POPBIO 2016

TŘEBOŇ 5-7 May

# ABSTRACTS

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# ABSTRACTS

# POPBIO 2016, TŘEBOŇ, CZECH REPUBLIC

# 29TH CONFERENCE OF THE PLANT POPULATION BIOLOGY SECTION OF THE ECOLOGICAL SOCIETY OF GERMANY, AUSTRIA AND SWITZERLAND (GFÖ)

## 5-7 MAY 2016

**Institute of Botany of the Czech Academy of Sciences**

**ORGANIZING TEAM:**
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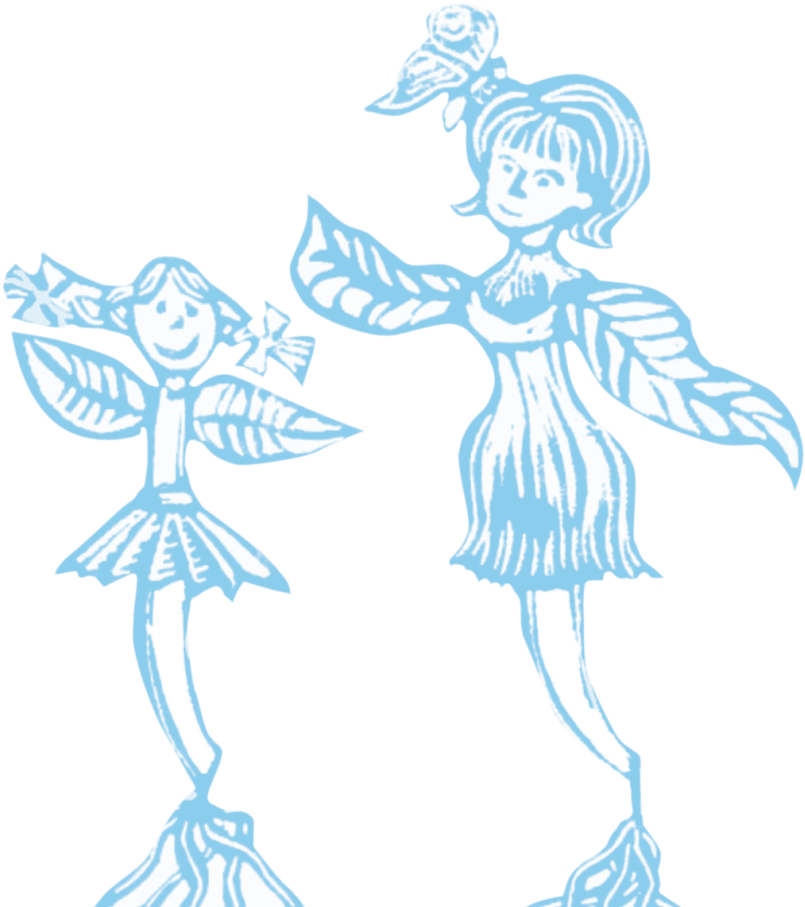
RADNICA

# KEYNOTE TALKS



# FUNCTIONAL TRAITS AS DETERMINANTS OF POPULATION SPATIAL AND TEMPORAL PATTERNS

**Francesco de Bello**
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Understanding the processes regulating populations' spatial and temporal patters is crucial to predict changes in species distribution under different global change scenarios. Functional traits, phenotypic attributes linked to species fitness, are hypothesized to provide an ideal tool for such predictions. A number of studies have tried to demonstrate that traits play a crucial role in determining the success or failure of species in a given environment and species' abundance within a landscape. Similarly it has been hypothesized that population temporal variability could be driven by functional trait trade-offs in resource acquisition and growth rate strategies. While reviewing the extent of empirical evidences supporting this set of hypotheses, I will highlight perspective areas of research by using various case studies based on functional traits. Notably, the effect of trait syndromes, i.e. how different combination of trait could results in similarly viable strategies, needs further developments. Further, relating species spread to functional traits requires accounting for the potential occurrence of species, and not only the observed spread, to better uncover dispersal, abiotic and biotic processes that filter species' traits.

# PLANT NATURALIZATION: FROM GLOBAL PATTERNS TO REGIONAL AND LOCAL DRIVERS

**Mark van Kleunen**
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The search for drivers of plant naturalization can be done at global, regional and local scales. Through the Global Naturalized Alien Flora (GloNAF) database, we now have the first overview of the worldwide extent and patterns of plant naturalizations. So far, this has revealed that plant naturalizations are not happening at random with respect to geography and taxonomy, and that bilateral trade plays a pivotal role in the distribution of naturalized alien plants around the world. A major pathway for introduction of alien plants into new regions is horticulture, which might result in the biased introduction of ornamental species with certain characteristics. We used path analysis of trait, introduction and naturalization data to unravel the direct and indirect effects of traits on naturalization success of ornamental plant species in Germany. Furthermore, using a data set of Asian woody species that have been introduced to Europe, we could show that climatic suitability is one of the major drivers of naturalization success. Given that many of the non-naturalized ornamental plants in Europe originate from warmer regions, they may have a head start under climate change. Using distribution modelling for almost 800 ornamental species, we have predicted the potential future invasion hotspots in Europe. While analyses of global and regional databases provide important clues about the potential drivers of plant naturalizations, and could inform management, the actual naturalization process (population establishment) happens at the local community scale. Therefore, I will end my presentation with several examples of local introduction experiments that are currently underway in my group. These studies address the role of functional traits, phylogenetic relatedness and responses to climate change, and should provide insights into the mechanisms driving the local, and consequently regional and global naturalization success of plants.

# ECOLOGICAL AND EVOLUTIONARY SIGNIFICANCE OF POLYPLOIDY: NEW INSIGHTS FROM POPULATION STUDIES

**Filip Kolář, Martin Čertner & Jan Suda**
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The evolutionary significance of polyploidy (multiplication of chromosome number above the diploid state) has intrigued biologists for over a century. It has arisen early in the diversification of eukaryotes and, more recently, in many extant lineages, especially within plants. Much research on ecological and evolutionary significance of polyploidy has emerged in recent years. Analyses of cytotype diversity, abundance and distribution have increased due to the availability of flow cytometry, which permits high-throughput surveys of ploidy diversity in natural populations. These studies have characterized cytotype diversity from fine to coarse spatial scales, and explored cytotype interactions using experimental and comparative approaches. Furthermore, research in mixed-ploidy species has become more multidisciplinary, taking ecological, reproductive, evolutionary, phylogenetic and genomic perspectives. The synergies between these research approaches have, in turn, contributed novel insights into the impacts of genome structure on phenotype, ecological interactions, and adaptive divergence. I will provide a synthesis of knowledge on the ecological and evolutionary significance of polyploidy by addressing the following themes: (i) What are the extent and spatial and temporal scales of ploidy diversity in natural populations? (ii) What is the extent of gene flow between ploidy states and what mechanisms may regulate opportunities for gene exchange? (iii) What are the mechanisms and factors regulating the establishment of polyploids within, and expansion beyond, diploid populations?

# SECRET PARTNERS OF PLANTS: CONTRIBUTION OF ARBUSCULAR MYCORRHIZAL FUNGI TO THE PLANT PERFORMANCE AND COMMUNITY DYNAMICS

**Mari Moora**
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Classical plant ecology relies on recording visible, well-recognizable traits, processes and patterns. For example, different plant species are determined using morphological characteristics and their abundance is measured or estimated visually. While we recognize plants well, we often ignore an inevitable feature of the great majority of land plants- they are not just plants but they are mycorrhizal plants. This means that the visible patterns which plant individuals, populations, species and communities exhibit in nature are mediated by their root inhabiting mycorrhizal fungi. In this talk I shall (1) introduce the partners and their role in mycorrhizal symbiosis; (2) explore the ways how being mycorrhizal influence plants' performance at different scales (from individual to species level, from local community to ecosystem level); and (3) discuss the variation of arbuscular mycorrhizal fungal communities and the impact of this variation on the host plants across environmental gradients.

# THE IMPORTANCE OF NICHE DYNAMICS IN RESTORATION AND CONSERVATION

**Katharine Suding**
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In this era of rapid environmental change, we are increasingly being faced with two challenges: how to conserve native rare species and how to control the dominance of exotic invaders. Research aimed at these challenges often looks to species traits to better understand what allows a plant to invade or stay rare. I will go back to classic niche-based arguments about determinants of abundance, and suggest that we are missing a fundamental piece of this puzzle applied to management: dynamics when rare can be quite different than dynamics when a species is abundant. These frequency-dependent effects can come into play to affect resilience following disturbance, restoration trajectories, and response to environmental stochasticity. I will talk about several projects from my research group where we find that frequency dependency influences whether a species is at high extinction risk when rare, whether an invader can capitalize on a changing environment, and whether our interventions affect restoration success


SPOŘITELNA

# TALKS

# LOCAL VERSUS REGIONAL: ARE WIDE GEOGRAPHIC GRADIENTS THE MAIN INFLUENCE ON THE DEMOGRAPHY OF *STERNBERGIA CLUSIANA* POPULATIONS?

**Gilad Ben Zvi, Merav Seifan & Itamar Giladi**
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Density, size and quality of suitable habitat patches are expected to decrease both towards species range margins and along climatic gradients. These changes in habitat availability towards range margins are expected to a) reduce population's demographic performance as expressed in density and reproductive output, b) reduce population size (both absolute numbers and population extent), and c) cause a steeper decline in local habitat quality with distance from sites of best performance at the local population core. These relations are studied in *Sternbergia clusiana*, a perennial geophyte whose southern range margin is in southern Israel. In Israel the species exhibits a disjunct distribution along sharp climatic gradient from the arid south towards the mesic north. We conduct a demographic study of six populations along parallel gradients of aridity and proximity to range margin. We measure inter- and intra- population variations in densities, reproductive outputs and vegetative variables. Local habitat quality gradient's steepness is evaluated for each population by measuring demographic variables along a transect radiating from population core to edge. Our results show significant inter-population variations, but not necessarily in the predicted trends. The gradient's arid edge exhibits the highest densities, while the semi-arid centre exhibits the most moderate local habitat quality gradient and the highest reproductive output. A possible explanation for the discrepancy between our large-scale predictions and these results is the strong effect of local (mainly edaphic) conditions that differ among populations and which may overshadow the effects of climatic gradient. Reproductive output was found to correlate negatively with density, hinting at density-dependence. *S. clusiana*'s ant-mediated seed dispersal may accentuate these trends by allowing control of dispersal distance. Changing dispersal distance and seed number according to suitable-habitat availability is a flexible dispersal strategy selected to fit local conditions - a key element for survival in highly fragmented environments.

# CAN ENVIRONMENTALLY INDUCED PHENOTYPIC VARIATION LEAD TO RECURRENT SPECIATION? - INSIGHTS FROM THE MOUNTAIN PLANT *HELIOSPERMA PUSILLUM* (CARYOPHYLLACEAE)

**Clara Bertel, Božo Frajman, Karl Hülber, Gilbert Neuner & Peter Schönswetter**
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Evolution is driven by natural selection, favouring individuals adapted to the environmental conditions at their growing site. Comparable natural selection pressures can lead to the formation of similar phenotypes. *Heliosperma pusillum* and *H. veselskyi* (Caryophyllaceae) from the south-eastern Alps represent an example of morphological and functional adaptation to divergent environmental conditions: *H. pusillum* has glabrous leaves and occurs in open, wet rock habitats in the alpine belt. In contrast, *H. veselskyi* has sticky glandular hairs and inhabits entrances of shallow caves and cliff overhangs below the timberline. As *H. veselskyi* is genetically inextricably nested within widespread *H. pusillum* it has likely evolved multiple times at different geographic locations. The species is thus a prime example to study mechanisms involved at the onset of environmentally-induced speciation. Comparing plants from six geographical regions, each containing two geographically close populations of both species, we (1) compare environmental conditions of their habitats to infer the role of ecological conditions possibly causing phenotypic differentiation. As only a heritable discontinuity in phenotypic variation indicates incipient divergence we (2) test if phenotypic divergence in morphological and functional traits is discrete or continuous in plants from their natural site and (3) test if phenotypic divergence is heritable in a common garden. We further (4) evaluate the extent and strength of reproductive isolation, which can prevent hybridisation between differentiated populations. To evaluate if the divergent phenotypes are adaptive we (5) compare phenotypic traits with environmental conditions and evaluate fitness and performance of the two species under the ecological conditions of both habitats. The obtained results will provide insights into processes of recent and convergent evolution in response to environmental conditions.

# DIFFERENTIATION ALONG ELEVATION AND TEMPERATURE EFFECTS ON FLOWERING TRAITS IN *CAMPANULA ROTUNDIFOLIA* AND *CAMPANULA SCHEUCHZERI*

**Hannah N. Bichsel, Halil Kesselring, Georg FJ Armbruster & Jürg Stöcklin**
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Floral traits are adaptations regulating the interactions between plants and pollinating insects. An increase of flower size in *Campanula* species with elevation has been confirmed repeatedly. It has been suggested that changing pollinators and visiting rates might be responsible for the increase. However, variability in floral size may also be driven by environmental factors, particularly by temperature. We studied floral trait variation along an elevational gradient among and within populations of the sister species *Campanula rotundifolia* and *C. scheuchzeri* from three regions in the Swiss Alps between 1000 and 2500 m, a.s.l. We used microsatellites to assess neutral genetic differentiation among populations and regions and to confirm the species delineation. Further, using a common garden approach, we grew plants from all populations under two different temperatures representing a difference of c. 1000 m in elevation (378 plants in total). Populations differed in flower size, number of flowers per stem, pollen-ovule ratio, seed set and seed weight depending on their elevational origin and on their species affiliation. However, the effect of temperature was even larger and, interestingly, corresponded for most traits in its direction with genetic effects. Flower size and number are negatively correlated, indicating a pronounced trade off. We conclude that genetic effects as well as temperature drive the increase of flower size with elevation in the two species. Whether pollinators act as selective agents on flower size in *Campanula rotundifolia* and *C. scheuchzeri* needs yet to be confirmed.

# PLANT GENOTYPE EFFECT ON HERBIVORE PERFORMANCE: A META-ANALYSIS

**Anna Bucharová & Florian Joos**
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Plant genotypes coming from different populations commonly show differentiation in many traits, including adaptation to abiotic and biotic factors. Differentiation in traits related to biotic interactions is specific, because the surrounding organisms not only affect the plants, but in reverse the plants also affects surrounding organisms. While existence of the plant genotype effect on interacting organisms is widely acknowledged, its general magnitude is not known. We focused on the intraspecific variation of plants in interaction with herbivores. We gathered data from 56 studies describing 43 herbivore species from 5 orders, feeding on 39 plant species from 12 families. Within each study, plant and herbivore species, we calculated the difference in plant genotype effect on herbivore fitness as ratio of the herbivore fitness on plant genotype one vs. genotype two. If this difference was equal to one, herbivores have the same fitness on both plant genotypes. If the difference was e.g. two, herbivores had twice higher fitness on one plant genotype than on the other one. Our final dataset contained 1241 of such genotype-genotype comparisons. Over all species and genotypes, mean of the difference in plant genotype effect on herbivore fitness was two. However, the data were strongly skewed. While median was 1.3, 10% of the differences in herbivore fitness between plant genotypes was higher than 3.6. It means that that when we compare herbivores fitness on two random genotypes of a random plan species, there is 10% chance that on one plant genotype, the herbivores have 3.6 times higher fitness than on the other plant genotype. Naturally, there were large differences among both herbivore and plant taxonomic groups. The differences were higher in monophagous than in polyphagous herbivore species.

# SHIFTS OF PHENOLOGICAL PHASES OF HERBACEOUS SPECIES AS DEPENDING ON PLANT FUNCTIONAL TRAITS ALONG ALTITUDINAL GRADIENTS IN THE BAVARIAN ALPS

**Solveig Franziska Bucher & Christine Römermann**
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Changes in the timing of phenological phases are a good and easily observable indicator for climate change. Previous studies on tree species along altitudinal gradients have shown that shifts in phenology occur along altitudinal, i.e., temperature gradients, yet they are highly species specific. The ability of species to track changes in abiotic conditions is essential for their vulnerability to climate change and may change the competitive balance within a community. We studied twelve herbaceous species along two altitudinal gradients ranging from 700 to 1800 m, a.s.l. in the Bavarian Alps, covering a difference of 6.6 K in mean annual temperature. We monitored flowering phenology at weekly intervals in 2012 and 2013. We also recorded plant functional traits related to plant performance such as SLA, leaf nutrient status as well as stomatal characteristics at peak flowering. We found that all species delayed their phenology with increasing altitude tracking interannual differences in climate, but their reaction differed between the flowering types (i.e. early flowering or late flowering). Likewise the influence of traits on flowering phenology differed between flowering types. In general, high SLA and leaf P content advanced phenology whereas leaf N, leaf K and stomatal characteristics delayed the onset of flowering. We concluded that not only climate leads to changes in phenology but that functional traits modulate this response.

# LONG DISTANCE POLLINATION RESULTS IN SHORT DISTANCE DISPERSAL

**Efrat Dener**
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Optimal seed-dispersal strategies are shaped by the genetic makeup of the seeds and the balance between selection pressures favoring and disfavoring dispersal. For example, intensive kin-competition selects for increasing dispersal by genetically-related seeds, while strong local adaptations selects for short distance dispersal. Thus, dispersal related traits should be correlated to genetic relatedness with respect to selection pressures. In this research we studied the effect of pollen source, representing gradient of genetic relatedness, on dispersal related traits in *Crepis sancta*, a heterocarpic annual plant. We pollinated target plants under controlled conditions, using pollen-donors that originated from increasing geographic distances (2 m - 120 km). We found an increase in achene production and a decrease in the potential dispersal-distances with the increase in geographic-distance between the parent plants. The pollen-dependent variation in dispersal potential was found for both a discrete trait (the proportion of non-dispersing achenes) and a continuous trait (terminal velocities of dispersing achenes). These results indicate that geographic (and probably genetic) distance has a significant effect on dispersal strategies and consequently on plants' reproductive success.

# WHEN WE SAY 'SEED DISPERSAL', WHAT EXACTLY DO WE MEAN?

**Itamar Giladi**
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Seed dispersal links the end of the reproductive cycle of adult plants with the establishment of their offspring. This apparently single demographic transition actually encompasses many intermediate transitions including seed release from the mother plant, seed movement (by one or more vectors), seed deposition, seed survival, germination and finally the establishment of adult plants. These transitions are often conceptualized and modelled as flows among compartments (e.g. seed rain to seed bank), with the spatial aspects of flows being either completely ignored, treated implicitly and rarely explicitly. I argue that there is a substantial gap between our spatial conceptualization of seed dispersal and the treatment of the various components of seed dispersal in our empirical studies. I demonstrate the extent of this gap by first reviewing the most recent literature on seed dispersal of desert annuals. I found that most (>65 %) studies of 'seed dispersal of annuals in deserts' had no spatial aspect of seed movement, 18 % treated it implicitly and only 16 % treated seed dispersal in a spatially explicit manner. In the second part of my talk I present a review of the literature on the effects of shrubs in arid environments on seed dynamics. I found that although the majority of studies include a description of spatial heterogeneity in seed patterns (either as seed bank, seed rain, seed predation, etc.), most do not include any measurements or estimation of seed movement per se. While there are many technical explanations for the paucity of studies that include a spatially-explicit quantification of seed dispersal, there is no excuse for being vague about what we do manage to measure.

# EVOLUTION OF PLANT DEFENCES ALONG AN INVASION CHRONOSEQUENCE: DEFENCE IS LOST DUE TO ENEMY RELEASE - BUT NOT FOREVER

**Michal Gruntman, Udi Segev, Gaetan Glauser & Katja Tielbörger**
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The success of invasive plants has often been attributed to rapid evolution, and in particular an evolutionary shift in resource allocation from herbivore defence to increased size, which could be selected for due to release from native enemies at the introduced range. However, such evolutionary processes can take place not only between the native and invasive ranges but also within the invasive range over time. In this study we examined the potential for post-invasion evolution in herbivore resistance in the invasive plant Impatiens glandulifera, by comparing plants from its native populations and from populations across its invasion chronosequence. Results of a common-garden experiment revealed that plants from native populations or older populations within the invasive range show greater resistance to a generalist herbivore, coupled with greater production a secondary defence compound. Results from a field survey suggested that older populations within the invasive range incur greater attack rates from local herbivores compared to recently-established populations. These findings support the idea that the selection pressure of enemy release at the introduced range might attenuate over time, leading to the evolutionary recovery of enemy resistance.

# INFERRING SPECIES POPULATION DYNAMICS AT LANDSCAPE SCALE FROM FEW POPULATIONS STUDIED IN DETAIL: A MODEL VALIDATION WITH FIELD DATA

**Zdeněk Janovský**
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Plant population biologists typically focus on detailed studies of species dynamics in few large populations. In this contribution, I would like to demonstrate the utility of such data for prediction of development of random sample of 120 populations in a study system of *Succisa pratensis*, a wet-meadow perennial. Comparison of model predictions with observed population changes indicates that the basic trends are predicted well, but detailed data coming from large populations tend to yield too optimistic results and population density might be an interesting proxy for rapid assessment and adjustment of population prospects. Knowledge of vegetation composition at *S. pratensis* populations together with herbivory levels was crucial for model performance, even though all populations are within a single biotope – wet meadows. Overall, it can be concluded that for short term predictions (<10 years) demographic data from only few populations are useful inferring species landscape dynamics provided they span the range of ecological conditions the species occurs in.

# INTERACTIVE EFFECTS OF DISTURBANCE, HERBIVORY AND PLANT ORIGIN ON SEEDLING RECRUITMENT ARE WEAKLY REFLECTED AT THE COMMUNITY LEVEL

**Lotte Korell**
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Disturbance, generalist herbivory and dispersal limitation may interactively affect seedling recruitment of exotic and native plant species and may in turn affect community diversity and productivity. In undisturbed communities rodents may release subordinate species (e.g. herbs) from competition by consuming dominant plant species (e.g. grasses), whereas gastropods preferentially feed on seedlings of these subordinate species. Disturbance, in turn, reduces competition by resident species, favors exotic plant species and may therefore also influence interactions between herbivore guilds and species origin. We therefore set up a combined exclosure (rodents vs. gastropods), disturbance (disturbance vs. no disturbance) and seed-addition (20 exotic vs. 20 native species) experiment in a grassland community in Central Germany. Gastropod and rodent herbivory interacted with disturbance and plant origin to determine seedling recruitment but not species richness, composition and productivity. At the community level, rodents tended to increase species richness and composition, but only if gastropods were absent. This compensatory effect of both herbivore guilds was likely brought about by i) a selective feeding of gastropods on subordinate species and ii) a strong negative effect of rodent herbivory on aboveground productivity and thereby a release of subordinate species from competition. Productivity was enhanced to a greater extent by exotic than native seed addition, while the opposite was true for species richness, suggesting that different mechanisms are responsible for the relationship between diversity and productivity in native- vs. exotic-dominated communities. The results indicate that complex interactions (disturbance x herbivory x plant origin) may be important during seedling recruitment but may be weakly reflected at the community level, which is affected by other (lower order) interactions. Our results may thus have important implications for the understanding of biological invasions as well as community dynamics.

# HOW DO TRAITS OF PAIRS OF CONGENERIC SPECIES CHANGE ALONG A PRECIPITATION GRADIENT?

**Birgit Lang, Anna Geiger, Munkhzul Oyunbileg, Julian Ahlborn, Batlai Oyuntsetseg, Henrik von Wehrden, Karsten Wesche & Christine Römermann**
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Predicting the response of vegetation to environmental and land-use change has become an important factor in recent theoretical and applied ecological research. One essential step is to determine the individual species' reactions, because individual plant species often show intraspecific variation. To find out how traits of pairs of congeneric species with usually different but partly overlapping distribution areas change with changing environmental conditions, we established 15 sites along a precipitation gradient in Mongolian rangelands, ranging from 104 mm to 248 mm mean annual precipitation. It's a large-scale transect over 700 km from the dry desert steppe in the south to the forest steppe belt in northern central Mongolia. Each site was separated into five plots with changing grazing intensity, from highly grazed plots to almost ungrazed plots. We focused on the three species pairs *Stipa krylovii* and *S. glareosa*, *Artemisia frigida* and *A. adamsii*, *Caragana microphylla* and *C. leucophloea*, which are common species in the Mongolian rangelands. All measurements were carried out on eight healthy adult individuals per grazing level plot to cover the intraspecific variability within this plot. Just the case that not enough individuals could be found the trait measurements were performed on a reduced number of at least three individuals. We hypothesize that the trait values of the respective species gradually change and alternate according to their alternating distribution ranges along the gradients. To test this, we measured leaf economic (specific leaf area and leaf nutrients) and hydraulic traits (delta $^{13}C$) as well as traits characterizing species performances. Traits used for the characterization of individual performance were canopy height, plant width, individual plant coverage and aboveground biomass. These performance traits were chosen due to their high influence by water availability which is the limiting source in arid and semi-arid rangelands for the biomass development. Results of univariate as well as multivariate analyses will be presented and discussed in the talk.

# THE ROLE OF TRANSGENERATIONAL EFFECTS IN ADAPTATION OF CLONAL OFFSPRING OF WHITE CLOVER (*TRIFOLIUM REPENS*) TO DROUGHT AND HERBIVORY

**Vítek Latzel, Alejandra Pilar Rendina González, Veronika Dumalasová & Jiří Skuhrovec**
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Adaptive transgenerational effects increase offspring success if offspring grows in parental environment. The ecological and evolutionary role of these effects in plants have been studied almost exclusively across sexual generations and only rarely across clonal generations. We therefore investigated whether drought stress and jasmonic acid, a key hormone involved in induction of plant defenses against herbivores, applied in the parental generation trigger transgenerational effects in offspring ramets of *Trifolium repens* and whether these effects are adaptive. We found that drought stress experienced by parents significantly affected phenotype of offspring ramets created by maternal ramets that were transplanted to parental or non-parental water regime. Offspring ramets were bigger if they were produced in parental water regime (control/drought). Repeated application of jasmonic acid on parents increased the growth of offspring ramets produced by maternal ramets that were disconnected from the parental clone. These offspring ramets were not resistant to *Spodoptera littoralis* caterpillars more than control offspring ramets suggesting no increased resistance to herbivory due to transgenerational effects triggered by jasmonic acid. We conclude that environmental interaction in the parental generation can trigger transgenerational effects in clonal plants and some of these effects can be adaptive. Transgenerational effects in clonal reproduction can have significant role in growth and behavior of clonal plants and ultimately on evolutionary trajectories of clonal populations.

This study was funded by the Czech Science Foundation (project no. GA14–06802S)

# ASYNCHRONY IN FLUCTUATION OF POPULATIONS AS DETERMINANT OF STABILITY

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Asynchrony in temporal fluctuation of populations is considered to be one of the stabilizing mechanisms. Nevertheless, even measurement of asynchrony is a challenging task, because of the asymmetry – all the populations can be perfectly positively correlated, but only two can be perfectly negatively correlated. Various methods of measuring asynchrony have been suggested – we will demonstrate their advantages and drawbacks, and suggest an improved measure. We will use the data about interannual fluctuation of population/functional group biomass in two long-term experiments in grasslands (Ohrazení and Zvíkov experiments), which include also removal of a population or of a functional groups (grasses/forbs), and manipulation of the productivity by fertilization. The fertilization increases the asynchrony among populations; whereas in unfertilized plots, slight positive correlation among populations prevail, in fertilized plots, the correlation was sometimes negative (i.e. increase of one species was compensated by decrease of another one). Nevertheless, in both the cases, the fluctuations are close to the independent (the correlations are very weak). Fertilization also increases the fluctuation of individual populations, and its final effect on the community biomass is destabilizing. Finally, it seems that the stabilizing effect of asynchrony really increases with the number of populations, as predicted by various theories. The removal experiment demonstrated that both, grasses and forbs fluctuated more in mixture than when alone, suggesting destabilizing effect of competition for individual competing components.

# IMPACT OF DROUGHT INTENSITY ON SEEDLING PERFORMANCE OF SIX FLOODPLAIN GRASSLAND SPECIES

**Kristin Ludewig, Jana M. Hanke, Bianka Zelle, Annette Otte, Eva Mosner, Lutz R. Eckstein & Tobias W. Donath**
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The performance of seedlings is crucial for the survival and persistence of plant species. Although drought is an important reason for seedling mortality, the effects of drought on seedling performance of floodplain grassland species were rarely investigated. In a greenhouse study, we exposed three weeks old seedlings of six floodplain grassland species to drought events of different intensity. The six species belonged to three plant families. Within each species pair, one species was characteristic of wet and one of dry zones of European floodplain grasslands. We tested the following hypotheses: 1) Drought events reduce the aboveground biomass, the height and the specific leaf area (SLA) of the seedlings; 2) Drought events affect the seedlings of species characteristic of wet grassland zones more (show larger reduction of aboveground biomass, height and SLA) than of dryer grassland zones. Generally, the responses were species-specific. Drought events reduced the aboveground biomass of four species and the height of two species, but increased the SLA of two species. The seedlings of species characteristic of wet and dry grassland zones did not respond in a uniform way.

# SYNCHRONY OF SPECIES TEMPORAL FLUCTUATIONS IN RELATIONSHIP WITH PLANT FUNCTIONAL TRAITS

**Maria Májeková, Francesco de Bello, Jiří Doležal, Alena Vítová & Jan Lepš**
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The degree of synchrony of fluctuations of individual species in a community is among the most important factors affecting the stability of communities. The positive correlation in temporal fluctuations among species, i.e. synchrony, is generally attributed to concordant species response to variation in environmental conditions. The negative temporal correlation among species corresponds to compensatory dynamics – the decrease of one species (particularly the dominant) could allow an increase of other, often subordinate species. We asked if the temporal correlations of pairs of species are affected by their mutual functional dissimilarity. We used a 16 years long field experiment with full factorial design of fertilization and dominant removal. We collected information on plant height, leaf traits and growth form. We tested the relationship between temporal correlations of pairs of species and their mutual functional dissimilarity with a Mantel test. We then compared temporal correlation of species of three height classes and tested differences in temporal correlations of pairs of species in the six height groups with one-way ANOVA and Monte Carlo permutation test. While in general there was no significant correlation between the synchronization of pairs of species and their traits dissimilarity, the pairs of the smallest species exhibited the highest positive synchrony, likely due to a concordant response to suppression or decrease by the stronger competitors (tallest species). Similarly, the pairs of tallest species often exhibited no or negative correlation in time suggesting they were alternatively over-competing each other across years. The results indicate that positive synchrony is not just an effect of fluctuations in abiotic conditions and that competition can affect patterns in community fluctuations.

# DOES PHYLOGENETIC DISTANCE BETWEEN INVASIVE AND NATIVE PLANTS MATTER?

**Eva Maria Malecore & Mark van Kleunen**
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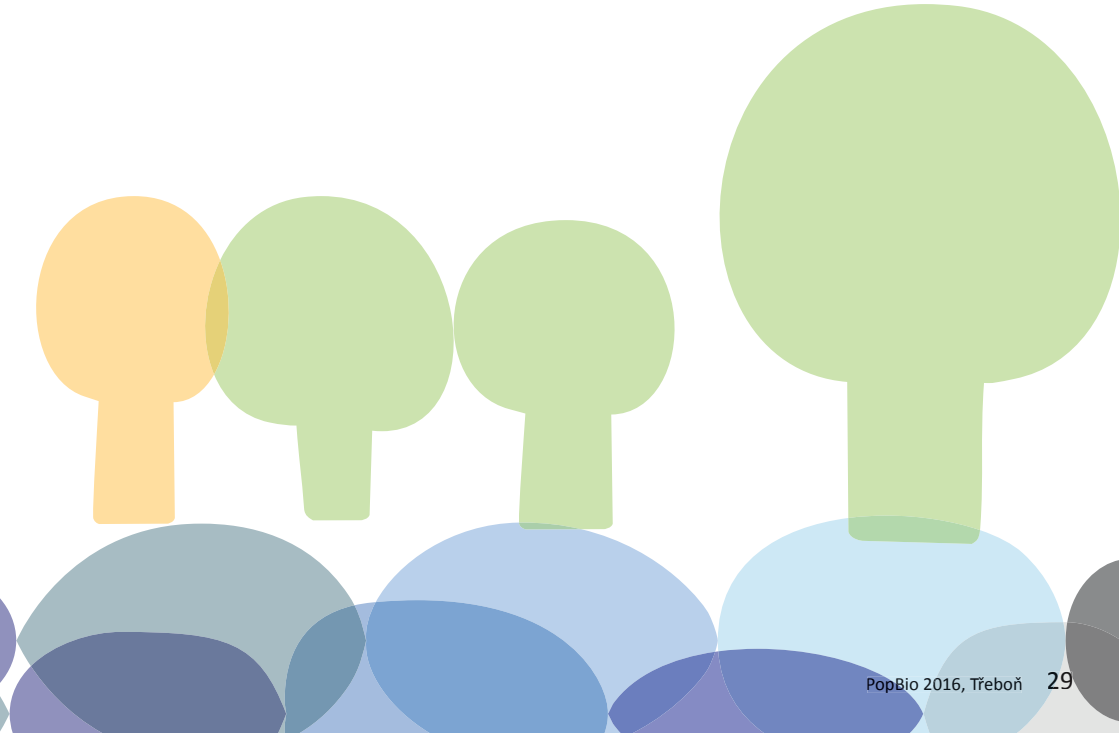
In the field of (plant) invasion biology one of the major goals is to determine the factors that allow an alien species to become invasive. The phylogenetic distance of an invasive plant to the native community may play a role in its establishment success in that community. Alien plants more closely related to native plants may suffer more from competition, because of increased niche overlap (Darwin's naturalization hypothesis). On the other hand, relatedness and similarity in niche requirements can be linked to preadaptation, and thus could facilitate invasion. To assess the role of phylogenetic distance in the establishment success of alien plant species, we used an already existing dataset, where alien plant species where introduced in grassland sites in Switzerland. We calculated three phylogenetic distance measures: (1) the mean phylogenetic distance to all resident native species, (2) the phylogenetic distance to the most abundant resident native species, and (3) the phylogenetic distance to the nearest relative among the resident native species. Overall, we found that alien plant species closer related to the native community are less successful than distantly related species.



# N:P:C SEED STOICHIOMETRY OF ANNUAL PLANTS

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Seed reproduction is an important part of the life cycle of plants. The emerging seedling cannot get resources necessary for its life in its early ontogeny and is hence dependent on the resources stored in the seed. Mother plant must put into the seed not only enough nutrients for the seedling development, but also the nutrients need to be in right proportions. This is particularly true for annuals which do not have any other possibilities such as clonal growth or postponing seed production due to wintering to the better season. Nutrient stoichiometry, especially stoichiometry of basic macronutrients like nitrogen, phosphorus and carbon, play an important role in natural processes such as growth. To optimise very precisely the seedlings' start conditions, nutrients stored in the seeds, is so more than necessity. It is likely that plants from soil-limited environments and plants from light-limited environments (i.e. experiencing different degree of competition for light and for nutrients) will have different seed stoichiometry and may also differ in their seed sizes due to different impact of asymmetric above-ground and symmetric below-ground competition. This work reports on with comparative nutrient stoichiometry of set of 53 annual species. We determined ratio of nitrogen, phosphorus and non-structural carbon in their seeds. We examined the relationship between nutrient stoichiometry and seed mass, and ecological conditions where the species typically occurs (namely nutrient status of their habitats and level of disturbance). As both seed nutrient stoichiometry and seed mass may be phylogenetically constrained, the data were also analyzed taking these relationships into account.

# THE ROLE OF HERBIVORE INDUCTION IN DETERMINING METAL HYPERACCUMULATION

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Some plant species actively accumulate exceedingly large amounts of heavy metals from the soil, a trait known as metal hyperaccumulation (mh). A key hypothesis proposed to explain mh is the elemental defence hypothesis, which suggests that mh may function as a defence strategy against herbivores. However, none of the previous studies have investigated if mh can be induced by herbivores. In this study we examined the role of herbivore induction in mh via root foraging or clonal sharing in the clonal plant *Arabidopsis halleri*. In the root-foraging experiment, plants were grown in a split root design with one root in Cd-rich soil and the other in Cd-poor soil with or without herbivore induction with Jasmonic acid. In the clonal-sharing experiment, two connected *A. halleri* ramets were grown with one ramet in Cd-rich soil and the other in Cd-poor soil with or without herbivore induction. The results of the two experiments reveal that herbivory can induce both root foraging for heavy metals as well as metal hyperaccumulation and metal sharing and among ramets, particularly in *A. halleri* originating from non-metalliferous soils, suggesting that mh might have a selective advantage in these habitats.

# RECENT LAND-USE CHANGES IN MANAGED GRASSLANDS OF THE SWISS ALPS AND THEIR IMPACT ON PLANT DIVERSITY

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Land-use changes motivated by socio-economic pressure are among the most important drivers for biodiversity in grasslands worldwide. In the Swiss Alps the impact on grasslands through intensification and abandonment was particularly strong during the decades since World War 2. We explore plant diversity in 216 grassland parcels at three altitudinal levels in 12 villages of three cultural traditions (Romanic, Germanic, and Walser). Twelve years ago, biodiversity of these grassland parcels was assessed a first time and suggested that a high land-use diversity promoted plant species richness in villages. Moreover, the type of land-use influenced species-richness of parcels the most. The land use changes observed 12 years ago reduced farmers' workload but decreased plant species diversity in parcels. Since then, the system of financial incentives for farmers was changed promoting among other things biodiversity of alpine grassland. We therefore re-examined the formerly studied parcels again in 2014/15, to assess, (1) whether changes in land-use had occurred, (2) if they occurred what their impact on plant species richness was, and (3) how much the observed changes were motivated by former and current financial incentives towards farmers. We found a surprisingly high change in land-use over the relative short time of 12 years. Although intensification and abandonment is still taking place, transitions to less-intensive land-use types were predominant indicating a positive response to incentives. Most recent land-use changes occurred in the mountainous valley bottom, were intermediate in subalpine regions, and least at the alp level. The shift towards less-intensive land-use types had a positive influence on maintenance and re-establishment of plant species richness including a gain of rare and threatened Red List species.

# FUNCTIONAL TRAIT DISSIMILARITY DECREASING THE EFFECT OF COMPETITIVE HIERARCHIES IN PLANT INTERACTIONS

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Ecologists have long understood that trait differences between species can maintain diversity in communities by promoting specialization and reducing competition. Interestingly these hypotheses remain largely unexplored in the context of multiple functional traits. Here we test the assumption of greater competition between functionally similar species. We conducted a pot experiment where genetically identical individuals of the apomictic species *Taraxacum brevicorniculatum* were grown in competition with 10 different species and itself (intra and interspecific competition). In all cases, a focal *Taraxacum* individual was planted in the centre of the pot in competition with 6 individuals of one of the 11 species; we replicated each of these treatments eight times. Above and belowground vegetative traits, offspring and total biomass were measured at the time of harvest. Additionally, the same traits of the 11 species grown without competition were measured to estimate functional distance to *Taraxacum*. We used general linear models to detect the relationship between the functional distance of each species and the intensity of its competitive effect on *Taraxacum*, considering also the effect of the aggregated biomass of the competitors in each pot. As expected, competitive effects increased with greater functional similarity of the competitor, i.e. the biomass of the focal *Taraxacum* was smaller when growing with more functionally similar species. Interestingly, we found an interaction between competitors' aggregated biomass and functional dissimilarity: when competitors' biomass was low, competition effect was stronger when the competitor was similar to *Taraxacum*; but when competitors' biomass was high, competition intensity increased and became relatively independent of functional dissimilarity. Our trait-based competition experiment confirms the theoretical expectations of the combined role of competitive hierarchies and functional trait dissimilarity in shaping plant-plant interactions.

# IS THE STORAGE EFFECT IN PLANT POPULATIONS RELATED TO PLANT COMMUNITY DIVERSITY?

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Grasslands are habitats offering the growth environment for a high number of plant species. It is not well understood what drives high species diversity at small scale and facilitates species coexistence. One mechanism driving coexistence is the storage effect. It describes the ability of populations to survive by relying on strong recruitment events in favorable years and the longevity of the established individuals in other years. Since it is difficult to detect such events under field conditions, little is known about the implementation of the storage effect in plant populations and the effects of species diversity on it. One possibility to study the storage effect is to regularly monitor permanent plots with marked plant individuals. However, this method is very laborious and tedious. Thus, we used growth-ring analyses. This method offers a possibility to detect years with strong recruitment events and to find long-lived individuals in only one sampling campaign. We worked with three common meadow species: *Plantago lanceolata*, *Plantago media* and *Knautia arvensis*, which form well distinguishable plant individuals with a relatively long-lived primary root and are therefore well suited for growth-ring analysis. We conducted our study in the Jena Experiment, a long-term grassland biodiversity experiment which allows for observing plant populations in plant communities of different species diversity (1 to 60 species) under the same environmental conditions. From each plot containing our species we sampled 20 specimens for each species. While the strongest cohort in *P. lanceolata* and *P. media* was three years old, it was four years old in *K. arvensis*. Age distribution of *K. arvensis* was slightly skewed to a higher proportion of older individuals, while this was not the case for both *Plantago* species. We also found that increasing plant diversity affects the age structure of the plant populations, but effects of plant diversity are species-specific.

# THE GOOD, THE BAD AND THE RAINFALL - DRYLANDS' STABILITY TOWARDS POSITIVE AND NEGATIVE RAINFALL ANOMALIES

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There is broad consensus that global change will increase the level of land-use and environmental stressors such as drought and grazing in drylands in the foreseeable future. These projected changes have the potential to considerably hamper primary production and the provision and functioning of ecosystem services in these regions. In a recently published study (Ruppert et al. 2015, Glob Change Biol), we could show that combined effects of drought and grazing may have tremendous effects on dryland stability assessed as the resistance to and recovery after a drought in aboveground net primary production. One of the main outcomes of the study was that drylands' stability is mainly related to the dominant life history of the herbaceous layer, hence, to principal strategies of resource acquisition and allocation (annual vs. perennial). Systems with an herbaceous layer dominated by annual vegetation were considerably less resistant during droughts, but showed considerable higher recovery after these have ended. However, with increasing length and severity of droughts under future climate regimes, odds are that systems dominated by annuals will gradually degrade and ultimately desertify (e.g. via seed bank depletion following recruitment failure). However, climate change will not only increase the frequency and severity of negative rainfall anomalies (i.e. droughts), but also that of positive anomalies. Still, little to none is known about drylands' responses to positive rainfall anomalies. The presented study seeks to fill this gap of knowledge and studies whether negative and positive rainfall anomalies act strictly in opposition to one another and whether there are differences in responses across the principal strategies of resource acquisition and allocation.

# INBREEDING LIMITS RESPONSES TO ENVIRONMENTAL STRESS IN *SILENE VULGARIS*

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Plants can respond to different environmental conditions by plastically changing morphological and physiological traits and patterns of biomass allocation. To test if these responses are influenced by inbreeding, we grew clones of self- and cross-pollinated offspring of *Silene vulgaris* under eight different stress treatments, including a control, drought, copper addition, simulated herbivory, and two levels of nutrient deficiency and of shade. Four non-reproductive traits, stem length, leaf area, leaf chlorophyll content and specific leaf area (SLA), were higher in the shade treatments than in the control, and lowest under nutrient deficiency, which can be regarded as functionally appropriate responses to the different conditions. The plasticity of these four traits was lower in offspring from self- than from cross-pollination. Biomass allocation patterns changed in response to the environment in agreement with the optimal partitioning theory, but were not influenced by inbreeding. Two traits potentially involved in general stress response – leaf senescence and the proportion of leaf area that is red, a measure of anthocyanin production – were increased under copper stress and nutrient deficiency but reduced in the herbivory and shade treatments. Leaf senescence was higher and the proportion of red leaf area lower in selfed than in crossed offspring. Fluctuating asymmetry (FA) of leaves, a measure of developmental instability, differed among stress treatments, but was not generally higher under stress. Inbreeding increased only one measure of FA, and only under high stress intensities. Our findings suggest that by reducing phenotypic plasticity, inbreeding limits the ability of plants to cope with changing environmental conditions. In *S. vulgaris*, leaf fluctuating asymmetry does not serve as an indicator of environmental stress, nor of genetic stress by inbreeding.

# ENVIRONMENTAL VARIABILITY AND INTRASPECIFIC DIVERSITY AFFECT POPULATION INVASIBILITY

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Evidence suggests that plant populations with low intraspecific diversity may be more susceptible to invasion than populations with high diversity. There is also evidence that environmental variability can promote invasion. However, it has not yet been investigated how intraspecific diversity and environmental variability interact. Such complex scenarios are increasingly likely in the future, as diversity continues to decline and climate becomes increasingly variable. To explore this, we grew artificial populations of *Arabidopsis thaliana* ecotypes of different diversity levels together with a strong competitor, Senecio vulgaris, under constant versus temporally variable temperature conditions. We assessed survival and phenology and measured vegetative and reproductive aboveground biomass of both species to assess their relative performance. In line with our expectation, increasing intraspecific diversity in *Arabidopsis* populations had a small but positive effect on the reproductive investment of *Arabidopsis* and on the *Arabidopsis*/*Senecio* aboveground biomass ratio. In contrast to expectation, we found that variable compared to constant temperatures led to higher survival rates, advanced phenology and stronger biomass accumulation of *Arabidopsis* at the expense of *Senecio*. These two responses did not interact. We conclude that climatic variability can change the competitive balance between species and that intraspecific diversity may decrease invasibility of plant populations. We speculate that a broader niche occupancy may explain the observed diversity effects on population invasibility.

# WHAT PREDICTS DISEASE PRESSURE IN PLANT COMMUNITIES: HOST ABUNDANCE, PHYLOGENY OR SPECIES ORIGIN?

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Pathogens can play an important role in shaping diversity of local communities by stabilizing – or destabilizing – plant species coexistence. A continuing debate refers to the potential host-density dependence of pathogen infestation, producing a rare-species advantage. In our study we additionally ask if there is a link between the abundance-related aspect of disease pressure and the enemy release hypothesis, suggesting that the invasiveness of exotic species is related to the absence of natural enemies in their new environment. Furthermore, variation in pathogen infection among plant species may also be affected by their phylogenetic relatedness, e.g. because of pathogen spillover onto closely related species. Working in US-midwestern grasslands and forest edges, we recorded pathogen infestation on all aboveground plant parts of species in three different communities as percent tissue diseased. Using relative abundance data for plant species and phylogenies for all communities we are then able to study the relative importance of these three factors for the incidence and diversity of fungal pathogens.

# IS THE EFFECT OF CLIMATE CHANGE LESS DRAMATIC THAN EXPECTED? LESSONS FROM A STUDY OF SHRUB SEEDLINGS

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Climatic conditions are crucial for the success of seedlings and may dictate population's establishment rate in the case of long-lived species. Therefore, it is expected that shrub seedling survival will be reduced in semi-arid regions, where climate-change models predict a reduction in rainfall availability. Additionally, the effect of rainfall on seedling performance is closely linked with the effect of neighbors. In particular, it is predicted that the negative impact of neighbors will weaken with decreased rainfall. Because climate change is expected to affect the whole community and not just individual species, predictions regarding its impact must be tested in relation to the effect on the interactions between species. Surprisingly, only few experimental studies have explicitly combined these factors. We tested the potential effect of the predicted decrease in rainfall on seedling survival of a dominant shrub species, in relation to neighbor presence. We used two approaches: 1) a space-for-time approach, studying the survival of shrub seedlings along a natural aridity gradient that mimics the predicted rainfall change. 2) an experimental approach, simulating the predicted change in rainfall using rainout shelters. In both experiments the effect of water availability was tested relative to the effect of the natural herbaceous neighbors. Our results show that neighbors always had a negative effect on shrub seedling survival. Moreover, unlike our expectations, the negative effect was intensified with reduced rainfall availability. Additionally, shrub seedlings that originated in arid conditions showed better survival than seedlings of mesic conditions. The unexpected results emphasize the importance of incorporating biotic interactions in studies of climate change effects and suggest that plant species growing in ecosystems prone to rainfall variability and dry conditions may be more resilient to climate change than previously predicted.

# EFFECTS OF GENETIC ADMIXTURE ON LOCAL ADAPTATION

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Admixture is the hybridization between previously isolated populations within one species. It can play a role in biological invasions by creating novel genotypes, increasing genetic diversity and lifting inbreeding depression. These benefits should also be prevalent in the native range. However, in the native range, through long-term evolutionary processes populations often are adapted to their local environments. Admixture with distant populations could break down this local adaptation by diluting the locally adapted genomes. Moreover, plant fitness would be further reduced by the breakdown of co-adapted gene complexes in following generations. Subsequently, in the native range admixed genotypes would be selected against by local environment, despite the benefits of heterosis. Here we tested the effect of admixture on local adaptation in the native range of the invasive plant Lythrum salicaria. We proposed the following hypotheses: 1) Native populations are locally adapted; 2) Admixture reduces fitness of the local populations in their home environment. We created three types of F1 offspring, with increasing parental distance, through controlled crosses in the greenhouse; within population F1, between population F1 and between region F1. We also obtained F2 seeds of all cross types. F1 and F2 seedlings were reciprocally transplanted at three common gardens across Europe (Wageningen, Potsdam, Tübingen) in pots with field soils inoculated with soil of the local focal population. Vegetative and reproductive traits were measured and levels of herbivory were recorded for two growing seasons. The first results show clear differences in plant growth between the three sites. Genetic admixture affected plant performance of both F1 and F2 offspring. We will discuss our results in the context of the balance between local adaptation and inbreeding depression in native populations and how the shift of this balance could lead to increased benefits of admixture in the introduced range of invasive species.

# MORE THAN JUST HETEROSIS: ADMIXTURE BETWEEN NATIVE AND INVASIVE *MIMULUS GUTTATUS* HAS BENEFICIAL EFFECTS BEYOND THE FIRST GENERATION

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Few studies have addressed the potential facilitating role of ongoing hybridization (i.e., admixture) in species that have already become invasive beyond the first generation. Here, we used plants of *Mimulus guttatus* from seven native North American populations, three invasive Scottish populations and four invasive New Zealand populations to address this. We generated two generations of seeds by self fertilisation, within-population outcrossing, between-population outcrossing within the same range, and outcrossing between the native and invasive ranges. In the first generation, between population outcrossing (especially between ranges) resulted in heterosis in terms of growth, and asexual- and sexual reproduction. In the second generation, the benefits of admixture could still be detected for some traits, but in general heterotic effects were reduced compared to the first generation or absent. However, admixture generally did not lead to hybrid breakdown, even when F2 progeny was formed by selfing. This suggests that breakdown of co-adapted gene complexes are of minor importance, and that the net-effects of admixture are positive. If this pattern can be generalized to other invasive species, it may be wise to impose restrictions on the import and export of already invasive species (which now normally do not exist).

# DEMOGRAPHY OF THE GIANT MONOCARPIC HERB *RHEUM NOBILE* IN THE HIMALAYAS

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Perennity combined with a single „big bang“ reproduction followed by death of the genetic individual is relatively rare among plants. Such monocarpic life histories are sometimes found in slow-growing plants of deserts, bogs or in alpine regions of the tropics or subtropics. A rosette stage of several years to decades is followed by a shift of all resources into a spectacular inflorescence and a heavy seed crop in a single year. Monocarpic perennials are vulnerable species. However, due to the inherent difficulties to assess if long-lived populations are growing or declining, their conservation status is frequently not known. We used integral projection modelling (IPM) to measure growth rate and passage time to flowering of *Rheum nobile*, a monocarpic perennial, and one of the most striking among the alpine plants from the Himalayas. In IPM's demographic rates are modelled as continuous functions of an individual's size rather than using discrete classes as in classical matrix models. Data was collected from plants at 4500 m, a.s.l. in Shangri-la County, Yunnan Province, southwest China. In four consecutive years (2011-14) and in two populations, 385 and 370 individuals were measured, respectively, and size-dependent growth, survival and fecundity parameters were calculated. In addition, germination percentage and seedling survival was assessed in both populations. Time to reach flowering size was on average 33.4 ± 4.1 years across time and populations. The mean population growth rate (λ) was 1.03 ± 0.04. When disturbance by grazing cattle was included in the model, λ dropped to values below 1.0. We conclude, that natural populations of *Rheum nobile* are sustainable, but that conservation efforts should be made to minimise human disturbances and to protect this slow-growing flagship species of the Himalayan mountain range.

# EXPERIMENTAL ASSESSMENT OF THE ROLE OF BIOTIC INTERACTIONS IN DELIMITATION OF THE COMMUNITY SPECIES POOL

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Differences in species composition between a community and its species pool are expected to reflect the effect of biotic community filters; however this could not be the case if the definition of species pool excludes species that actually cannot live in a site because of competition. If we define the species pool as a set of species able to reach a site and form a viable population in a given abiotic environment, the difference in species composition should correspond to the effect of biotic interactions. However, most of the operational definitions of the species pool are based on co-occurrence patterns (definitions based on the functional plant traits, Ellenberg indicators or Beals index) and thus also already reflect the effect of biotic relationships. We conducted a sowing experiment on the moisture gradient to demonstrate that many species not accounted by current measures of species pools in a site should be included because they are in fact able to establish successfully if competition is removed. In our experiment, we studied the establishment and survival of species after the removal of competition and in intact vegetation; the investigated species included 12 species resident in the locality and 18 species typical for different habitats and not expected in the species pool according to existing algorithms. Many of the species with different habitat preferences were able to grow in the focal habitat if competition was removed (including species typical for much drier conditions: *Sanguisorba minor* which reached the reproductive stage, and *Hypericum hirsutum*, *Nardus stricta*, *Origanum vulgare*, *Thymus pulegioides*, *Trifolium montanum*, *Carlina acaulis*), but none of them survived under the competition of the intact community. These species are thus not limited by abiotic conditions, but by competition. Beals index was the best predictor of species relative success in the intact community, followed by matching of the Ellenberg indicator for moisture to the community weighted mean of the plot where plants were transplanted; other Ellenberg indicators had no explanatory power. Comparison of realized vegetation composition with the corresponding species pool can greatly underestimate the potential impact of the biotic filter if the delimitation of the species pool is based on the realized niches of species.

# ON THE EFFECT OF ENVIRONMENTAL FILTERING VERSUS BIOTIC INTERACTIONS ON INTRASPECIFIC TRAIT VARIABILITY

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Plant functional traits are widely used in ecology. Often so called species mean trait values are applied relying on the assumption that in macroecological contexts the intraspecific trait variability (ITV) is much smaller than the interspecific trait variability. At the same time – due to several dedicated studies and the emergence of comprehensive trait databases such as TRY - it has become obvious that many plant functional traits can vary substantially for a given species and it becomes unclear when ITV should be included in trait based research. We provide a field study on ITV aiming to disentangle the effect of environmental filtering and species interactions (neighborhood effects). We measured individual based trait distributions for five species based on 62 populations and 1082 individuals across Europe. We have further measurements on site conditions and the traits of the four most important neighbors respectively. We can show that biotic interactions as well as environmental filtering influence ITV. Using variation partitioning we show that a great proportion of ITV can be explained either by both - biotic interactions or by environmental filtering. This points to a combined effect where the environment shapes the biotic interactions which in turn shape ITV.

# FIELD EXPERIMENT TESTING FOR THE EFFECT OF FIRE SEASON ON PLANT REGENERATION RATE AND ON SPECIES COMPOSITION IN MEDITERRANEAN WOODLAND

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Plants regenerate after fire by resprouting or via seed germination. We suggest that fire season can have important consequences on the post-fire regeneration rate of plants adopting these two different strategies, leading to changes in community composition. Specifically, we hypothesized that autumn fires will be more intense then spring fires, due to lower plant and soil water content, thus, creating new microsites for seed germination, i.e., favoring the seeder strategy. Resprouters, on the other hand, will regenerate faster following spring fires, which inflict lower damage on their tissues compared to autumn fires. We also hypothesized that autumn fires will reduce dominance level to a greater extent than spring fires, while increasing the abundance of less prevalent species, resulting in a higher community diversity. To test these hypotheses, prescribed spring and autumn fires were conducted in Mediterranean woodland in Israel. Community composition surveys were held before and after the fires. Resprouting and germination capacity were evaluated during the first post-fire growing season. Autumn fires were more intense than spring fires in terms of flame heights and above- and below-ground temperatures. Germination densities did not differ between spring and autumn fires, but were significantly higher in burned than in unburned areas. Resprouting occurred only in the burned areas, however, resprouting intensity did not differ significantly between the spring and autumn fire treatments. The relative growth rate of the most dominant resprouter, Pistacia lentiscus, was significantly faster after autumn fires. Autumn fires decreased dominance and increased the abundance of less prevalent species, resulting in higher community diversity compared to spring fires. Our findings illustrate that fire season influences community composition through its differential effects on different plant species.

# MISSION SUICIDAL – PUTATIVE TRAGEDY OF THE COMMONS LEADS TO STERILE POPULATIONS IN FOUR DENSELY GROWING *ARABIDOPSIS THALIANA* ECOTYPES

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During the decades of using *Arabidopsis thaliana* as model organism in genetical, physiological and ecological studies various ecotypes and recombinant inbred lines have been grown in dense stands with high degree of intraspecific competition. In only one case (plants sown as densely as ca 333 000 seeds per square meter) a 94% sterility in mature plants has been reported (Myerscough & Marshall 1972). We sowed 20 ecotypes of *A. thaliana* with considerably lower density (ca 11 000 per square meter) and observed fine vegetative growth but 100% sterility in four ecotypes (Can-0, Cvi-0, Mt-0, Zu-0). Among these only Mt-0 flowered and built sterile siliques, the remaining three did not produce generative organs at all. The sterile ecotypes grew significantly more roots than fertile ones (per unit area as well as per individual plant) and their per capita total biomass was significantly higher. This allows to suspect that population level sterility was a drastic (suicidal) result of the tragedy of the commons – excessive allocation to competitive organs led to an inability to produce generative structures or to produce seeds in small but fully developed siliques. Further studies are in process to explain this phenomenon.

Myerscough, P. J. & Marshall, J. K. 1973. Population dynamics of Arabidopsis thaliana (L.) Heynh. strain Estland at different densities and nutrient levels. New Phytologist 72: 595-617.

# ENVIRONMENTAL CUES - THEIR ROLE IN THE GROWTH OF CLONAL PLANTS

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Seed germination, flowering onset, height - these plant traits are well known to respond to environmental cues. Although plants are mostly clonal, differences in clonality syndrome, both plastic and inter-specific, are seldom linked to the environment. Using experimental data for several dozens of species, we show some of these patterns. We show that clonal plants are less likely to root-forage for nutrients than non-clonals, and we hypothesize that clonals forage by ramets instead of roots. At least in one case, formation of new ramets is triggered by the nutrients availability in the environment, what strengthens the nutrient-clonality link further. On the other hand, spatial extent of the clonal propagation is affected by the environment in a more intricate way: light availability, neighbour presence and availability of belowground resources all take their part in the process. Apparent difficulty of the synthesis may be eased when light is shed on the differences within the clonal plants group, identifying possible apples and oranges.

# INTRASPECIFIC FACILITATION: RESPONSE AND EFFECTS OF CONSPECIFIC GENOTYPES WITH DIFFERENT STRESS TOLERANCE

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Plant interactions are at the core of ecology, especially for understanding and predicting the response of plant communities to complex environmental changes. In nature, plants species can affect each other both negatively and positively. However, there is more and more evidence for positive interactions in the past two decades, plants can also help each other through shading, hydraulic lift, fertility islands, mycorrhizal fungal networks, protection from herbivore and decreasing the performance of a third species, etc. One eminent difference between competition and the increasing body of facilitation studies is that facilitation has been mostly observed or studied in an interspecific context, but concepts of intraspecific facilitation have been not cogitated before or in a very limited theoretical framework. In the greenhouse, we conducted an experiment to study the facilitation in conspecifics of cohorts. In this experiment, we used different genotypes of *Arabidopsis thaliana* to test our 4 hypotheses: 1. In stressful environments, positive interactions can overwhelm competition even for conspecifics; 2. Stress-Gradient-Hypothesis still holds for intraspecific facilitation; 3. Non-tolerant genotypes should demonstrate stronger facilitative response to conspecific neighbors; 4. Non-tolerant individuals are better neighbors in stressful environments.


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# INTRA- AND INTER-SPECIFIC PLANT INTERACTIONS: AN EXPERIMENTAL APPROACH USING THREE MODEL SPECIES

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Competition is regarded as one of the most important factors shaping dynamics, composition, and structure of plant communities. However, there is much less agreement about the mechanisms by which competition functions, and through which it is defined. We suggest that a better assessment of the relationships between plant traits, resource depletion and performance outcomes across species may provide a better understanding of the underlying mechanisms of plant interactions. Specifically, we assess the generality of competitive mechanisms by comparing intra- and inter-specific competition of three related model species: *Arabidopsis thaliana* (At), *Anastatica hierochuntica* (Ah) and *Eutrema salsuginea* (Es), (Brassicaceae). To achieve a better insight into plants' performance when experiencing competition, we employed phenological measurements, such as number of leaves, flowers, and above/below ground biomass as well as physiological measurements such as stomatal conductance, non-photochemical quenching and water content. Under intra- and inter-specific combinations, a decrease pattern in water content and stomatal conductance was seen in (At) and (Es) individuals. Contrarily, (Ah) showed an increase under the same conditions mentioned above. Phenological observations were more variable among the three species. A reduction on the average number of leaves and developed flowers was observed under intra- and inter-specific competition in (Es) and (Ah) individuals. Contrastively, inter-specific interactions showed only an increase in survival and fecundity in (At) at the expense of plant biomass. Under such control conditions it was difficult to find a common response of plants to their neighbors, probably because of different adaptations of the three species. Additionally, we showed that related species may employ different mechanisms for survival that engage unique plastic responses. We suggest that this study will enable us to provide a stronger theoretical basis for the study of plant interactions through an integrative approach combining ecological and physiological knowledge and, to reduce miscommunications due to different interpretation of fundamental concepts of plant ecology.

# HOW FAR CAN WE GO AND GROW TOGETHER? LATERAL SPREAD AND PERSISTENCE OF CONNECTION IN CLONAL PLANTS

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Plants often seem to prefer sedentary lifestyle; however, some of them are more restless than others and like to move horizontally to whatever direction. Clonal plants can move via vegetative growth of stem derived organs or roots diverse in their morphology, which are often hidden beneath the soil surface. This complicates measurements of clonal traits, including lateral spread and persistence of connection. Lateral spread is distance between shoots produced in following years. Persistence of connection describes how many years are parent and offspring ramets interconnected. Although much data about these two traits is available in CLO-PLA 3 database (http://clopla.butbn.cas.cz), they are divided into quite broad categories and lack preciseness. We decided to get more detailed data especially for longer distance lateral spread and ramets connected for more than four years. We focused on plants with epigeogenous and hypogeogenous rhizomes where seasonal increments are likely to be measurable. Plants were excavated from their natural habitats with at least two interconnected shoots or whole belowground organs and then drawn in scale. Lateral spread was measured in all years visible along the rhizome thus responding to the persistence of connection. More precise measurements can help us to assess better the roles of vegetative means of regeneration and spreading in plant communities as well as to get better picture about size of the belowground storage organs referring to belowground carbon sequestration in plants.

# THE GLOBAL CHANGE EXPERIMENTAL FACILITY (GCEF) – A UNIQUE PLATFORM TO STUDY THE ECOSYSTEM IMPACT OF CLIMATE CHANGE UNDER DIFFERENT LAND-USE OPTIONS

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Climate change scenarios predict rising temperatures and lower precipitation rates during the summer months in Central Germany. To investigate the effects of these changes on ecosystem processes, a large long-term field experiment was established in 2014. The experimental site is part of the field research station of the Helmholtz-Center for Environmental Research near Halle, Saxony-Anhalt. The GCEF was set up using a split-plot design: 10 main plots, each of 80 m x 24 m, were established to manipulate climatic conditions. Five of the main plots were randomly assigned to future climate, and the five remaining plots to ambient climate. Plots with future climate are equipped with mobile shelters and side panels to increase night temperatures. The roofs also reduce summer precipitation by app. 15% and the irrigation system increases spring and autumn precipitation by app. 5%. Control plots with ambient climate are also equipped with a steel construction, but without the mobile shelters, to account for side effects of the infrastructure. Within each of the 10 main plots, 5 subplots with a size of 16 m x 24 m were set up and randomly allocated to five different land-use scenarios: conventional farming, organic farming, intensively used grassland (mowing), extensively used grassland (mowing) and extensively used grassland (grazing by sheep). The size of the plots allows land-use management under real conditions, meaning e.g. mowing and ploughing with farm machines. We will present and discuss the first results about the effect of climate conditions on species composition and biomass yield of the different grassland sites during the first two years of the experimental period.

# DIMENSIONS OF PRECIPITATION CHANGE THAT MAY PROMOTE SPREAD OF ORNAMENTALS

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Many plant species that are invasive today have been introduced as ornamentals, and we continue to bring a large number of exotic species to our parks and gardens. It is possible that ongoing climate change will enable even more of those species to escape cultivation and spread in native habitats. In a previous experiment we showed that some exotic species were more successful relative to the natives when exposed to drought. Here we explored in detail the role of several dimensions of precipitation change on the success of exotic ornamentals. In particular, we tested the effects of drought timing, drought intensity and drought duration on the success of four exotic ornamental plant species growing together with native grassland species in mesocosm communities. We found that the relative success of ornamentals was influenced by timing, intensity and duration of the drought. Overall, drought timing seemed to play the greatest role. The ornamentals were particularly successful when they experienced early drought compared to late drought. This effect was most pronounced under strong drought, and when the plants were exposed to one long drought period rather than several shorter ones. Our results indicate that exotic ornamentals may become more successful under future climatic conditions, depending on how precipitation will actually change. Our study also highlights the importance of considering different dimensions of environmental change in ecological experiments.

# INTER- AND INTRASPECIFIC VARIATION IN STOMATAL PORE AREA INDEX ALONG ELEVATIONAL GRADIENTS AND ITS RELATION TO LEAF FUNCTIONAL TRAITS

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Stomata are mediators of gas exchange and thus important for photosynthesis and plant performance. The aim of this study was to analyze the ecological explanatory power of the stomatal pore area index (SPI) calculated via stomatal size and density. We studied the SPI on sun leaves of 22 herbaceous species on 22 study sites being distributed along two elevational gradients in the northern Alps ranging from 700 to 1800 m, a.s.l. We analyzed its correlation with other functional traits related to plant performance namely specific leaf area (SLA), area based leaf nitrogen and carbon (Narea and Carea respectively) as well as carbon discrimination $\Delta^{13}C$ within as well as between species. On a subset of four species we also measured light saturated net photosynthetic rate at ambient $CO_2$ concentration (Asat) and stomatal conductance on all sites. We found that SPI was positively correlated with Asat, yet the relation was weaker than expected. The reaction of SPI along the elevational gradients was highly species-specific and related to variations in other investigated leaf traits. The relationship with functional traits, however, differed between the inter- and intraspecific level in strength and direction. SPI was positively related to Narea and Carea and negatively with SLA and $\Delta^{13}C$ for most species. However, we found no significant relation considering species mean values for $\Delta^{13}C$ and Narea. The relation of SPI to SLA was the most consistent displaying no difference when comparing the relation between and within species. This research shows that different processes may act on different organisational levels leading to the detected differences in trait-trait correlations on the inter- and intraspecific levels. It may have important consequences also for macroecological and modelling studies.

# COMPENSATION STRATEGIES OF PLANTS

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During the vegetation season plants must face the attack of herbivore predators. One of the results of such attack is loss of the biomass. The reactions of plants which lost their tissue differ depending on the plant species and timing during the vegetation season when such loss occurred. To determine patterns in compensation ability of plants, we performed an experiment during the 2015 vegetation season, using 15 Asteraceae species. Three times in the season (with an interval of 31 days) half of the leaf biomass of the plants was cut and plants were treated by jasmonic acid to simulate herbivory. Plant species in the experiment behaved in three different ways. One group of plant species showed the highest ability to compensate after loss of the biomass in the middle of the experiment (leaves cut in late June), while the second group showed the opposite trend. The ability to compensate the loss of the biomass of the plants from the third group during the experiment was descending. While these responses represent clear-cut types of response to biomass removal and herbivory, they do not seem to be linked to any simple measured trait of the species or habitat preference.

# ECOLOGICAL NICHES AND LOCAL ADAPTATION OF TWO CLOSELY RELATED *SAXIFRAGA ROSACEA* SUBSPECIES WITH DIFFERENT PLOIDY LEVELS

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Polyploids have been found to occupy a wider range of environments than their relatives with a lower ploidy level. As they are often more heterozygous, their higher genetic diversity may confer them the ability to exist in a wider range of habitats. To evaluate the ecological differentiation between the two closely related taxa *Saxifraga rosacea* subsp. *sponhemica* (2n = 48) and *S. rosacea* subsp. *rosacea* (2n = 64), we investigated environmental characteristics of 22 populations of the two subspecies. *S. rosacea* and *S. sponhemica* showed different ecological niches as the composition of the vegetation of their habitats differed significantly. Analyses of local climatic conditions in the 22 populations confirmed this differentiation. While *S. sponhemica* is restricted to Central Europe, *S. rosacea* also occurs in Central Europe, but has a much wider distribution including the arctic. To investigate a possible adaptation to local climatic conditions in the two subspecies, we planted rosettes of both subspecies originating from different populations into field gardens in two different climatic regions: Luxembourg (Central Europe) and Iceland (arctic). The two subspecies responded differently to climatic conditions at the two sites. In Iceland, survival of *S. rosacea* was twice as high as that of *S. sponhemica*, while in Luxembourg *S. sponhemica* survived much better the more continental climatic conditions.

# TRANSGENERATIONAL EPIGENETIC VARIATION UNDER VARIABLE HEAT STRESS IN *ARABIDOPSIS* ECOTYPES

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Epigenetic variation in plant populations can change under environmental stress. In addition, there is evidence showing that epigenetic variation can be passed on over several generations, which could be a mechanism for rapid adaptation to changing conditions. Here we investigate whether climate variability can have effects on plant growth and development through epigenetic changes and whether such changes are heritable. We assessed epigenetic variation under variable heat stress in a multi-generation experiment with the model organism *Arabidopsis thaliana*. We grew seedlings from 11 *A. thaliana* ecotypes and exposed the plants to heat stress which varied in timing and frequency. To explore transgenerational effects, we collected their seeds and grew 2$^{nd}$ generation offspring under control and stress treatments. We will investigate phenotypic responses of the 2$^{nd}$ generation plants to maternal stress as well as the interaction between maternal and offspring stress. Additionally, we will investigate global methylation levels. Those data allow us to compare epigenetic variation and its transgenerational effects both among different ecotypes and between variable environments as well as the relationship between epigenetic variation, plant phenotypes and fitness.

# DO COMPETITION OR SHADING CAUSE MATERNAL EFFECTS LEADING TO TRAIT DIFFERENCES IN *ERODIUM CICUTARIUM*?

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Rapid adaptation to environmental conditions through phenotypic plasticity is crucial for plants to maintain fitness across a range of diverse environments. It has been shown that such adaptations may not only happen as a response to current conditions, but also to those experienced by the parents. Light is a crucial resource for plants and cross-generational effects of light conditions seem likely. We chose the annual grassland species *Erodium cicutarium* to investigate the influence of light conditions experienced by the maternal plants on trait expression and plasticity in the offspring. We collected seeds in eight populations that differed in the level of competition, and grew them in two experiments with well-defined light conditions and controlled competition. Seeds harvested from these experiments were planted in experimental blocks, with one half of each block being shaded by light filters and the other half remaining unshaded. We expected seeds from mothers growing in competition or shading to be lighter and more variable, and based on inferior provisioning of those seeds we expected faster growth and postponed flowering. In addition we expected plants descending from mothers growing in shade or competition to show lower plasticity in response to shading. Maternal light conditions affected seed size and variability of seed size, size and growth rate of rosette diameter, and increase in leaf length in *E. cicutarium*. Furthermore interactions between competition proxies measured at source population sites and maternal environment were detected for rosette diameter. Offspring of plants experiencing artificial competition and light conditions similar to those at the source population sites expressed the largest rosette diameters. These results seem to indicate a generation-spanning plastic response to shading, potentially enhancing fitness of offspring facing the same environmental conditions already experienced by their mothers.

# INCREASED HERBIVORY AFTER CLIMATE CHANGE WILL NOT ENDANGER *SALVIA NUBICOLA* IN NEPAL

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Organisms are going to move upwards in the mountains due to rise in temperature in near future as a consequence of climate change. As plants are likely to migrate at slower rates than herbivores, the climate change will not only change plant species distribution but also the intensity of plant-herbivore interactions. This change might lead to alternation in strategies how plants respond to herbivore damage. We thus studied population dynamics and herbivore damage of *Salvia nubicola* along a wide elevational range in the Himalayan region. Further we tried to predict effects of climate change on plant-herbivore interactions by estimating performance of the plant populations in the presence of changing herbivore pressure. Since we recorded strong differences in the extent of herbivore damage along the elevational gradient, we expected that plants from different populations along the elevational gradient will be adapted to current herbivore pressure and respond to herbivory in different ways. Surprisingly, it was not the case and although we found positive effect of herbivore damage on survival of *S. nubicola* and negative effect on length of the inflorescence (seed production), these effects were consistent in populations from low and high elevations. Although we found differences in population dynamics and extent of herbivore damage between populations from high and low elevations, there were no significant differences in their populations' growth rates and response to herbivore damage. Populations of *S. nubicola* thus seem not to be endangered by increased herbivory under future climate change.

# DOES RESOURCE SHARING HELP TO WIN IN COMPETITION?

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Plants with clonal integration of ramets have been shown to cope better with environmental heterogeneity. Moreover, it is often assumed that clonal integration could be beneficial in competition with other plants as the competitors themselves generate heterogeneity in both belowground resources and light. However, this hypothesis has not been yet properly tested. Study of experimental communities poses one of possible approaches to this issue. Prior to conducting our own experiments, we have started with exploring data from a long-term biodiversity experiment in Jena. In this experiment, grassland communities were established by sowing different combinations of species to experimental plots. These communities vary in number of sown species as well as in proportion of clonally integrated species. Biomass of individual species is reported annually, which allows us to observe success of clonally integrated species in different communities. We address following questions: (i) Does biomass of clonally integrated species in the communities differ from their expected biomass? (ii) Does proportion of clonally integrated species affect species richness and productivity of the communities?

# ASSESSING SEED ZONE DELINEATION OF GRASSLAND SPECIES WITH GENOTYPING-BY-SEQUENCING (GBS) DATA

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Next-generation-sequencing allows genotyping at thousands of loci and thus may outperform traditional genetic marker types like AFLP. Here, we compare genetic differentiation among accessions of two plant species (Arrhenatherum elatius, Hypochaeris radicata) from eight German seed transfer zones based on GbS-SNP and AFLP data. Moreover, we test, whether pooling of samples is possible for GbS and compare results of pooled and individual data. Preliminary analyses show that in general AFLP and GbS-SNPs produce similar patterns of genetic differentiation. However, pooling of individuals for GbS-SNP analysis is feasible and might allow cost-efficient genotyping with much larger numbers of markers than AFLP thus giving higher genomic coverage.

# A TEST ON THE EFFICIENCY OF A NOVEL DEMETHYLATION AGENT-SPRAYING METHOD

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Heritable epigenetic changes play an important role in ecology of plants. Changed DNA methylation patterns are one of the key mechanisms of this non-genetic inheritance. Several studies have demonstrated that DNA-methylation marks can be successfully removed from plant DNA by germinating seeds in demethylating media such as 5-azacytidine solution. Although this method is efficient in terms of demethylation, seedlings treated this way exhibit development problems at later stages, especially in the development of roots. Here we present a test of a novel, and potentially less aggressive method to apply the demethylation agent: repeated spraying of 5-azacytidine solution on leaf tissue of growing plants. We established a pot experiment to test the efficiency of the novel method and compare it to the standard practice. To reduce the effect of genetic and epigenetic variation in the experiment, we collected seeds from individuals of an apomictic species, *Taraxacum brevicorniculatum*, grown in the same conditions for several generations. Seeds were divided into three groups; seeds in the first group received the traditional treatment (seeds were germinated in filter paper saturated with 5-azacytidine), the second group was sprayed with a 5-azacytidine solution daily right after germination, the third group was a control experiencing no demethylation. The effect of individual treatments was evaluated both at morphological level by measuring shoot and root traits and at molecular level by quantifying the amount of methylated DNA using a standardized global methylation quantification kit.

# FLUCTUATIONS OF FLOWERING PLANTS NUMBERS IN LOCAL POPULATIONS OF A MONOCARPIC SPECIES (*VERBASCUM SPECIOSUM* SCHRAD.) AT NORTHERN LIMIT OF ITS GEOGRAPHICAL DISTRIBUTION: TWENTY YEARS STUDY

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Mullein *Verbascum speciosum* Schrader is a threatened plant species of the Czech and Slovak Flora, included into the Red Data Book of the Czech Republic and Slovak Republic (Holub, Eliáš 1999). As a monocarpic plant it forms flowering stalk in 3rd to 5th years (Eliáš 1985, 1988, 1986), depending on environmental conditions. Habitat disturbances (mechanical damage, fire etc.) created open spaces for colonizations and increased the population size (Eliáš 1986, 1988). Local populations of the monocarpic plant have been studied in SW Slovakia, Central Europe, in localities at the northern geographic limit of the species in Central Europe. Since 1978 all flowering plants and rosettes of *V. speciosum* have been counted yearly in several localities. Some rosettes were transported to the experimental garden of the Institute of Botany of the Slovak Academy of Sciences in Bratislava to estimate critical rosette size for the species experimentally. In the contribution we present results of the long-term study of the population size and dispersion in the largest local population of the species in Slovakia near the railway track Pezinok – Šenkvice (km 21.0-23.0). The plants were counted and measured in 50-m-long segments of two parallel 800-m-long transects along the track. The population dispersion was aggregated due to short-term dispersal type. The number of flowering plants fluctuated between years from few tens to thousands. The rosettes older than two years (usually 3-5 years) produced flowering stalk. The critical rosette size for flowering was determined by rosette size (diameter) and number of leaves in the rosettes (Eliáš, 1985, 1988). Field research carried out in 2008 and 2009 showed that the human activities during the railway-track reconstruction resulted in creation of new opened habitats, increasing of seed/plant dispersal in surroundings, ruderalization of the biotopes as well as in secondary succession in new habitats. Track management have damaged all flowering plants and rosettes. Surviving plants have been located outside the radius of the effects of the moving mechanisms. The disturbances did not dramatically damage the local population of *V. speciosum* because the population have been restored from rich seed bank and flowering plants survived in habitats situated in the longer distance from the rail-track.

# TEN PLUS ONE SCIENTIFIC MEETINGS OF PLANT POPULATION BIOLOGY IN SLOVAKIA

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In 1989 the Working Group of Plant Population Biology of the Slovak Botanical Society of the Slovak Acadeny of Sciences in Bratislava was established to support plant populations research in former Czecho-Slovakia, especially in Slovakia. Since 1990 seminars and/or conferences of botanists, ecologists and others have been organized by the Group in two years intervals. They were focused on current issues and trends of plant population biology as a scientific discipline in Slovakia and in Central Europe, research topics and funding (research projects) and education of young scientists in the moder field. Previous scientific meetings were organized in Bratislava (in 1990 and 1992 in former Czecho-Slovakia, in 1994 in Slovak republic) and in Nitra (1996, 1998, 2000, 2002, 2004, 2007, 2009), in cooperation with the Slovak Ecological Society (SEKOS) and Department of Ecology of the Slovak University of Agriculture in Nitra. The scientists from Slovakia, Czech Republic, Poland, Ukraine and Austria participated in the meetings. Talks (plenary and presented in sections) and posters were concentrated on population structure and dynamics, regulation mechanisms and interactions in plant populations. University students presented results of the ongoing PhD projects and final theses. The conferences sections were organized by several plant groups, e.g. (1) short-living plant species (ephemeral, annual, biennial); (2) perennial plants, plants with clonal growth; (3) woody plants (trees, shrubs etc.); (4) rare and threatened plant species; (5) alien plants: invasive plants; (6) parasitic plants; (7) genetic structure of local populations; (8) metapopulations; (9) interactions; (10) coenopopulations etc. Full papers were published in Plant Population Biology series until 1998, then in Book of Abstracts and Proceedings of full papers published in next years. Reports and conclusions of the meetings were published in journals Biologia, Bulletin of the Slovak Botanical Society, SEKOS Bulletin, newsletter Protected Areas of Slovakia and in the university news Poľnohospodár (Agriculturist). The scientific meetings evaluated state and progress of the plant population biology in Slovakia, noted to needs of development of the scientific field and its applications in nature / biodiversity conservation, esp. in protection of local populations of rare and threatened plant species. The international conferences significantly contributed to the propagation and development of the plant population biology in Slovakia and in Central Europe. Last conference was held in 2014 in Nitra to celebrate 25 years of activities of the Working group and to assess the progress in the field during the period 1989-2014, esp. in Slovakia. Bibliography of papers on plant population research in Slovakia was presented.

# THE COMBINED EFFECT OF HARVESTER ANT NESTS AND DESERT SHRUBS ON SOIL PROPERTIES AND ANNUAL PLANT COMMUNITY

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The separate effects of desert shrubs and harvester ants on soil properties and on the adjacent herbaceous vegetation have been thoroughly studied in arid and semi-arid ecosystems. However, even though harvester ants often construct their nests under shrubs, the combined effects of those two ecosystem engineers have never been studied. We have investigated four treatments: nest of the ant *Messor ebeninus*, predominant desert shrub, the combination of these treatments (i.e., nest+shrub), and control. In these treatments, we compared the desert soil properties in the wet and dry seasons, and analyzed annual herbaceous plants in the wet season (during the dry season annuals are absent). We hypothesize that due to the different mechanisms by which harvester ants and desert shrubs alter their environment (e.g. seed accumulation vs. shading), each of these ecosystem engineers, and specifically their combination, will generate distinct effects on soil properties and on the herbaceous vegetation. Our results indicated that the levels of soil nutrients are highest in the nest+shrub treatment and lowest in the control; for phosphorus and nitrate, this trend was more pronounced in the dry season than in the wet season. The nest alone and nest+shrub treatments had greater biomass of annuals than shrubs alone or the control. On the other hand, species richness, though spatially variable, did not differ among treatments. An analysis of the specific response of the six most prominent herbaceous species indicated a positive effect of nest and/or shrub on biomass, whereas the control patch mostly ranked lowest. The results suggest that ant nests significantly impact the herbaceous vegetation in a desert environment, and that there is an additive effect of shrub and nest combinations on soil properties.

# VARIATION IN GLOBAL DNA METHYLATION OF TWO GRASSLAND PLANT SPECIES IN THE BIODIVERSITY EXPLORATORIES

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There is growing evidence that complex plant traits relevant to ecology and evolution (e.g. flowering time or root length) can have an underlying epigenetic component. The most thoroughly studied epigenetic mechanism is DNA methylation. It is particularly relevant in plants because it can be transmitted across generations, and it is involved in stress responses, silencing of transposable elements and genome expansion. It has been recently shown that even the proportion of methylated cytosines over the entire genome exhibits considerable variation between and within species. Moreover, global cytosine methylation is negatively associated with several size- and reproduction-related plant traits. In the three regions of the Biodiversity Exploratories in Germany, several common grassland plant species show intraspecific variation in phenotypic traits, correlated to land use intensity (LUI) or to its components; mowing, grazing or fertilization. The objective of this study is to explore this relationship on the level of global cytosine methylation in the two species *Cerastium holosteoides* and *Trifolium repens*. We established a common garden in Tübingen (Germany) with seeds originating from ten individuals from each of 34 and 36 populations of *C. holosteoides* and *T. repens*, respectively. We quantify the extent of global DNA methylation of the material by means of ELISA-based assays, and aim to link its variation to LUI and its components, as well as to several phenotypic traits (e.g. phenology and reproductive allocation), and also look into the heritability of this measure of epigenetic variation.

# INTRASPECIFIC DIFFERENCES IN GERMINATION TIMING IN THE INVASIVE ANNUAL *ERODIUM CICUTARIUM*

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Invasive species occurring in a wide range of different environments offer the opportunity to analyze how closely plant traits match their current biotic and abiotic conditions. As germination is a highly important phase during a plant's life cycle, selective pressures should act strongly here, and population differences should be especially visible with respect to germination, at least within the native range. We chose the annual grassland species *Erodium cicutarium* to test for intraspecific differences in germination timing, how they are linked to abiotic and biotic features of the source populations, and whether such links can also be found in the invaded range. We sampled *E. cicutarium* in its native region in Germany, and in the two invaded regions California and Chile. In each region, sampled populations covered a gradient from sparse vegetation with very low cover of neighboring plant species, to dense cover of tall grasses and herbs. These different situations within the regions, and also the differences among the three regions represent environments varying in their selective pressures. We expected that highly competitive environments favor fast germination, but also a high variability in germination timing (bet hedging). In addition we expected population differentiation to be more pronounced within the native area compared to the invaded regions. To test these predictions, we performed germination experiments with previously propagated seeds. Preliminary analyses indicate that germination velocity and percentage of germinated seeds differ according to the level of past competition. Across regions, seeds from high competition sources germinated faster than seeds from low competition sources. If seeds were exposed to different temperatures, strong differences among the source regions became apparent. Seeds from California and Chile responded to high temperatures with a low proportion of germinated seeds, which was not the case with seeds from Germany.

# THE IMPORTANCE OF THE HYDROLOGICAL REGIME ON STRUCTURING PLANT COMMUNITIES

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Water is one of the main forces structuring vegetation patterns across a wide range of scales. It is important to understand which patterns of plant communities are driven by water dynamics given that the hydrological regime is prone to anthropogenic alteration and expected to be strongly influenced by climate change. Plant functional traits mediate the interrelationship of the hydrological regime and the plant community and link community characteristics to colonization, survival, and competition strategies. We developed a generic individual-based model which describes plant functional trait abundance as a function solely of the hydrological regime and community level behavior. An important innovation is that there are no a priori defined trade-offs so that the model is neither restricted to a certain set of species nor is it scaled to a specific ecosystem. Our results highlight the importance of the hydrological regime to structure plant communities. Two results strengthen this conclusion. First, plant functional traits and their combinations segregated along soil water pressure potential gradients. Second, water stress above a certain threshold changed the direction of trait correlations associated with the classical competition – colonization trade-off.

# THE ROLE OF GROWTH PHENOLOGY ON LARGE SETS OF SPECIES

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Phenology, as one neglected axis of niche differentiation, plays an important role on species coexistence. Most studies of phenology have focused on flower phenology, e.g. differentiation of flower onset and flower duration among species. However it is also important to testify the role of growth phenology over large sets of species in plant community. Few studies have examined the role of growth phenology over a large set of species due to the difficulty of such data collection. Here we recorded growth phenological data using plant collections in the Botanical Garden of Charles University in Prague. The garden is close to species' natural habitats and it makes possibility to do frequent recordings over a huge number of species during one vegetation season. In this survey, 6-8 individuals of each of 400 species were selected, and maximum height, width and length of whole plant and of its leaves were recorded once every 1-2 weeks from March to August. Then, a logistic curve was fitted to the growth trajectory of each of above plant traits using nonlinear least squares model. This yielded growth phenological parameters for each trait: temporal shift (a), i.e. the Julian day of the maximum growth, and maximum growth rate (b). By analyzing a and logarithm of b among species, we found significant differentiation of growth phenology among habitat types, relationships between phenological parameters and key species traits (SLA, leaf area, height at maturity), and relationships between phenological parameters and ecological parameters of species expressed using Ellenberg indicator values (productivity, light, soil moisture). Further, we plan to examine correlations between growth phenological parameters and genome size (as a proxy for the cell size) and the role of plant belowground resource proxied by the size of belowground organs.

# DOES THE GLOBE ORCHID DUPE ITS POLLINATORS THROUGH GENERALIZED FOOD DECEPTION OR MIMICRY?

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Non-rewarding orchids rely on various ruses to attract their pollinators. One of the most common is for them to resemble flowers sought by insects as food sources. This can range from generalized food deception through to mimicry of specific sympatric food plants. We investigated the basis of pollinator deception in the food-deceptive European „globe orchid“ *Traunsteinera globosa* which has unusually compact flowerheads resembling those of sympatric rewarding species in the genera *Knautia* and *Scabiosa* (Dipsacaceae), and *Valeriana* (Caprifoliaceae). Visual signals of the globe orchid are very similar in both fly and bee vision models to those of the sympatric food plants used in the choice experiments, but scent signals are divergent. Field experiments conducted in Austria and the Czech Republic showed that both naive and experienced (with respect to visitation of *T. globosa*) insect species approached the orchids at the same rate as food plants, but direct contact with orchid flowers was taxon-specific. Flies were most easily duped into probing the orchid, and, in doing so, frequently received and deposited pollinaria, while most bees and butterflies avoided landing on orchid flowers. We conclude that the globe orchid is a mimic of a guild of fly-pollinated plants, but the ecological dependence of the orchid on its models remains to be fully tested.

# SUCCESSFUL CONTROL OF AN INVASIVE PLANT BY OPTIMIZED MOWING REGIME

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Common ragweed (*Ambrosia artemisiifolia*) is one of the worst IAS worldwide. I.e., its pollen induce serious health problems in human populations. Besides agricultural fields it expands in Europe preferably along highways that are cut several times a year mostly for security reasons. Obviously, the actual cutting regime favours seed production and also further spread by machinery. We tested various cutting regimes in the greenhouse as well as in field studies along highway verges for their influence on flower and seed production, and on the amount of seeds in the soil seed bank in a long-term experiment. The commonly practised 2-cut-system (one early and a second autumn cut) enables ragweed almost optimal seed production. We found that the cutting dates have to be adapted with respect to the main aims. Aiming at population decrease (including the soil seed bank) simply 2 cuts are most effective if set as follows: 1$^{st}$ cut about two weeks after start of flowering and 2$^{nd}$ cut ca. 3-4 weeks after. If one aims also on reduction of pollen production 3 cuts are necessary: 1$^{st}$ cut just before beginning of male flowering, 2$^{nd}$ cut 3 weeks later, and a 3$^{rd}$ cut again 3 weeks after the 2$^{nd}$. The experiment lasted from 2009 to 2013. At the end the soil seed bank allowed to evaluate the efficacy of the tested mowing regimes in the before mentioned sense. Mowing can help to control ragweed very effectively, but only if applied at the right dates.

# MYRMECOCHORY - ADVANTAGES FOR ANTS AND PLANTS

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Myrmecochory, a plant dispersal by ants is also a mutualism. Advantage for ants is elaiosome, a nutrient rich appendage of seeds or fruits. Its chemical composition is important determinant of diaspore attractiveness. Different advantages for plants were proposed, and they probably differ among habitats. The main hypotheses are: 1) distance dispersal – reduction of the intraspecific competition for resources 2) escape from density dependent predation and pathogens and 3) direct dispersal to microsites suitable for recruitment. How effective is the relationship for both sides in temperate conditions? The quality of food reward gained by ants was tested by determining of the chemical content and also by the attractivity for ants in a cafeteria experiment. Focal nutrients amino acids, free fatty acids, organic acids, polyols and sugars were determined separately in both elaiosome and seed itself. We focused on four plant families with 2 different genera in each (represented by a single species) and diaspores of 3 populations per each species were sampled. Therefore we were able to separate the variability in selected chemical groups explained by each hierarchical level. The phylogenetic relatedness explained large part of chemical composition of elaiosomes and seeds, the differences among populations within species were small. There were pronounced differences between elaiosome and seed itself. Elaiosomes have higher content of easily digestible compounds than seeds, specifically amino acids and shorter chained free fatty acids. Nevertheless, the chemical concentrations are species specific and a cafeteria experiment of diaspores from the same populations will be used to relate the ant removal frequency to it. Chemical content will be used to explain the ant preference. Our next step will be to evaluate the advantages provided to plants.

# FUNCTIONAL TRAITS MODULATE CHANGES IN PLANT PHENOLOGY

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**Aim:** Numerous studies reported changes in first flowering day (FFD-changes) of plants in response to changes in climate. However, regarding the intensity (number of days decade-1) as well as the direction (advances vs. delays) of FFD-changes, there are remarkable differences between species, even when observed in the same location. Here, we examine if, besides changes in climate as drivers of FFD-changes and modulating factors such as local site conditions, plant functional traits act modulating on interspecific differences in FFD-changes. In particular, we investigate whether traits contribute to explain observed differences between different species covering different growth forms.Location: 18 sites distributed over the northern hemisphere.
**Methods:** We compiled data from the literature on changes in first flowering day (FFD-changes) over the last decades for 562 species. We related FFD-changes (direction and intensity) to variables associated with (i) changes in climate, (ii) local site conditions and (iii) functional traits using a machine learning based regression approach.
**Results:** We could not unravel factors driving the direction of changes in FFD, but we could well explain differences in the intensity of FFD-advances using the selected predictor variables. We found that decreasing precipitation was more important than increasing temperature to explain the intensity of FFD-advances. In addition, the intensity of FFD-advances depended on site conditions: FFD-advances were most intense in polar tundra and dry and hot habitats. We showed that traits related to growth rate (plant height, specific leaf area and leaf dry matter content) are essential. The importance of the variables related to the three predictor categories (i-iii) differed between growth forms, with the highest importance of traits in trees and grasses and an equally importance of traits and changes in climate in herbs. In shrubs, variables related to site condition contributed most to explain the intensity of FFD-advances.
**Main conclusions:** Plant functional traits modulated species-specific differences in FFD-advances. Hence, in future phenological observations and predictions, functional traits should be taken into consideration, especially those related to growth rate.

# CHANGES IN TIMING OF GERMINATION IN RESPONSE TO NEIGHBORING SEED IDENTITY

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The time when the seed germinates is very important. To a large extent, emergence timing determines the future success of the plant's ability to survive and its fitness. Even a small lead, like a few hours, can mean a significant advantage among competing seedlings and, subsequently a victory in a competition. On the other hand, even a one day shift towards earlier germination may kill the plant because of the last day of frost. Ability to change the time of germination may be very advantageous in solving the trade-off. Early neighbor recognition may allow the seed to postpone the emergence and avoid the late frost risk, depending on the neighboring plants and seeds. Because of the competitive superiority of fully grown plants over the seedlings, this ability should be particularly developed in species that frequently occur at sites where the main competitive pressure comes from seedlings, namely in communities of annuals and early successional communities. For a better understanding to this mechanism, I conducted an experimental study with fifteen species. The species were selected according to their position in long succession seres of mesic/xeric abandoned fields in Český Kras. The seeds were left to germinate in pairs in all combinations between them. Each combination was replicated ten times and seedling emergence was noted daily. Here I present the initial results of the study, where I show how the time of emergence changes, depending on various neighbors and focal species identity.

# SEED DISPERSAL ABILITIES OF TWO FOREST ORCHIDS

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The minute orchid seeds are often thought to be practically unlimited in their dispersal. However, the statistical chance of seed rain clearly decreases dramatically with the distance to the mother plant. Our present knowledge on orchid seed dispersal is based on few studies of meadow species showing that impressing reports of long distance dispersal need to be regarded as extremely rare cases. In forest habitats, the dispersal efficiency of windborne seeds might be particularly lower due to restricted air movement. In addition, it can vary in different types of forest according to density of herb layer. We investigated the dispersal abilities of *Epipactis atrorubens* and *Cephalanthera rubra*, green calciphylous orchids growing in two forest types - beech and pine forests differing in composition of herbal layer and density of trees. For a study of short distance dispersal abilities, we used seed traps spaced in a 20×20 m network laid around investigated plants. This data were complemented by a molecular study of the genetic relatedness of populations that enabled us to study long distance dispersal. Our poster will present model of dispersal abilities based on this data.

# PLASTIC CHANGES OF SLA IN RESPONSE TO SHADE

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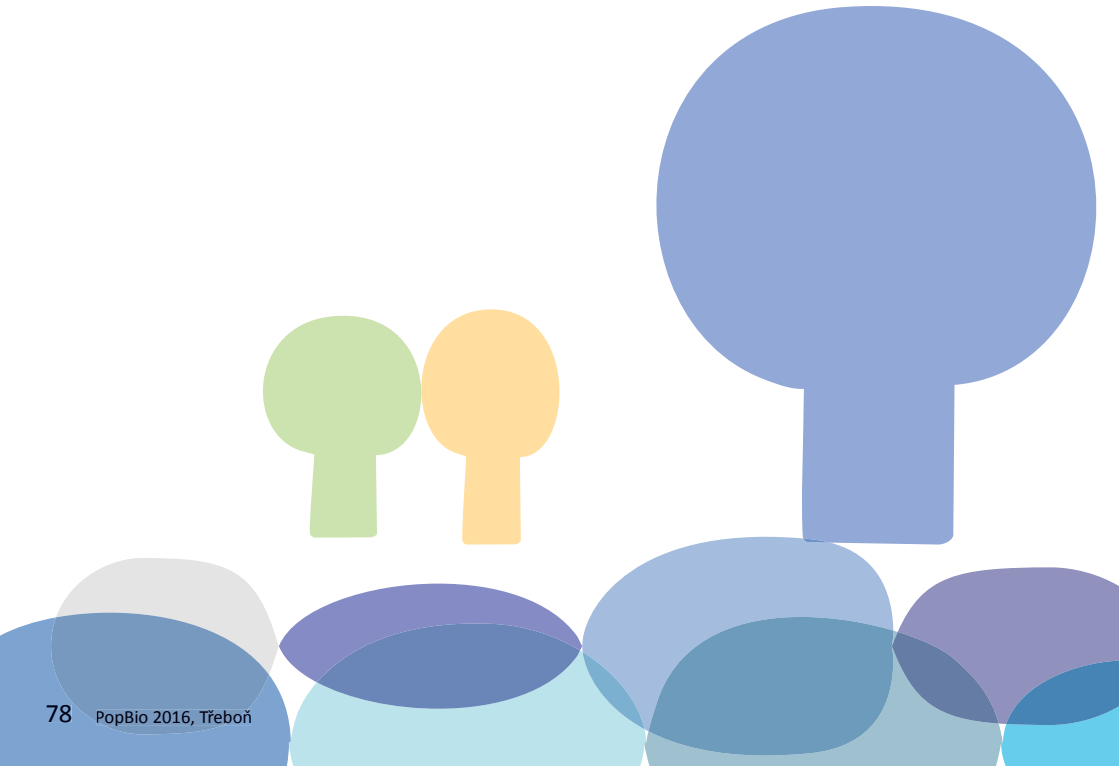
Specific leaf area (ratio of leaf area and its dry weight) has been identified as good correlate of relative growth rate already long ago. This feature together with the fact, that it is easy to measure, made it one of the basic traits in analysis of ecological data. Westoby incorporated it into his LHS scheme that was meant to replace Grime's CSR concept by easy-to-measure traits. This approach takes into account only species level means though. SLA is known to vary within communities, populations and even individuals. But less is known about how individuals adjust their SLA in reaction to changed light amount and competition cues – generally the main idea is that plants increase their SLA in shade but this kind of treatment usually mixes the two main light components. To address this concern we performed an experiment with 40 species where we separately manipulated the light amount and the light colour (red/far-red ratio). We found out that some species changed their SLA actively and some of them even changed the shape of the leaf blade resulting in differences in fractal dimension between treatments. The data are still fresh and they will be presented and discussed.



# ANALYZING GENETIC AND CLONAL DIVERSITY OF *ARNICA MONTANA* – A MEANS TO STOP THE SPECIES' DECLINE?

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Merely restoring habitats is not always the key to counteracting a species' decline whereas population genetics can often provide missing links between the decrease of a threatened species and the ultimate cause for its decline. *Arnica montana* is an endangered species of nutrient poor grasslands of Central Europe. Although protected by law, populations have been declining strongly over the last decades, especially in lowland regions. The species is capable of sexual and vegetative reproduction but is considered self-incompatible. Moreover, observations in the field and in the greenhouse show that *A. montana* develops distinct clonal structures. The number of individuals and their relatedness as well as the number and size of clones probably affect the population's success, but the extent of this effect is yet unknown and might be variable depending on population size. In this study, we examine 25 populations in Hesse, Germany using 14 polymorphic nuclear microsatellite markers. We focus on lowland sites of varying population size but include a comparison between lowland and montane regions as well. In order to achieve accurate and defined distances between samples, two sampling grids were established differing in size. Using the small sampling grids, we provide insights into genetic and clonal diversity while the large grids help us to identify differentiation parameters between sites. Using these data, we establish a relationship between genetic and geographic distance and give an overview of the spatial-genetic structure in our model region Hesse. Beyond the mere point of research, our work draws conclusions concerning possible threats and conservation issues with population size as a factor. The information gathered in this study will help identify strongly threatened and healthy populations. That way, plants from genetically diverse sites can act as seed donors and ex situ conservation will aid those *A. montana* populations that are specifically endangered.

# COLONIZATION OF DISTURBED SITES BY A CENTRAL EUROPEAN FLORA - NEW INDICATOR VALUES SUGGESTED

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We used species frequencies in the database of successional series of various disturbed sites across the Czech Republic (DaSS, 2822 phytosociological relevés, 1022 vascular plant species) for calculation of two indices: Index of Colonization Ability (ICA) and Index of Frequency in Seral Stages (IFSS). Because colonization of newly-created sites by species is determined not only by traits of the species but also by their frequency in the surrounding landscape (mass effect), the ICA values are corrected by their occurrence in the Czech National Phytosociological Database (CNPD). The values were accompanied by information about the first, optimum, and last occurrence during succession represented by five successional stages (initial, early, middle, late, old) and by information about the highest percentage cover reached in the optimum stage. The optimum stage represents a successional status of species (SSS). Species with high both indices will probably more likely to spread in landscapes continuously disturbed by human activity. Thus, our indices may help predict future vegetation changes and restoration success in the central European landscape.

# SEED DISPERSAL BY FREE-RANGING HERBIVORES AND ITS IMPACT ON VEGETATION

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Seed dispersal is a crucial process for the dynamics of plant populations. A free-ranging animal can be a very effective dispersal vector because it keeps visiting similar biotopes and therefore, the seed has a higher chance of being deposited into a favourable environment. This type of dispersal – endozoochory – is being studied as part of a long-term project focused on the relationship between free-ranging herbivores and vegetation. The project is conducted in military area Hradiště in the Doupov Mountains (western Bohemia). Here we are primarily interested in three species of herbivores: red deer (C*ervus elaphus*), sika deer (*Cervus nippon*) and wild boar (*Sus scrofa*). All three species of herbivores act as very good dispersal vectors; however, species composition in dung samples of individual animal species differs significantly. 80 % of all seedlings extracted from the dung piles collected throughout vegetation season 2012 belonged to stinging nettle, *Urtica dioca*. Nevertheless, data collected so far do not give us much information about how the process of seed dispersal works in the field and therefore, we have started a so-called sowing experiment which might give us answers to following questions: (1) What is the seedling emergence from dung pellets in natural localities? (2) How does the deposited dung influence vegetation? (3) How does it affect the succession on disturbed stands?

# POST-INTRODUCTION EVOLUTION OF INVASIVE *CHROMOLAENA ODORATA* TO WATER DEFICIT

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The success of invasive plants which populations have lost considerable genetic variation is often attributed to phenotypic plasticity or to post-introduction evolution. To study the roles of phenotypic plasticity and post-introduction evolution on the invasion success of *Chromolaena odorata*, we compared phenotypic traits of 15 invasive and 13 native *C. odorata* populations in common environments. In another common garden experiment, we compared the differences in growth and biomass allocation of plants from native and invasive ranges under ambient conditions and a 50% rainfall removal treatment. We found that phenotypic traits (16 of 17 traits) of invasive populations showed significantly less variation than plants from native populations and were phenotypically similar to populations from native ranges (Florida, Trinidad and Tobago). No significant differences in phenotypic plasticity in plant growth and biomass allocation to soil water availability were detected between plants from native and invasive populations. Plants from native and invasive populations of *C. odorata* showed inverse clines in biomass allocation patterns along water deficit gradients of their source habitats. Parallel clines in biomass allocation patterns associated with water deficit of their source habitats were detected in invasive populations grown under both water treatments. Our results suggest that post-introduction evolution could occur despite of founding events. Invasive *C. odorata* might further colonize habitats with lower water availability during the dry season by allocating less biomass to leaf development but more into stem growth and reproduction.

# RELATIONSHIP BETWEEN MULTIPLE ESTIMATES OF PRODUCTIVITY AND DIVERSITY IN MEADOW COMMUNITIES CHANGES WITH SPATIAL SCALE

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The species richness–productivity relationship (SRPR) has been a long studied problem in plant communities. Unimodal humped-shaped pattern is widely documented for temperate grasslands. Virtually majority of studies uses various direct or indirect surrogates for productivity level but rarely multiple estimates for one particular area. Firstly, we have asked what is the best predictor of SRPR at three different spatial scales and if each predictor can be replaced by another one without a significant impact on SRPR. In other words, if different estimates of a productivity level are similarly strong predictors of species richness or not. And secondly, whether productivity estimates should be used in combination to explain a certain phenomena for instance ratio between competition for light which is assumed to be more important in nutrient rich environment and competition for nutrients more pronounced in poor soils. Thirty moderately to high productive meadows (productivity range from 100 g/$m^2$ to 550 g/$m^2$) were sampled in the vicinity of České Budějovice, South Bohemia, Czech Republic. Aboveground biomass, belowground biomass and amount of nutrients in the soil were used as a surrogate for productivity level and number of species was determined at three spatial scales (0.04 $m^2$, 1 $m^2$, 25 $m^2$) at the peak of vegetation season. The competition for light was estimated by measuring maximum percentage of light (photosynthetic active radiation) passing through the plant cover to the ground. The results show slower proportional species number decrease with increasing aboveground biomass at small spatial scales and faster at larger spatial scales, supporting our proposed homogeneity hypothesis, and contradicting the individual density decrease hypothesis. Negative correlation between root biomass and aboveground biomass highlights the importance of a competition for light in highly productive localities.

# LEAF DEMOGRAPHY OF A TALL HERBACEOUS PERENNIAL (*SAMBUCUS EBULUS* L.) IN A CLEAR-CUTT AREA

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*Sambucus ebulus* is a clonal rhizomatous herb forming monodominant vegetation patches in open man-made habitats of cultural landscape. The dominant species forms dense leaf canopy at top layers of the stands excluding other species by shading lower layers. Synchronized rapid growth of *S. ebulus* above-ground shoots (ramets) starts usually in end of March and/or in beginning of April, and the close canopy is formed in May, supporting the dominant role of the species in the community. The populations of the species were studied in a clear-cutted areas of the former I.B.P. Forest Research Site Báb, SW Slovakia, during growing season 2015. Shoots and leaves (leaf pairs) were counted and measured in plots 1.00 $m^2$ located in the same patches. First leaves of the main stem appeared in April and new leaves grew during the whole season. Individual plant produced 12 leaf pairs in maximum. First death leaves were observed in the beginning of June following closing of the canopy. Death of the mainstem leaves was induced by low light intensity level within the *Sambucus* stand. For leaf longevity, spring cohorts (leaves produced in April and May) lived very short time, leaf life span was estimated to 30-40 days. Leaves born in June and July survived until end of September/October, leaf life span of the summer cohorts was 60-90 days. Leaf birth rates, leaf death rates, leaf mortality were calculated. The results were compared with similar studies carried out by the second author in ruderal habitats (Trnava town, SW Slovakia). The leaf demography and longevity of cohorts was similar. In the autumn leaf canopy is formed by leaves of the lateral branches with inflorescences and fruits.

# DO CLONAL PLANTS COPE WITH DISTURBANCE BETTER THAN NON-CLONAL ONES?

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Disturbance is important factor which influences plants by removing or damaging their biomass. Recovery of plant population after a disturbance event depends either on seeds buried in the soil, or on the bank of buds that survived the disturbance. Bud bank is a pool of dormant meristems from which new shoots can regrow and replace the lost ones. It is typically localized on organs placed out of the reach of disturbance, i.e. belowground or close to the soil surface, such as rhizomes, bulbs, tubers and roots. Nevertheless, disturbance may also affect soil thus removing or killing roots and/or fragmenting belowground organs. There is nothing like a bank of root primordia from which new roots could regenerate; however, some plant species are able to produce adventitious roots on stem-derived organs, i.e. clonal plants. These two traits, location of the bud bank and capability to form adventitious roots define the ability of a plant to survive disturbance. Since clonal species form adventitious roots in order to produce clonal offspring, e.g. ramets, while non-clonal plants are usually not capable of doing so, we hypothesise that clonal plants are able to cope better with various types of disturbance than non-clonal plants. In the intended experiment, we will investigate performance of 17 congeneric pairs of clonal and non-clonal species under five types of disturbance, simulating grazing, short-term flooding, spring frosts, micro soil slides and snail/insect herbivory. We will use the results to address the question whether clonal perennial plants cope with disturbance better than non-clonal perennial ones and whether disturbance type plays any role. Moreover, using phylogenetical techniques, we will examine the hypothesis that disturbance could lead to the evolution of clonality in herbs.

# EVALUATING THE CHEMICAL TYRANT – ASSESSING ALLELOPATHIC EFFECTS OF RAGWORT (*SENECIO JACOBEA* L.)

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Shifts in species frequency and dominance are one of the core topics in population dynamics studies. *Senecio jacobea* – a poisonous grassland species - is currently showing dramatic increases in its distribution and abundance in extensively managed grasslands of high nature conservation value throughout Northern Germany. As a consequence, the affected meadows' agricultural management and the associated biodiversity are jeopardised. Here we aim at deciphering ecological mechanisms on local and landscape scales that underlie the current proliferation of *S. jacobea*. One hypothesis that could explain the success of *S. jacobea* in grasslands on the local scale is allelopathy. Thus we examined the allelopathic potential of *S. jacobea* in a lab experiment. We used seeds of 24 species of four plant families (Fabaceae, Asteraceae, Poaceae, Caryophyllaceae) to evaluate the allelopathic effects of ragwort on mesotrophic grassland species. To do so, we exposed these seeds to four different solutions: i) aqueous extract of *S. jacobea*, ii) aqueous extract of *S. jacobea* treated with carbon to test for allelopathic effects, iii) distilled water as control and iv) mannitol solution to account for the effects of a different osmotic potential. First results indicate that the *Senecio*-extracts delayed and diminished germination. Highest resistances to the inhibitory effect of *S. jacobea* occurred in *Lolium perenne*, whereas most other species seem to have been inhibited considerably in their germination. Our results so far suggest allelopathic effects of *S. jacobea* on a wide spectrum of plant species, which might contribute to the species' current success. An identification of factors potentially triggering the current shifts in *S. jacobea*'s frequency and distribution is subject of our ongoing research.

# RESTORING SPECIES-RICH MEADOW BY TURF TRANSPLANTATION: LONG-TERM EXPERIMENT IN CENTRAL EUROPE

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We tested whether transplanted turfs of preserved meadow vegetation has potential to enrich the ex-arable land with species and promote meadow restoration. For this an experiment was established where 25 meadow turfs 40 cm × 40 cm × 30 cm in size were transplanted to ex-arable land. Experiment was located in Bílé Karpaty Mts., SE Czech Republic. Species composition and cover of the transplanted turfs and their adjacent surrounding was monitored in three plots 40 cm × 40 cm plots positioned in row (transplant, and its near and far surrounding) for period of 12 years. With the turfs 80 species were transferred out of which 53 we recorded in turf surrounding on ex-arable land. After 9 years the number of species did not differ between the turf and its surrounding and was on average 16 species per plot. Most of these species were those which were transferred, typical for the meadow vegetation and forming majority of plant cover. Weedy species, originally abundant on the ex-arable land, did not penetrate to the turf and retreated with time. The species composition converged between turf and its surrounding, but it also departure from original turf source meadow. It was mainly due to expansion of competitive grass *Brachypodium pinnatum* on the expense of *Bromus erectus*. The species expanding best to the arable land had high leaf dry matter content. Species with best performance in the turf had high ability for lateral clonal spread. Turf transplantation promoted the establishment of target meadow species on ex-arable land and restoration of meadow vegetation, but its composition changed from turf source and the expansion of target species from the turf desired long time period.

# POPULATION BIOLOGY OF ROCK OUTCROP PLANTS ON THE EXAMPLE OF *AURINIA SAXATILIS*

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Plant species of rock outcrops are amongst the most endangered species and it is thus important to find the most suitable way of conservation. The aim of this study is to elucidate population dynamics of rock plant species, predict their future performance based on the detection of critical life-cycle stages, and also reveal the way of dispersal, genetic diversity between and within populations, and then apply these findings to conservation of species with this special habitat. As a model species we have chosen basket of gold (*Aurinia saxatilis* subsp. *arduni*), which is a typical species for rock outcrops enclosing the Vltava River in central Bohemia. Survey of population dynamics and sampling will be carried out in its natural environment, i.e. the rocky slopes along the lower flow of the Vltava River. We will compare three similarly sized populations differing in position, the character of the rock and other abiotic factors. The differences between populations will be also described by microsatellite analysis, which allows to detect the gene flow intensity and consequently the intensity of dispersal among populations of the species. Since river corridor generally facilitates spreading of plants, it is possible, that in terms of population genetics, the populations will not be as isolated as it is expected (in such fragmented area). Results of this study, together with findings from previous studies, will be used for creating such a generalized concept of the conservation of rock plant species.

# MONITORING OF CYANOBACTERIAL TOXINS IN FRESH WATER RESOURCES IN SOUTH BOHEMIA INVADED BY *PECTINATELLA MAGNIFICA*

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*Pectinatella magnifica* (Leidy, 1851) is an invasive freshwater invertebrate that lives in colonies built from a gelatinous matrix covered by hundreds of individual filter feeding zooids. A native area of the animal is east part of the Mississippi River (USA). Recently European countries around rivers of Rhine, Danube, Oder and Vltava (Lužnice) have confirmed invasion of *Pectinatella magnifica* (PM), including fresh water reservoirs (ponds, sandpits) in South Bohemia (Czech Republic). So far there are no evidence about a toxicity of PM metabolites. However, the colony gelatinous matrix is during PM lifetime also a host for algae, bacteria and cyanobacteria. Therefore in this contribution we applied a high performance liquid chromatography (HPLC) method for determination of several known toxins related to cyanobacteria (microcystin LR, microcystin RR, nodularin). The HPLC method was adapted for instrumentation Dionex Ultimate 3000. Samples from selected ponds and sandpits of South Bohemia from seasons 2009-2015 were analyzed.

Acknowledgment — The project was supported by the Czech Science Foundation (GAČR P503/12/0337)

# LOCAL ADAPTATION TO HEAVY METAL CONTAMINATED SOIL IN HYPERACCUMULATOR *ARABIDOPSIS HALLERI*

**Veronica Preite, Stephan Höreth, Ricardo Stein, Clemens Stolpe, Caroline Müller, Stephan Clemens & Ute Krämer**
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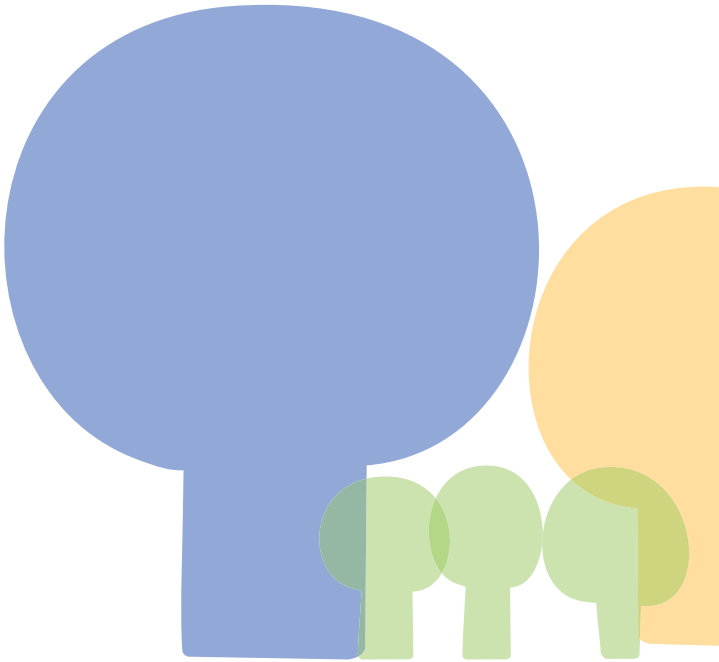
The metal hyperaccumulator *Arabidopsis halleri* grows on metalliferous as well as on non-metalliferous soils. From both soil habitats *A. halleri* accessions were reciprocally transplanted to a high-metal and a low-metal field site, which revealed hints of local adaptation to metalliferous sites. Moreover, this experiment gives insight into the tolerance to extreme edaphic conditions and theory how and why this phenomenon of heavy metal hyperaccumulation evolved in plants.



# RESPONSE OF SEMI-ARID STEPPE TO SIMULATED CLIMATIC CHANGE: THE BUD BANK PERSPECTIVE

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Understanding climate change effect on ecosystem composition and function is a challenging task for vegetation scientists. In ecosystems dominated by perennial herbs belowground bud banks are more important for population dynamics than regeneration from seeds as they represent the potential for shoot establishment after adverse season or unpredictable disturbance. We studied the response of belowground bud banks to the most important predicted environmental changes on the typical steppe of Inner Mongolia, China: nitrogen addition (10 g/m$^2$ $NH_4NO_3$, once per year, in May), increased summer precipitation (addition of 120 mm, i.e., 1/3 of the mean annual precipitation), and their combination. Our results showed that (1) nitrogen addition had negative effects on total bud density while increased precipitation and the combination of nitrogen addition and increased precipitation had no significant effects on total bud density, (2) the bud bank of grasses and forbs responded differently, bud banks of grasses being supported by nitrogen addition and suppressed by higher precipitation while bud bank of dicots and bulbous monocots responded in opposite direction, and (3) five species whose bud banks were evaluated separately showed species specific responses of their bud banks to experimental treatments. Our results show on the level of bud banks that response to environmental change is species specific and will lead not only to changes in vegetation composition and also in abilities of community to buffer climate changes due to availability of dormant buds.

# TRANSGENERATIONAL STRESS-INDUCED EPIGENETIC MEMORY IN THE CLONAL PLANT *TRIFOLIUM REPENS*

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By means of reversible epigenetic marks (DNA methylation, histone modifications and small RNAs) a stressed plant can respond with plastic transcriptional modifications that can be maintained and even transmitted to the next generation. The questions that remain to answer are how reliable is the heritability of environmentally induced epigenetic variation among generations and for how long these modifications can be inherited in absence of the original stress. In this regard, DNA methylation is one of the best known epigenetic mechanisms that are stably maintained during DNA replication. In the particular case of studying clonal plants, the fact of working with genetically identical individuals, thus without concerning about recombination and the epigenetic resetting that occurs during a meiotic event, allows us for an easier disentangling of DNA sequence variation and epigenetic effects. In this study we tested how stress in maternal generation induces epigenetic variation and for how many clonal generations is heritable. The experiment was conducted during the spring in 2014 with the induction of four kinds of abiotic stresses (salt, drought, shade and heavy metal) to five genotypes of maternal generations. A maternal cutting was then transplanted to produce clonal offspring in a controlled environment. After two months of growth phenotypic data were analyzed and epigenetic variation was assessed with M-SAP marker. First results show that, as expected, there is a genetic basis for the epigenetic response to stress given that the observed polymorphisms were significantly genotype dependent. Nevertheless, the variation within genotype shows a tendency to group certain types of stresses in similar epigenetic profiles suggesting a stabilized inheritance and related response to particular kinds of stress and these changes can be maintained for at least three clonal generations. Given that the technique assesses only anonymous loci, further information of the sequences of the differentially methylated sites should be investigated to better understand the environmental induced epigenetic targets. We conclude that transgenerational stress-induced epigenetic memory is a significant player in the evolution of clonal plants.

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# ROOT LITTER AND SOIL LEGACIES: ARE LOCAL AND SYSTEMIC PLANT RESPONSES POSSIBLE?

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Plants react towards their neighbours in a competitive or avoiding way by changing their root placement and architecture. Root growth and branching is stimulated or reduced depending on the perceived identity of the neighbour. Plants not only interact directly but also indirectly through the legacy they leave in soil via their root litter and specific soil microbial communities. Soil microbial legacies have often been found to suppress plant growth, generally attributed to pathogen accumulation. Studies on litter legacies have found both growth stimulating and growth suppressing effects, however these have mainly focussed on aboveground litter and the role of root litter legacies remains to be tested. Here we test the legacy effects of 7 different plants species (3 grasses, 3 legumes, 1 non-legume forb species) via soil biota and via roots on the local and induced root responses (biomass, SRL, root diameter, nodulation) of white clover. We hypothesised that both soil and root litter legacies will affect root traits locally but depending on the origin of the species, with growth stimulation by root litter of legume species due to nutrient effects and growth reduction with soil inoculum of white clover (*Trifolium repens*) caused by pathogen accumulation. We further hypothesised that plants show differential root placement between split-root pot halves of soil or litter legacies from different species. We found that the soil inoculum of one legume species (*Vicia cracca*) decreased the number of root nodules per gram of biomass. Overall we found spatial negative legacy effects of *T. repens* and *T. pratense* on white clover estimated root length, where plants tried to place roots away from conditioned soil. Root litter caused spatial effects in root architecture in case of few litter species. Less branched roots that were small in diameter were developed in section of pot that contained *V. cracca* litter. Litter of *T. pratense* induced mild increase in root diameter. This outcome suggests of local rather than systemic response towards some root litter types.

# THE GENETIC BASIS OF EDAPHIC ADAPTATION TO HIGH METAL CONCENTRATIONS

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Adaptation to diverse soil environments is a central factor in plant species diversification. Micronutrients such as Ca, Mg, and Zn are essential for plant growth. In excess levels, however, they can be toxic. Thus phytotoxic levels of metals in soil constitute a strong selective force on plant colonists. We aim to identify genes under selection by comparing adapted and sensitive genotypes in *Arabidopsis arenosa* and *A. halleri* from heavy metal contaminated (M) and uncontaminated (NM) soils. We sampled multiple individuals of both species from 5 M-NM paired sites, resequenced each individual to ca. 10x genome-wide coverage, and measured the metal content of 17 elements in leaves and soils. By combining these approaches we are developing genome scanning approaches to identify signatures of selective sweeps which are associated with adaptation to metal contaminated soils.

# SHOOT APICAL MERISTEM AS ONE OF THE MAJOR TRADE OFFS IN PERENNIAL PLANTS

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This study is devoting to the detailed analyses of the shoot apical meristem (SAM) of perennial plants and try to correlate the meristem size with other plant trade offs. Shoot apical meristem is a set of rapidly proliferating cells located at the tip of the shoot apex that produce all aboveground plant organs. The size of the SAM determines the size of developing plant organ as well as the size of the whole plant and the amount of produced seeds. On the other hand, the size of the SAM is predetermined by the seed size or by the size of developing buds in perennials. However, with respect to plant development and other plant traits such as genome size, type of the plant (e.g. rosette and non-rosette plants), cyclicity, the SAM size may be changed. In dependence on plant type, shoot tips or developing buds were collected early in the spring or late in the autumn from perennial plants. Always at least two congeneric plants differing in leave size or genome size or cyclicity were studied. SAM was removed under the dissecting microscope from fresh plants. The dissected tissue was fixed in FPA fixative. After rehydration, the meristems were stained by 5 mg/ml propidium iodide in 0.1 M L-arginine pH 12.4 and wieved with an argon laser (excitation 514 nm) using the Zeiss confocal LSM 5 microscope. The photos were than evaluated by the LSM image browser program. In this study, the size of the SAM was measured as the cell number and the whole SAM size on the cross sections. Results and conclusions Comparative analysis of the SAM showed great differences between studied plants not only in the size but also in the shape. The most pronounced effect had the genome size and leaf area. Species with larger genome showed larger SAM anatomic parameters (SAM width, SAM periphery, low length). The size and the shape of the meristem was not influenced by cyclicity.

This study was funded by the Czech Science Foundation (project no. 14-36079G, Centre of Excellence PLADIAS).

# THE EFFECTS OF SPATIAL HETEROGENEITY IN MYCORRHIZAL INOCULATION POTENTIAL ON PINE SEEDLING DEVELOPMENT

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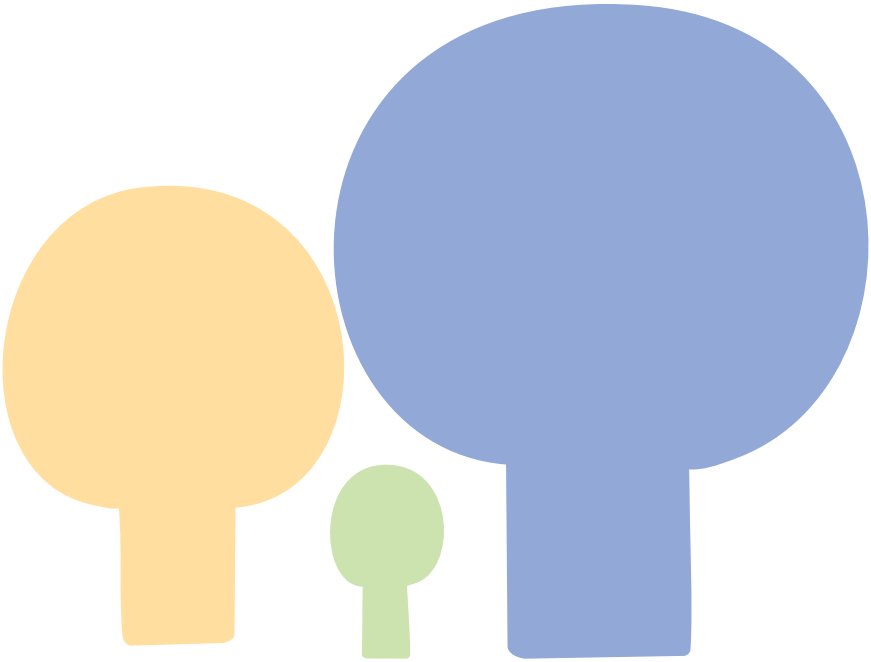
Spatial heterogeneity plays a pivotal role in ecological processes. For example, individual plants experiencing patchy fertilizer availability outperform plants receiving the same amount of fertilizer evenly distributed within the soil. Less is known about the role of spatial variability of mutualistic interactions. Mycorrhiza is a common and ecologically important mutualistic interaction. The mycorrhizal inoculation potential is not evenly distributed in space. We tested how the spatial distribution of mycorrhizal spores (homogenous/patchy) affects pine (*Pinus halepensis*) seedling growth. Plants experiencing homogenous inoculation potential developed 156% & 125% more shoot biomass and side branches respectively than seedlings exposed to heterogeneous inoculum. The results highlight the difference between spatial heterogeneity of biological interactions and a-biotic resources.



# TWO WIDESPREAD GREEN *NEOTTIA* SPECIES (ORCHIDACEAE) SHOW MYCORRHIZAL PREFERENCE FOR SEBACINALES IN VARIOUS HABITATS AND ONTOGENETIC STAGES

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Plant dependence on fungal carbon (mycoheterotrophy) evolved repeatedly. In orchids, it is connected with a mycorrhizal shift from rhizoctonia to ectomycorrhizal fungi and a high natural $^{13}C$ and $^{15}N$ abundance. Some green relatives of mycoheterotrophic species show identical trends, but most of these remain unstudied, blurring our understanding of evolution to mycoheterotrophy. We analysed mycorrhizal associations and $^{13}C$ and $^{15}N$ biomass content in two green species, *Neottia ovata* and *N. cordata* (tribe Neottieae), from a genus comprising green and nongreen (mycoheterotrophic) species. Our study covered 41 European sites, including different meadow and forest habitats and orchid developmental stages. Fungal ITS barcoding and electron microscopy showed that both *Neottia* species associated mainly with nonectomycorrhizal Sebacinales Clade B, a group of rhizoctonia symbionts of green orchids, regardless of the habitat or growth stage. Few additional rhizoctonias from Ceratobasidiaceae and Tulasnellaceae, and ectomycorrhizal fungi were detected. Isotope abundances did not detect carbon gain from the ectomycorrhizal fungi, suggesting a usual nutrition of rhizoctonia-associated green orchids. Considering associations of related partially or fully mycoheterotrophic species such as *Neottia camtschatea* or *N. nidus-avis* with ectomycorrhizal Sebacinales Clade A, we propose that the genus *Neottia* displays a mycorrhizal preference for Sebacinales and that the association with nonectomycorrhizal Sebacinales Clade B is likely ancestral. Such a change in preference for mycorrhizal associates differing in ecology within the same fungal taxon is rare among orchids. Moreover, the existence of rhizoctonia-associated *Neottia* spp. challenges the shift to ectomycorrhizal fungi as an ancestral pre-adaptation to mycoheterotrophy in the whole Neottieae.

# FUNCTIONAL TRAITS VARIATION IN ALPINE PLANTS SPECIES GROWING ON ICE HOLES AND ALPINE BELT AS A PREDICTION OF LONG-TERM ADAPTATION TO CLIMATE CHANGE

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Ice holes are microthermal biotopes occurring at low elevations such as 500 m, a.s.l. characterized by azonal vegetation adapted to higher elevation climatic conditions such as the ones at ca 2000 m, a.s.l. This phenomenon is due to cold air that descends through blocks of material belonging to old, probably post-glacial, landslides, and accumulates over concave landforms, forming a permanent cold-air pool of 4-5 m in depth. The position of extra-zonal alpine plant species in a warmer climatic zone exposes them probably over thousands of years to extra-ordinary abiotic conditions. In this context it is highly interesting to study the possible climatic effects on these plant species in terms of their functional adaptation. Functional traits are important carriers of ecological information and vary also within species, reflecting phenotypic adaptation possibly also related to epigenetic and/or genetic modifications. The aim of this study is firstly to analyze the phenotypic plasticity of functional traits of alpine species growing on ice holes compared to the same species occurring on the alpine belt considering leaf traits. We compare siliceous ice holes (550 m and 660 m, a.s.l. respectively) with siliceous alpine sites, e.g. in the Lagorai group (ca 2000 m, a.s.l.) in the Italian region of Trentino Alto-Adige. For each key species in each study site we sampled the functional trait attributes of 10 individuals. Ice holes individuals were further differentiated in central and marginal based on their proximity to the cold air source. We will report the results of specific leaf area (SLA), leaf dry matter content (LDMC), leaf phosphorus content (LPC) and leaf nitrogen content (LNC) of selected alpine species. The findings of the phenotypic analysis on functional traits diversity will be, in a second step, examined at the epigenetic level, knowing that modification of levels and patterns of cytosine methylation can generate heritable variation in many plant functional traits.

# DISTRIBUTION OF ORCHIDS ALONG ENVIRONMENTAL GRADIENTS REGARDING THEIR BIOTIC INTERACTIONS

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Central to orchid ecology is the ability to establish mutualistic relationships both for reproduction through pollinator attraction, and for resource acquisition through mycorrhizal interactions. The nature and the specificity of these interactions are hypothesized to strongly depend on environmental conditions determining their costs and benefits. Here we addressed the relationship between reproductive and trophic strategies of orchids over a broad range of climate and land-cover in France. We informed ecological properties related to biotic interactions, morphology and phenology for 140 terrestrial orchid taxa, and analysed their presence-absence data in more than 27 000 sampling sites. We performed a RLQ analysis to address the relationship between orchid ecological properties and the biotic and abiotic environment in sampling sites, and we quantified orchid niche width from this analysis. We showed that ecological strategies for resource acquisition and reproduction are strongly related to local environmental conditions in terrestrial orchids. Pollinator specific orchids occurred preferentially in drier Mediterranean ecosystems. Under more temperate climate, we found a gradient of strategies from autotrophic taxa in open habitats to fully heterotrophic taxa in closed habitats. We found more specific interaction with pollinators to be related to narrower orchid niche, while niche width was unrelated to the specificity in mycorrhizal interactions. These results are of fundamental interest by improving the understanding on how local biotic interactions influence large-scale orchid distributions, and of practical interest for better prediction and management of orchid populations in the face of environmental changes.

# SECONDARY DISPERSAL – HOW MUCH OF THE INVADERS GENETIC VARIABILITY CAN SLIP BETWEEN OUR FINGERS – A CASE STUDY OF *POA ANNUA* ON KING GEORGE ISLAND

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*Poa annua* L. is the only alien vascular plant that has established a stable population in the Maritime Antarctica. The species has been noted in the vicinity of Arctowski Polish Polar Station on King George Island, South Shetlands for 30 years. Another population of this species has been observed in the austral summer of 2008/2009 on Ecology Glacier forefield some 1.5 km away from the first one. In the presented study we addressed two research questions: 1. Does the forefield population stem from the Arctowski population due to secondary dispersal or originates from a totally new dispersal event into Antarctica; 2. If the forefield population stems from the Arctowski one how much genetic variability of the species has „escaped". We performed AFLP analysis yielding 252 and 231 scorable bands with 74 and 44 polymorphic bands for the Arctowski and forefield population respectively. The forefield population most probably stems from the one in the vicinity of the Station. UPGMA dendrogram of Jaccard's genetic distance revealed that the forefield population was a sub-cluster of Arctowski population. There were no private bands in the forefield population while they were present in the Arctowski one. Genetic distance between individuals from the forefield population was smaller than between individuals in the Arctowski population. Nei's genetic distance between studied populations was 0.345. We have also found a bottleneck effect for the forefield population. Our results indicate that considerable amount of genetic variability may be transferred during a secondary dispersal event of an alien invasive species. Therefore special care must be taken in the search and removal of daughter populations if a species is to be eradicated. We started the eradication of Arctowski population as well removed the forefield population during the 2014/2015 austral summer. We continue further long term monitoring and eradication of this species from Point Thomas Oasis.

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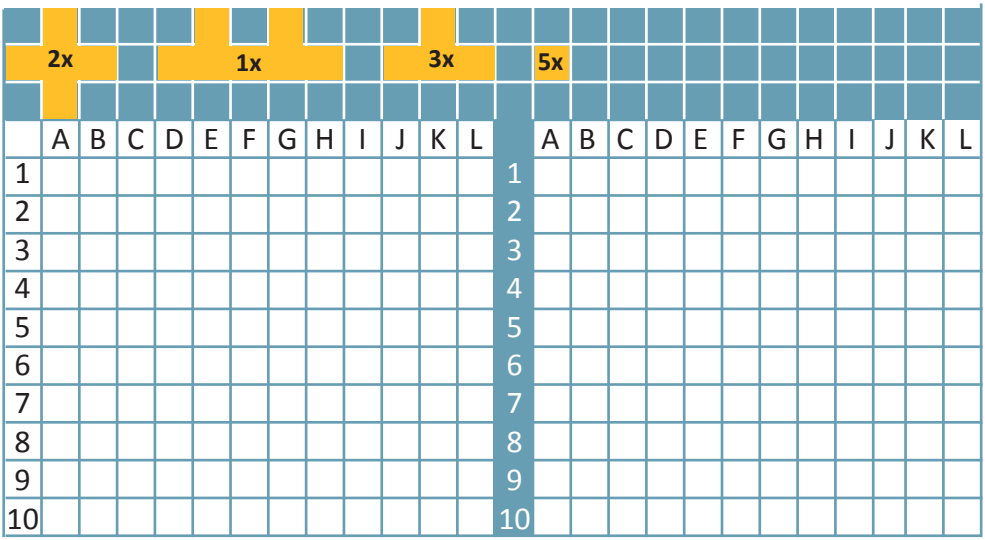
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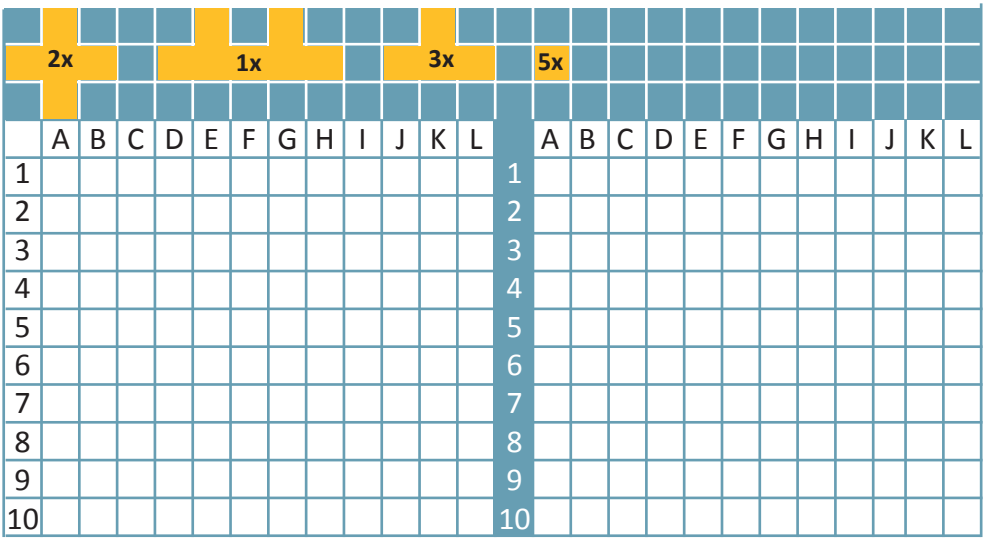
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