF

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Galera Halina, Rudak Agnieszka, University of Warsaw Invasive species can easily establish new populations outside their native range. These new populations interfere with local communities reshaping them by driving many local species to extinction or altering interspecific interactions. Changes in flora and vegetation invoke decisions to eradicate the invasive species in order to protect the local communities. These decisions lead to the initiation of long term eradication campaigns involving the engagement of qualified personnel and substantial funds. The actions have to be evaluated at the beginning and during their execution. Evaluation and comparison of successful and unsuccessful actions can lead to our better understanding of factors limiting eradication success. This is however difficult as up to date there is no universal and widely applicable comparison system to evaluate eradication feasibility.

Based on literature survey and our own experience gained during the eradication of annual bluegrass from Point Thomas Oasis, King George Island, South Shetland Islands we prepared an evaluation system enabling the comparison of eradication feasibility of different eradication actions. Each of the 24 eradication related factors included in our Unified System for assessing Eradication Feasibility (USEF) has been assigned with a 3 to 5 step ordinal scale enabling scoring of the eradication feasibility. Selection of scoring categories was based on their universality and ease of classification. We propose first to divide the scored value by the maximum value for each factor to calculate the factor's input. The sum of factors' inputs results in an overall eradication action feasibility assessment. The greater the number the more difficult it is to eradicate the species. The higher the number of factors, which cannot be evaluated due to the lack of information the lower the quality of the assessment.

The system may be used to report and analyze eradication campaign data in order to (i) prioritize alien species for eradication, (ii) create the strategy for controlling invasive plants, (iii) compare efficiency of different eradication actions, (iv) find gaps in knowledge disabling a sound eradication campaign assessment. The main advantage of using our system is unification of reporting eradication experience data used by researchers performing different eradication actions in different systems.

Keywords

biological invasions, eradication feasibility, exotic pests, extirpation success, non-native plants