SCAPE 2016

Abisko 13-16 October

Welcome to SCAPE 2016!

SCAPE 2016 is organized by the Department of Plant Ecology and Evolution, Evolutionary Biology Centre, Uppsala University and the Department of Ecology, Environment and Plant Sciences, Stockholm University

Organising committee

Jon Ågren	Uppsala University
Johan Ehrlén	Stockholm University
Magne Friberg	Uppsala University
Nina Sletvold	Uppsala University

Oral Presenters: Please, ensure your talk is pre-loaded onto the conference laptop in the break prior to your session. For those of you presenting on Thursday, pre-load your talk before dinner. For help, please find our session moderators.

Poster Presenters: Please, set up your poster on Thursday. Presenters will have the chance to briefly advertise their posters at the beginning of the poster session, and are expected to remain with their poster for the rest of the poster session on Friday. We would like to keep posters on display until Sunday.

Acknowledgement

We thank the Linnean Centre for Plant Biology in Uppsala for financial support.

LINNEAN CENTRE for Plant Biology in Uppsala

PROGRAMME

THURSDAY 13 OCTOBER

15:00-18:00 **Arrival and registration**

18:00-19:15 **Dinner**

19:15-19:25 **Welcome**

19:25-20:55 **SESSION 1: MANAGING POLLINATION** **CHAIR: ANDERS NIELSEN**

19:25 **Ainhoa Magrach:** Increasing pollinator functional complementarity does not translate into increased reproductive success when involving the dominance of honeybees

19:40 **Lina Herbertsson:** Mass-flowering rapeseed benefits wild plant pollination – but not always!

19:55 **Juho Lämsä:** Field realistic exposure to imidacloprid reduces foraging motivation of *Bombus terrestris*

20:10 **Dara Stanley:** Investigating sublethal pesticide effects on bumblebee learning and foraging

20:25 **Beate Strandberg:** Pollinators and resources at organic farms – results from the BeeFarm project

20:40 **Jane Stout, Jeff Ollerton & Tina D'Hertefeldt:** Journal updates

21:00- **Get-together**

FRIDAY 14 OCTOBER

07:30-08:45 **Breakfast**

09:00-10:00 **SESSION 2: INVITED TALK** **CHAIR: NINA SLETVOLD**

09:00 **Bruce Anderson:** Tracking pollen: A giant leap for evolutionary biologists

10:00-10:30 **Coffee break**

10:30-12:00 **SESSION 3: BEHAVIOUR AND DIVERGENCE** **CHAIR: MAGNE FRIBERG**

10:30 **Tonya Lander:** A novel method for investigating pollinator foraging in heterogeneous landscapes

10:45 **Rosalie Burdon:** Multimodal signal honesty in *Penstemon digitalis* enhances bumblebee foraging

11:00 **Klaus Lunau:** How bee-pollinated flowers cope with pollenophagous pollinators

11:15 **Mohamed Abdelaziz:** Plant speciation and mating system evolution driven by pollinators

11:30 **Katarzyna Roguz:** Evolution of flower characters in the genus *Fritillaria* L. (Liliaceae) in response to pollinator shift

11:45 **Kathleen Kay:** Testing the Grant-Stebbins hypothesis: experimental sympatry between divergently adapted flowers

12:00-13:30 **Lunch**

13:30-14:30 **SESSION 4: INVITED TALK** **CHAIR: JOHAN EHRLÉN**

13:30 **Sharon Strauss:** Beyond competition: the challenges to coexistence of congeners through reproduction

14:30-15:00 **Coffee break**

15:00-16:30 **SESSION 5: COMMUNITIES AND NETWORKS** **CHAIR: JENS MOGENS OLESEN**

15:00 **James Rodger:** Pollinator sharing: competition, facilitation or interference in the co-flowering *Oxalis namaquana* and *Romulea citrina*?

15:15 **Gita Benadi:** Can optimal foraging of pollinators promote the pollination success of rare plants?

15:30 **Sara Reverté Saiz:** Pollinators show flower colour preferences but flowers with similar colours do not attract similar pollinators

15:35 **Saskia Klumpers:** The influence of plant traits and generalization degree on year-to-year fluctuation in flower-visitors and visitation rate

16:00 **José M. Iriondo:** Disintegrating a network: within-season dynamics of plant-pollinator interactions

16:15 **Jeff Ollerton:** Spatio-temporal stability of an island endemic plant-pollinator interaction

16:30 **Leg-stretcher**

16:40-18:20 **POSTER SESSION**

18:30-20:00 **Dinner**

20:00- **Get-even-more-together**

SATURDAY 15 OCTOBER

07:30-08:45 **Breakfast**

09:00-10:00 **SESSION 6: INVITED TALK** **CHAIR: JON ÅGREN**

09:00 **James Thomson:** Pollination deficits in theory and practice

10:00-10:30 **Coffee break**

10:30-12:00 **SESSION 7: CLIMATE AND HABITAT** **CHAIR: TOMMY LENNARTSSON**

10:30 **Jane Ogilvie:** Climate, flowering phenology, and bumble bee abundance

10:45 **Marilin Mõtlep:** Pollinators of *Platanthera bifolia* and *P. chlorantha* in populations under different management regimes in Estonia

11:00 **Amy Parachnowitsch:** Patch size is more important for fitness than urbanization in fireweed

11:15 **Maria Steinert:** Plant communities in power-line clearings: maintaining open-canopy habitats through frequent clearing could positively affect diversity of pollinating insects

11:30 **Solveig Haug & Arrian Karbassioon**: Pollinator interactions between wild raspberry and the surrounding plant community along an altitudinal gradient

11:45 **Kate Gallagher:** Effects of experimental shifts in soil moisture and flowering phenology on plant-pollinator interactions

12:00-13:15 **Lunch**

13:15-15:30 **Field trip in the close surroundings**

15:30-16:30 SESSION 8: POLLINATOR-MEDIATED SELECTION CHAIR: RENATE WESSELINGH

15:30 **Liedson Carneiro:** Geographic selection mosaic in an oil bee-plant mutualism across Brazilian dry diagonal

15:45 **Judith Trunschke:** Pollinator assemblage and patterns of selection in woodland and grassland populations of the orchid *Platanthera bifolia*

16:00 **Karin Gross:** Floral perfumes become different: region-specific selection in a terrestrial orchid

16:15 **Yuval Sapir:** Rethinking flower evolution in irises: are pollinators the agents of selection?

16:30-17:00 Coffee break

17:00-18:30 SESSION 9: MATING SYSTEMS CHAIR: MARCIN ZYCH

17:00 **Jane Stout:** Pollination ecology of Shea (*Vitellaria paradoxa*) in West Africa

17:15 **Thomas Martignier:** Variation in sex ratios and sex allocation in trioecious populations of the herb *Mercurialis annua*

17:30 **Åsa Lankinen:** Sexually antagonistic evolution caused by male-male competition in the pistil

17:45 **Marcos Méndez:** Sexual dimorphism in the scent of gynodioecious Silene vulgaris

18:00 **Marc Stift:** Did low genetic load facilitate the evolution selfing in North American *Arabidopsis lyrata*?

18:15 **John Pannell:** On the loss of outcrossing mechanisms under mate limitation

19:00- SCAPE banquet

SUNDAY 16 OCTOBER

08:00-09:30 Breakfast

09:30-10:00 Concluding discussion

10:30-11:00 Coffee

11:00- Departure

INCREASING POLLINATOR FUNCTIONAL COMPLEMENTARITY DOES NOT TRANSLATE INTO INCREASED REPRODUCTIVE SUCCESS WHEN INVOLVING THE DOMINANCE OF HONEYBEES

Ainhoa Magrach[1], Juan P. González-Varo[1,2], Montserrat Vilà[1] & Ignasi Bartomeus[1]

[1]Estación Biológica de Doñana (EBD-CSIC) Sevilla, Spain
[2]Conservation Science Group, Department of Zoology, University of Cambridge, UK

Agricultural expansion is one of the major causes of habitat loss and species extinction. Alongside land use change, agriculture also entails the use of other inputs such as fertilizers or pesticides as well as honeybee hives in the case of pollinator-dependent crops. The use of managed honeybee hives has increased across the world making *Apis mellifera* (the European honeybee) the single most important crop pollinator. In the case of mass-flowering crops, honeybees feed on crop flowers during blooming but then "spillover" towards adjacent semi-natural habitats where they collect pollen and nectar from native plants with potential impacts for them as well as for other pollinators. The aim of this study was to assess changes in honeybee abundance and wild pollinators during and after the blooming of orange orchards in eight sites located in areas with high cover of the crop compared to control areas with low crop cover. We further evaluated how changes to the pollinator community translated into the network of interactions between plants and pollinators in semi-natural habitats and valued the effect this had for pollinator function (seed set) for two of the most abundant plant species. Our results show that following orange blooming managed honeybees abundance is almost doubled compared to that present in those same areas during crop blooming. This increase of honeybees consequently affects network structure, which shows a dominance of interactions involving honeybees and an increase in functional complementarity of the pollinator community as other pollinators probably feed preferentially on less abundant resources. The preference of honeybees for the two most abundant plant species however has a negative effect for their reproductive success related to their foraging behavior that leads to a significant reduction in pollen tube growth with increasing numbers of honeybee visits. This study therefore highlights the negative effects that increasing densities of managed honeybee hives have on native plant reproduction and calls for an adequate understanding of the number of honeybee hives needed in order to ensure sufficient pollination services to crops while minimizing negative effects over neighboring natural habitats.

MASS-FLOWERING RAPESEED BENEFITS WILD PLANT POLLINATION – BUT NOT ALWAYS!

Lina Herbertsson

Centrum för miljö- och klimatforskning, Lund University, Sweden

Mass-flowering crops can affect the abundance and distribution of wild pollinators. The mass-flowering crop rapeseed attracts short-tongued pollinators and can benefit some bumble bees and solitary bees, but after the blooming it can have a negative effect on long-tongued bumble bees, likely due to increased competition for pollen and nectar. This trait-dependent impact on pollinators could have consequences for the pollination of wild plants in the agricultural landscape. We expected that high proportion of rapeseed fields in the surrounding landscape would have a positive effect on strawberry pollination, which in theory can be pollinated by any pollinating insect (pollination generalist). On the other hand, we expected a negative effect on pollination of red clover, which is mainly pollinated by long-tongued bumble bees (pollination specialist). We placed three pots of each plant species in 16 semi-natural habitats, embedded in agricultural landscape with either high or low proportion rapeseed fields. Indeed we found that strawberry pollination was positively affected by rapeseed cultivation, but we found no similar effect on red clover, suggesting the pattern to be caused by differences in pollination strategy. More studies are needed to assess if rapeseed and other mass-flowering crops can have long-term effects on plant community structure.

FIELD REALISTIC EXPOSURE TO IMIDACLOPRID REDUCES FORAGING MOTIVATION OF *BOMBUS TERRESTRIS*

Juho Lämsä, Juha Tuomi, Erno Kuusela, Sini Juntunen & Phillip Watts

Department of Ecology, University of Oulu, Finland

Neonicotinoids, such as imidacloprid, are the most widely used class of insecticides and often linked to the diminishing populations of wild bees. In this factorial experiment we studied the effects of chronic sublethal doses of imidacloprid on bumblebee (*Bombus terrestris*) learning and foraging abilities. The experiment was carried out in laboratory conditions using automatized, computer controlled artificial flowers having either sugar solution or bitter quinine solution depending on symbols. Data collection was arranged in a 15 m^2 flight cage, where bumblebees were released one at a time from a separate nest cage. Data consists of 3 control nests and 3 pesticide treatment nests, 159 individuals in total. In pesticide treatment, bees were fed with sugar solution containing 1 μg/kg of imidacloprid for two weeks. The avoidance-learning was not affected by the pesticide treatment. However, the time spent feeding was reduced and the bees started foraging later than in the control group. Also, fewer flower types were visited. These results indicate that even very low sublethal concentrations of neonicotinoids can affect bumblebee foraging behavior, and possibly, have detrimental effects for the food intake of the bumblebee colonies. Similar concentrations of imidacloprid (1 μg/kg) are commonly measured from honeybee wax in the agricultural areas of France and the USA, where the decline of bees is a serious problem.

INVESTIGATING SUBLETHAL PESTICIDE EFFECTS ON BUMBLEBEE LEARNING AND FORAGING

Dara A. Stanley[1] & Nigel E. Raine[2]

[1]Botany & Plant Science, Ryan Institute, National University of Ireland Galway, Ireland
[2] School of Environmental Sciences, University of Guelph, Ontario, Canada

The use of neonicotinoid pesticides in agriculture has caused concern over the sub-lethal impacts they may have on bees and pollinations services. However, the majority of experimental research has taken place on honeybees, when impacts on other wild bee taxa may not be the same due to differences in their physiology and biology. We investigated the impacts of field realistic levels of the neonicotinoid thiamethoxam on bumblebee learning and foraging. We assessed learning and memory ability using proboscis extension response (PER) conditioning, and tracked bumblebee foraging in the wild using radio frequency identification (RFID) tagging. We found that bees exposed to pesticide learn more slowly than control bees, go on longer foraging trips and collect less pollen. However, exposed individuals visit more flowers than controls showing an increase in individual activity. This has implications for both pesticide usage policy and pollination service delivery. In particular, the importance of results in the context of pollination services to both crops and wild plants are discussed.

POLLINATORS AND RESOURCES AT ORGANIC FARMS – RESULTS FROM THE BEEFARM PROJECT

Beate Strandberg[1], Vibeke Langer[2], Yoko Dupont[1], Peter B. Sørensen[1] & Lise Hansted[2]

[1] *Department of Bioscience, Aarhus University, Denmark*
[2] *Department of Plant and Environmental Science, University of Copenhagen, Denmark*

Wild bees are dependent on the availability of resources in habitats for nesting, foraging and hibernation within a limited spatial range to complete their life cycle. Many factors have negative effects on resource availability. In agricultural areas, some of these factors, i.e. habitat loss, degradation and fragmentation and exposure to agrochemicals, are more prominent than elsewhere. Consequently, wild bees are declining in Denmark as in the rest of Europe, resulting in yield instability of insect pollinated crops, insufficient pollination of wild plants and loss of biodiversity. Within the BeeFarm project we have developed a farmer's tool for assessing resources for bees at the farm. The tool includes a guided tour through the fields and semi-natural habitats of a farm, in order for the farmer to systematically assess the bee resources on the farm. The tool is developed in collaboration with organic red clover seed producers and apple growers. The tool will make it possible for the farmers to identify resources, which are potentially limiting wild pollinator populations, and hence pinpoint what can be done in order to improve yield stability of insect-pollinated crops and biodiversity at the farm. In addition to the resource assessment, we have trapped pollinators in order to evaluate bee diversity relative to resource availability at the farm. In addition to the farmer's tool, we will present part of the result and discuss some of the important project findings regarding pollinators and resources at organic farms.

TRACKING POLLEN: A GIANT LEAP FOR EVOLUTIONARY BIOLOGISTS

Bruce Anderson

Department of Botany and Zoology, Stellenbosch University, South Africa

Flowers display an astonishing amount of variability in their morphology, and it is likely that much of this variability is the result of different evolutionary strategies to enhance pollen transfer and limit pollen wastage. However, because of our inability to track granular pollen grains, most studies on floral evolution have only attempted to quantify components of plant fitness in terms of seed set or fruit set (female fitness). This has resulted in a one-sided perspective on how floral traits evolve, which is especially problematic given the very real possibility that floral traits evolve primarily through components of male fitness. By developing a new technique to label and track the fate of pollen grains, we finally have the tools needed to counter-balance the historically deficient paradigm of studying female fitness in near isolation. I will explain the technique and demonstrate how we have used it to study the evolutionary significance of stylar polymorphisms from the perspective of pollen movement and transfer efficiency, both important aspects of male fitness.

A NOVEL METHOD FOR INVESTIGATING POLLINATOR FORAGING IN HETEROGENEOUS LANDSCAPES

Tonya Lander

Department of Plant Sciences, University of Oxford, UK

The global decline of both wild and managed pollinators is a serious problem for continued ecosystem function and human food security. Although there is a general consensus that habitat loss is particularly important in the decline of wild pollinators, we have an extremely limited understanding of how the presence or absence of habitat, particularly forage resources, at the landscape scale affects patterns of pollinator movement. Traditional approaches to investigating pollinator movement such as mark-recapture, bait/feeding station observation, or plant population genetics only provide information on where pollinators start and end individual foraging flights, not the path taken in-between. However, between any two points in a heterogeneous landscape there are a variety of paths a pollinator could take, each crossing a different combination of land-uses or habitat types and therefore different types and concentrations of resources for the pollinator. Current models that attempt to predict pollinator movement through heterogeneous landscapes perform poorly when compared to empirical data on pollen flow because, in essence, we do not know what types of land-uses or vegetation communities encourage or discourage pollinator travel. We have developed a novel molecular method to trace pollinator foraging paths in the endemic South Africa *Rediviva* oil-bee / *Diascia* oil-plant pollination mutualism. Results from this study will feed into the development of predictive models of the movement of pollinators in heterogeneous landscapes.

MULTIMODAL SIGNAL HONESTY IN *PENSTEMON DIGITALIS* ENHANCES BUMBLEBEE FORAGING

Rosalie Burdon

Department of Plant Ecology and Evolution, EBC, Uppsala University, Sweden

Animal-pollinated plants produce a remarkable diversity of floral signals to attract pollinators, yet we know surprisingly little about why floral displays consist of so many elements. An unresolved question is why flowers produce multimodal signals, i.e., scent plus colour as opposed to colour plus pattern, when multiple signals may be more costly to produce than single-element displays. It is suggested that displays producing multimodal signals are better at attracting the attention of pollinators, and can act additively or synergistically to enhance the detection/ foraging ability of pollinators. However these hypotheses are under the assumption that floral signals should honestly signal reward, yet few experiments assess if multiple traits within the same system can be honest, and how honesty of multiple traits may function to benefit the plant or pollinator. Therefore we compare the signal-reward associations of multiple traits of *Penstemon digitalis* that are already known to be under selection. We also assess whether multiple signals within a display need to correlate with reward to reinforce bumblebee foraging preferences and whether there is a compromise to be made in the strength of that correlation. We show that multiple floral signals can be correlated with reward in the same system and that multiple signals correlated with reward will increase bumblebee foraging efficiency and promote learning. We conclude that plants will be chosen more frequently if honestly signalling reward with multiple signals and suggest that plants balance greater attraction by varying the availability of reward.

HOW BEE-POLLINATED FLOWERS COPE WITH POLLENOPHAGOUS POLLINATORS

Klaus Lunau

Institut für Sinnesökologie, Department Biologie, HHU Düsseldorf, Germany

Bee-pollinated flowers and pollen-collecting bees compete for pollen. The pollen dilemma of bee-pollinated plants arises, because bee-pollinated flowers need pollen for sexual reproduction as well as for rewarding pollen-collecting bees and because pollen-emptied flower are no longer attractive for pollen-collecting bees. In view of this pollen dilemma of bee-pollinated plants the mechanical defense against the collection of pollen by bees as well as well as pollen mimicry by floral guides and the use of safe sites on the bees' body for the pollen transfer between conspecific plants are evaluated. Results from experimental tests are presented indicating various aspects of the pollen dilemma. 1. Spines on pollen grains impede pollen collection by corbiculate bees. 2. Pollen foraging bumblebees stop pollen-collecting if forced to switch to a new pollen source offering spiny pollen grains. 3. Pollen mimicking floral guides attract bees towards nectaries and distract bees from real stamens. 4. Bee-pollinated flowers use safe sites for pollen transfer which bees are less capable to groom. 5. Flowers have evolved mechanisms to get pollinated by pollen grains the bees have stored in transport organs.

PLANT SPECIATION AND MATING SYSTEM EVOLUTION DRIVEN BY POLLINATORS

Mohamed Abdelaziz

Department of Genetics, Faculty of Science, University of Granada, Spain

The causes and consequences of speciation have drawn the attention of scientists from the first studies in evolutionary biology. The causes of speciation lie in a continuous interaction between ecological and genetic mechanisms, and the importance of natural selection for creating barriers to gene flow between diverging taxa (ecological speciation) has been recognised. In the other hand, one of the main and most recurrent consequences of speciation in plants is the evolutionary transitions between different mating systems. In the present work we use two close related species belonging to genus *Erysimum* L.: *E. incanum* and *E. wilczekianum* to study a singular example of speciation in which the pollinators play a central role. These species are distributed through the Western Mediterranean basin and they mainly differ in flower size, suggesting the existence of important dissimilarities in mating systems. In that sense, we studied the mating systems of these species carrying out over 2300 hand-pollinated crosses in 140 different plants. On the same plants, more than 500 controlled crosses were made to estimate the post-zygotic reproductive barriers between them. Finally, in order to explore the pre-zygotic reproductive barriers between our species we created an artificial plot including plants from both species in a sympatric population to evaluate the preferences exhibited by pollinators. We found strong but asymmetric barriers to gene flow between both species. We also found important differences in the mating system presented by them and in the mechanisms promoting the success of these mating systems.

EVOLUTION OF FLOWER CHARACTERS IN THE GENUS *FRITILLARIA* L. (LILIACEAE) IN RESPONSE TO POLLINATOR SHIFT

Katarzyna Roguz & Marcin Zych

Botanic Garden, Faculty of Biology, University of Warsaw, Poland

The majority of *Fritillaria* species are entomogamous, but there are also some North American and Asian bird-pollinated species. The evidence indicate that the switch from entomophily to ornitophily happened at least once in the history of the genus. We assume that pollinator shift can by accomplished by divergence in several floral characters. These features might also act as a phenotypic filter when flowers become repelling or invisible to illegitimate flower visitors. We discuss some pathways of the floral character divergence in *Fritillaria* promoting ornithopily and reducing attractiveness of flowers to less effective pollinators.

TESTING THE GRANT-STEBBINS HYPOTHESIS: EXPERIMENTAL SYMPATRY BETWEEN DIVERGENTLY ADAPTED FLOWERS

Kathleen M. Kay

Ecology and Evolutionary Biology, University of California, Santa Cruz, USA

The high species richness found in animal-pollinated plant lineages is thought to result from how pollinators affect plant mating patterns and gene flow. Under the classic Grant-Stebbins model, variation in pollinator assemblages across a geographic range leads to divergent specialization on the most effective local pollinator, resulting in reproductive isolation among populations. Alternatively, adaptation to a new pollinator may come at little cost to the effectiveness of an ancestral pollinator and be unlikely to reduce gene flow among populations. I test this model in two species in the genus *Clarkia* with abutting ranges in California that are adapted to effective pollination by diurnal insects versus nocturnal hawkmoths. I ask to what extent geographical divergence in floral adaptation contributes to reproductive isolation upon experimental secondary sympatry. Using multiple populations of each species, I quantify ethological and mechanical floral isolation by exposing naive hawkmoths to both homo- and heterospecific floral arrays. Although hawkmoths are more motivated to visit the hawkmoth-adapted species in single species arrays, they show no visitation preference in mixed arrays, and thus contribute no ethological isolation. For mechanical floral isolation, the likelihood of heterospecific pollen transfer depends on the population origin of the diurnal insect-adapted species used in the trial. Populations with small flowers and narrow floral tubes are strongly isolated from the hawkmoth-adapted species, whereas larger-flowered populations experience no isolation. Counter to the Grant-Stebbins model, adaptation to a novel pollinator in one part of the geographic range has not automatically resulted in reproductive isolation; rather, the outcome of sympatric contact depends on the specific pairings of individual plants. Whereas most floral isolation studies involve young plant species that are currently sympatric, my work shows weak ethological and floral mechanical isolation prior to widespread secondary contact, but also that genetic variation for floral traits conferring isolation is abundant.

BEYOND COMPETITION: THE CHALLENGES TO COEXISTENCE OF CONGENERS THROUGH REPRODUCTION

Sharon Strauss

Department of Evolution and Ecology, University of California, Davis, USA

Understanding coexistence of closely related species lies at the nexus of speciation history, niche overlap, and reproductive isolation. A fundamental duality occurs when species are relatively recently diverged from one another (Darwin 1859). On one hand, the biological similarity and geographic origins of closely related species can promote their co-occurrence in the same areas. On the other, close relatives can ecologically and reproductively interfere with one another owing to their similarities. A rich history of research on the drivers of coexistence in close relatives includes the study of limiting similarity, character displacement, species:genus ratios, island radiations, hybridization and reinforcement. Very pertinent to SCAPE, challenges to coexistence may come from reproductive interference (RI); RI occurs when species are reproductively isolated, but still impede each other's fitness when they co-occur. In plants, this interference can arise through stigmatic clogging by heterospecific pollen, or pollen lost to non-target heterospecifics. First, I review the evidence for RI between close plant relatives; then, I discuss how RI can influence the conditions for ecological coexistence from a modeling standpoint, as both RI and competitive outcomes are frequency dependent processes. Third, using data from a clade of mustards for which we have extensive taxon sampling, I explore the degree to which closely related plant species share floral morphology and scent, and whether floral traits diverge with increasing range overlap. I explore whether there is evidence that flowering time is phylogenetically conserved, and whether habitat shifts have the potential to reduce RI between close relatives.

POLLINATOR SHARING: COMPETITION, FACILITATION OR INTERFERENCE IN THE CO-FLOWERING *OXALIS NAMAQUANA* AND *ROMULEA CITRINA*?

James G. Rodger[1,2], Marinus de Jager[1] & Allan G. Ellis[1]

[1]*Department of Botany and Zoology, Stellenbosch University, South Africa*
[2]*Department of Ecology and Evolution, University of Lausanne, Switzerland*

Plant species that occur together, flower at the same time and have the same pollinators may interact by competing, facilitating, or interfering with each other's pollination through heterospecific pollen transfer (HPT). The presence and strength of these interactions will depend on absolute and relative densities of the plant species, as well as pollinator behaviour and pollen placement on pollinators. *Oxalis namaquana* and *Romulea citrina* are co-flowering species with similar looking yellow flowers that co-occur in seasonally damp areas in Namaqualand. We hypothesised that pollen limitation would occur due to competition and HPT, especially at low absolute and relative density of the focal species. We identified honeybees as the primary pollinators of both species as they were by far the most frequent visitors and carried substantially more pollen than other visitor species. Although most individuals displayed constancy when foraging, some switched between the two species frequently. Pollen load analysis showed that the areas of the honeybee body that the plants used for pollen transport overlapped substantially. These results indicate a pathway for HPT to occur and we indeed observed heterospecific pollen on both species, although more on *O. namaquana* than *R. citrina*. Breeding system data suggest that *O. namaquana* is largely pollinator dependent and show that *R. citrina* self-fertilises autonomously, so the former should be more vulnerable to pollen limitation than the latter. Although effects of conspecific and heterospecific density on pollinator visitation and pollen receipt were detected, these did not translate into effects on fruit or seed set in either species. *R. citrina* and *O. namaquana* thus seem to suffer no ill-effects of pollinator sharing and heterospecific pollen transfer.

CAN OPTIMAL FORAGING OF POLLINATORS PROMOTE THE POLLINATION SUCCESS OF RARE PLANTS?

Gita Benadi

Biometry and Environmental System Analysis, University of Freiburg, Germany

Many plant species rely on the mobility of animals to transfer pollen from flower to flower. Since the amount of conspecific pollen received from pollinators determines the reproductive success of a plant, pollinator behaviour can have a strong impact on the fitness of individual plants and the average fitness of plant species in a community. According to ecological theory, diversity in a community is maintained if each species' average fitness increases when it becomes rare relative to other species, while a positive relationship between relative abundance and fitness decreases diversity. Thus, a change in conspecific pollen receipt with changing relative abundance could have far-ranging consequences for plant community dynamics. Based on optimal foraging models, previous studies have predicted that, all else being equal, abundant plant species should receive more conspecific pollen than rare ones. Here I re-evaluate this issue using a simple mathematical model of flower selection by pollinators and an individual-based simulation which includes real-world complexities such as flower constancy of pollinators and the dynamics of floral reward depletion and replenishment. Both models predict that with constant and equal rewards per flower the pollination success of abundant plants should be higher than that of rare plant species. However, if reward levels fluctuate asynchronously, the pollination success of a rare plant species can exceed that of a more abundant plant. This result suggests that pollination may play a role in maintaining diversity in communities of flowering plants and provides testable predictions for empirical studies of plant-pollinator interactions.

POLLINATORS SHOW FLOWER COLOUR PREFERENCES BUT FLOWERS WITH SIMILAR COLOURS DO NOT ATTRACT SIMILAR POLLINATORS

Sara Reverté Saiz

Centre of Ecological Research and Forestry Applications (CREAF), Autonomous University of Barcelona, Spain

Colour is one of the main floral traits used by pollinators to locate flowers. Although pollinators show innate colour preferences, the view that the colour of a flower may be considered an important predictor of its main pollinators is highly controversial because flower choice is highly context-dependent, and initial innate preferences may be overridden by subsequent associative learning. Our objective is to establish whether there is a relationship between flower colour and pollinator composition in natural communities. We measured the flower reflectance spectrum and pollinator composition in four plant communities (85 plant species represented by 109 populations, and 32 305 plant–pollinator interactions in total). Pollinators were divided into six taxonomic groups: bees, ants, wasps, coleopterans, dipterans and lepidopterans. We found consistent associations between pollinator groups and certain colours. These associations matched innate preferences experimentally established for several pollinators and predictions of the pollination syndrome theory. However, flowers with similar colours did not attract similar pollinator assemblages. The explanation for this paradoxical result is that most flower species are pollination generalists. We conclude that although pollinator colour preferences seem to condition plant–pollinator interactions, the selective force behind these preferences has not been strong enough to mediate the appearance and maintenance of tight colour-based plant–pollinator associations.

THE INFLUENCE OF PLANT TRAITS AND GENERALIZATION DEGREE ON YEAR-TO-YEAR FLUCTUATION IN FLOWER-VISITORS AND VISITATION RATE

Saskia G.T. Klumpers, Peter G.L. Klinkhamer & Martina Stang

Plant Ecology & Phytochemistry, Institute of Biology, Leiden University

Plant-flower-visitor interactions are known to fluctuate through time and recent studies have revealed inter-annual fluctuations in generalization levels at the community level due to both species' flexibility in the interactions and species turnover. However, little is known on how plant species differ in their year-to-year fluctuation of their flower-visitors and how this is related to plant traits such as nectar tube depth and their generalization degree. In this study we used a three year dataset of a flower-visitation network of plant species belonging to the Asteraceae in the Colorado Rocky Mountains to investigate: 1) whether nectar tube depth determines plants' generalization degree, 2) how the fluctuation in (the number of) flower-visitor species is related to the nectar tube depth and generalization degree of plant species and 3) how nectar tube depth and generalization degree of plant species affect visitation rate. We found that the number of flower-visitor species decreased with increasing nectar tube depth, but this relationship was not significant in all three years. Further, the flower-visitors of shallow-tubed, generalized plants fluctuated more across years. We did not find any relationship between visitation rate and both nectar tube depth and plants' generalization degree. These results indicate that, for plants, specialization and generalization are two different strategies that might be equally successful in ensuring pollination and thus reproduction.

DISINTEGRATING A NETWORK: WITHIN-SEASON DYNAMICS OF PLANT-POLLINATOR INTERACTIONS

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Plant-pollinator networks are normally studied using all the interactions recorded in the community throughout the whole flowering season. This integrated approach allows the analysis of the network as a whole, characterizing the system with a single set of parameters. Nevertheless, the information that it provides is limited by the temporal integration. A first limitation is that it cannot assess the structural dynamism of the network through the flowering season. Furthermore, it does not inform if the recorded interactions concur in time. Consequently, it is not possible to infer if the different pollinators that visit a particular plant species are competing at the same time for the same resources or visit the plant at different time periods. Thus, we cannot tell if the lack of interactions between pairs of species are due to a lack of temporal synchrony between flowering time and the adult stage of the insect or to incompatibilities between flower and insect morphologies. In this study we aimed to assess the effect of within-season temporal variation of plant and pollinator activity on network structure. We analysed the temporal dynamics of a plant-pollinator network in a Mediterranean alpine grassland community during one complete flowering season. In our approach we (i) built a quantitative interaction network, (ii) split it up into three time-aggregated subnetworks and (iii) studied the dynamics through beta diversity and modularity analysis. Given the short period of life activity in Mediterranean high-mountain grasslands, we hypothesized that the flowering period would be short and the flowering peak of most plant species would coincide within a short period of time. Furthermore, we expected temporal replacement of species to be constrained and that modularity would not be associated to temporal variation in the interactions. In contrast with our expectations, plant species had marked temporal differences in their flowering period, the subnetworks presented a significant species turnover and the modules found in the integrated network were associated to the phenology of their constituents.

SPATIO-TEMPORAL STABILITY OF AN ENDEMIC ISLAND PLANT-POLLINATOR INTERACTION

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Endemic oceanic island plant-pollinator relationships have generated particular interest because there is a theoretical mismatch in the expectations of the outcomes of dispersal and establishment of biotically pollinated plants to islands. The ancestors of endemic plants should, in theory, be more likely to establish on an island if they are generalists capable being pollinated by a wide range of taxa. At the same time, island pollinator faunas tend to be of rather low diversity and abundance, and plant reproduction is often pollinator limited, making pollination niche segregation more likely via specialisation on a single pollinator or functional group of pollinators. The relative importance of specialist versus generalist strategies for biotic pollination are therefore unclear for island plants. At the moment, however, too few detailed studies of oceanic island plant-pollinator interactions have been conducted to properly assess the generality of any patterns and further case studies are required, particularly over a longer time scales and across multiple populations to assess spatiotemporal variation in the interactions between plants and their pollinators. Since 2003 I have been studying the pollination ecology of a Canary Island endemic plant species, the Canary Wallflower *Erysimum scoparium* (Brassicaceae), on Tenerife. *E. scoparium* employs a flower colour change strategy to manipulate its principal pollinators, which comprise a guild of medium sized bees, dominated by an endemic solitary bee *Anthophora alluaudi* (Apidae). The interaction between *E. scoparium* and *A. alluaudi* is stable over that time period and in multiple populations over an altitudinal range of almost 1000 m (range = 1300 to 2250 m.a.s.l). The period of study includes one of the driest winters recorded on Tenerife and I discuss the effect of changes in community composition on the ecology of this endemic plant-pollinator interaction, and the reproductive success of the plant.

POLLINATION DEFICITS IN THEORY AND PRACTICE

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Concerns about declining pollinator populations have driven speculation that many plant species may be experiencing deteriorating pollination service, but there are very few studies that have measured pollination deficits over a long enough period to support such claims. I will discuss the general concept of pollination deficits, the methodology for measuring them, and biases in that methodology. I will then describe a case study in which I have measured pollination deficits in *Erythronium grandiflorum*, a wild North American lily, over 24 years. To my knowledge, the length of this study is unique, but trends in pollination service are heterogeneous within the time series. Recent years' data contradict an earlier report of progressive deterioration. Without more long-term studies, reports of general and widespread pollination declines remain speculative.

CLIMATE, FLOWERING PHENOLOGY, AND BUMBLE BEE ABUNDANCE

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Given ongoing climate change, it is important to understand whether climate can influence bee population sizes either directly by affecting survival and life history events, or indirectly by influencing the amount and timing of floral food resources. We conducted a 7-year observational study of three bumble bee (*Bombus*) species, the floral assemblages that they visit, and climate at a subalpine site in southwestern Colorado, USA, where the flowering season is limited to a short snow-free period. Using structural equation modelling, we show that inter-annual variation in the abundance of two *Bombus* species (*B. bifarius* and *B. flavifrons*) was driven primarily by the indirect effects of summer precipitation and snowmelt date on peak floral timing. As peak floral timing (the time between snowmelt date and peak floral abundance) increased, so too did bee abundance. However, the abundance of a third species, *B. appositus*, was better explained by the direct effect of snowmelt date and either floral timing (indirect climate effect) or summer precipitation (direct climate effect), two variables that strongly co-varied. Using a 41-year flower dataset from the same study site, we further show that peak floral timing is occurring later relative to snowmelt date, but peak floral abundance has not changed directionally. Thus, at this subalpine site, lengthening timespans before the floral peak should increase *Bombus abundance*. More generally, our results suggest that bee populations are sensitive to climate change primarily through indirect climate-driven changes in floral resources, although some species may have direct responses to climate.

POLLINATORS OF *PLATANTHERA BIFOLIA* AND *P. CHLORANTHA* IN POPULATIONS UNDER DIFFERENT HABITAT MANAGEMENT REGIMES IN ESTONIA

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In agricultural landscape semi-natural communities are one of the richest in biodiversity. Management of these communities for conservational purposes should be based on the requirements of plants as well as their pollinators. Our study focused on the pollination of *Platanthera bifolia* and *P. chlorantha* which are common species in semi-natural habitats in Estonia and in a close mutualistic relationship with pollinating moths. By observing and catching moths during pollination in 2014–2016 and comparing the length of their proboscises with the length of spurs of *Platanthera* species we aimed to determine effective pollinators in populations under different habitat management regimes (18 populations, 3 have been regularly grazed or mown, 5 are abandoned, 4 are being restored and 6 are natural). Another aim was to see if there was a correlation between flower visitor abundance (number of flower visitors per night) and fruiting success. We also wanted to find out if fruiting success differed between species and populations. Pollinator assemblages did not differ between natural, restored and abandoned populations of *P. bifolia*, main pollinators were *Sphinx ligustri* and *S. pinastri*. In *P. chlorantha* populations under grazing differed from others and constant grazing has led to lowest species richness. We found no differences in pollinator abundance and fruiting success between management regimes, fruiting success did not differ between species either. Flower visitor abundance correlated with the fruiting success of *P. bifolia* but no correlation was found for *P. chlorantha*.

PATCH SIZE IS MORE IMPORTANT FOR FITNESS THAN URBANIZATION IN FIREWEED

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Urbanization is a spreading environmental change that can have large impacts on the species living in those environments. Plant-pollinator interactions might be particularly vulnerable to urbanization because both partners must tolerate or adapt to the changing environment. Using *Chamerion angustifolium*, we examined whether plants, and in particular their interactions with pollinators, were affected by the degree of urbanization in the Swedish town, Västerås. Surprisingly, almost no aspect of the plants flowering or fitness was affected by the degree of urbanization, including pollen limitation. In general plants were not pollen limited, with a slight trend towards increased pollen limitation in the outskirts of town rather than the centre. Instead, we found patch size was an important predictor of plant fitness with plants growing in larger patches having higher fitness. Furthermore, patch size and urbanization was not related. Our results suggest that for a generalist pollinated, disturbance specialist such as *C. angustifolium*, urbanization might not pose a difficulty as long as they are able to establish in large enough populations or patches.

Plant communities in power-line clearings: maintaining open-canopy habitats through frequent clearing could positively affect diversity of pollinating insects

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Linear utility corridors, such as roads and power-line clearings, have been thought to affect biodiversity negatively. However, during the last decade several studies have highlighted the potential value of power-line clearings as habitats for several taxonomic groups, like bees and butterflies. In forested landscapes, the vegetation below power-lines is continuously reset to earlier successional stages, which provides suitable habitats for several native plant species hosting diverse assemblages of pollinating species. With proper management, power-line clearings could be important for conservation of species associated with open-canopy habitats. We wanted to investigate the effect of different management practices on species composition of vascular plants important for pollinators, using a large-scale field experiment from 19 sites in the main power-line grid in southeast Norway. At each site, we established three plots and randomly assigned one of the following treatments; 1) Cut: all woody vegetation cut and left to decay, 2) Cut + Remove: all woody vegetation cut and removed, 3) Uncut: un-cleared. The following three seasons we surveyed understory plant communities within nine 1-m^2 plots in each treatment and sampled habitat characteristics and environmental conditions. Preliminary results show that the treatments Cut and Cut + Remove had a positive effect on plant species richness second and third year after cutting. In addition, landscape fragmentation had a positive effect on species richness. We are currently analyzing effects of management practices, under different environmental conditions, on other plant community response variables. The results will be presented on SCAPE 2016.

POLLINATOR INTERACTIONS BETWEEN WILD RASPBERRY AND THE SURROUNDING PLANT COMMUNITY ALONG AN ALTITUDINAL GRADIENT

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To study how climate change affects plant-pollinator interactions is difficult as there is paucity in longitudinal studies or monitoring programs documenting change over time. One way to tackle this lack of temporal data is to use a space-for-time approach. By observing plant-pollinator interactions along an elevation gradient where the climate conditions vary (temperatures decrease with elevation) we have studied changes in plant-pollinator interactions and how they are affected by local climate conditions (temperature and humidity). These projects survey variations in the size and structure of the pollinator community of wild raspberry (*Rubus idaeus*) and common cow-wheat (*Melampyrum pratense*) in Norefjell, SE-Norway, along an elevation gradient from ~150-850masl. We collected data on flower visitation and seed/fruit-set in forest clear cuts within intensively managed spruce forests. These clear cuts are important habitats for wild raspberry as it can occur in high densities, providing substantial amounts of floral resources to the pollinator community. Within each forest clear cut we established study plots centered on raspberry and cow-wheat patches. Observations related to the two projects were conducted in the same plots and at the same time. The first project will focus on the structure and diversity of the pollinator community to wild raspberry as such. This project will give insight into how the pollinator community of an important commercial crop might change in response to climate conditions. The second project will focus on the structure of the plant-pollinator system of cow-wheat in relation to wild raspberry. We will use the abundance and attractiveness of wild raspberry, a dominant species, in models describing the pollinator community of the surrounding cow-wheat.

EFFECTS OF EXPERIMENTAL SHIFTS IN SOIL MOISTURE AND FLOWERING PHENOLOGY ON PLANT-POLLINATOR INTERACTIONS

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Warmer springs and earlier snowmelt associated with climate change are altering the timing of plant reproduction and pollinator emergence (i.e. phenology), as well as soil moisture during the growing season. Both shifts in flowering phenology and water availability can affect pollinator visitation and plant reproductive success. Moreover, because they are unlikely to occur in isolation, the effects that differences in flowering phenology have on plant pollination are likely to vary with changes in water availability. To test this hypothesis, we manipulated flowering phenology and soil moisture in a factorial experiment with the subalpine perennial *Mertensia ciliata* (Boraginaceae) and measured effects on vegetative and floral traits, pollinator visitation and identity, and seed set. Declining pollinator visitation rates suggest pollen limitation may increase throughout the season; however, this pattern was not reflected in seed set, which differed among water treatments groups and not among phenology weeks. Differences in the composition of pollinators among water treatment groups suggest that flower size and nectar amount, which increased with water availability, likely have a greater influence on pollination by bumblebees that dominate late in the season than they have on pollination by solitary bees that are more common early in the season. This work provides valuable insight into the mechanisms that influence how two important co-occurring drivers, water availability and flowering phenology, impact plant-pollinator interactions.

GEOGRAPHIC SELECTION MOSAIC IN AN OIL BEE-PLANT MUTUALISM ACROSS BRAZILIAN DRY DIAGONAL

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Floral diversity may evolve in response to pollinator-mediated selection. As plants interact with different pollinator assemblages along their range, the geographical component seems to be important for the evolutionary outcomes. In this study, we aimed to evaluate the geographic structure of the specialized interaction between *Krameria grandiflora* and oil-collecting bees, exploring the possible existence of selection mosaics. *Krameria grandiflora* flowers bear a showy calyx and dimorphic corolla: reduced petals by which oil bees hold with their mandibles, and two lateral oil-secreting petals (elaiophores), scraped by them for oil gathering. We assessed the extent of spatial variation of pollinator assemblage and estimated strength and form of selection on sepal length (attraction trait), distance between the petal part held by the bees and the stigma (mechanical-fit trait) and oil amount. Pollinator assemblage diverged, comprising mainly oil bees and few pollen collectors. Cubic splines and selection estimates suggest a significant negative directional and/or disruptive (most increasing variance among lower values) selection on attraction and mechanical-fit traits in three populations. However, the most isolated population diverged from this pattern, with significant gradients for disruptive selection increasing variance in higher values of the attraction trait and positive directional selection on the mechanical-fit trait. Moreover, this population showed a significant negative directional selection on oil amount and correlational selection between this trait and the mechanical-fit trait, favoring opposite combination of them. This divergent population is associated with one oil bee species and the others, with a more diversified pollinator assemblage.

POLLINATOR ASSEMBLAGE AND PATTERNS OF SELECTION IN WOODLAND AND GRASSLAND POPULATIONS OF THE ORCHID *PLATANTHERA BIFOLIA*

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In animal-pollinated plants, differences between populations in the morphology and behaviour of dominating pollinators may result in differences in pollen limitation and in the targets, strength and direction of pollinator-mediated selection. In the present study, we documented pollinator visitation with night-vision cameras, quantified pollen limitation, and documented phenotypic and pollinator-mediated selection in two woodland and two grassland populations of the hawkmoth-pollinated orchid *Platanthera bifolia* on the island Öland, SE Sweden. The woodland populations were mainly pollinated by the long-proboscis hawkmoth *Sphinx ligustri*, whereas the grasslands populations were predominantly visited by the short-proboscis noctuid moth *Cucullia umbratica* and more rarely by the smaller hawkmoth *Deilephila porcellus*. The woodland populations were more strongly pollen limited than were the grassland populations. Whether the observed differences in pollen limitation were associated with differences in selection on floral traits is currently analysed and will be reported at the meeting.

FLORAL PERFUMES BECOME DIFFERENT: REGION-SPECIFIC SELECTION IN A TERRESTRIAL ORCHID

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Geographically structured phenotypic selection can lead to adaptive trait divergence. In flowering plants, intraspecific divergence in floral signals important for pollinator attraction is common. However, divergent selection has rarely been shown, and selection on floral signals, in general, is little understood. In the present study, we measured phenotypic selection on display size, floral colour, and floral scent in four lowland and four mountain populations of the nectar-rewarding, terrestrial orchid *Gymnadenia odoratissima* in two consecutive years. We also quantified regional differences in these traits as well as in the composition of pollinator communities. Our results show positive selection on display size in both regions and years. Different floral scent compounds and floral colour were under positive selection, negative selection, or selection was absent. The main floral scent compounds were under consistently stronger selection in the lowlands than in the mountains, and lowland plants emitted higher amounts of most of these compounds. The composition of pollinator communities also differed between the lowlands and the mountains, suggesting that different pollinators impose divergent selection on the floral scent bouquet. Overall, our study is the first to document consistent regional differences in selection on floral scent. This pattern of selection might be one of the evolutionary forces contributing to regional divergence in floral chemical signalling.

RETHINKING FLOWER EVOLUTION IN IRISES: ARE POLLINATORS THE AGENTS OF SELECTION?

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Flower color and size are visual attractions for pollinators and are expected to be under pollinator-mediated selection. To date, there are a handful of studies that tested pollinator-mediated selection experimentally by manipulating pollen limitation. We tested for pollinator-mediated selection on color and size in three species of irises: *Iris atropurpurea*, with continuous shades of colors, growing in the coastal plain in Israel, *Iris pumila*, a color polymorphic species in Serbia, and *Iris lutescens*, a color dimorphic species in France. In *I. atropurpurea* we found positive directional pollinator-mediated selection on flower size, but no selection on color; using artificial iris flowers we detected pollinator preferences for larger flowers, and a hint for stabilizing selection due to reduced preference for the over-sized flowers. In *I. pumila*, no selection found for color, and despite natural selection on flower size was found, this selection was not mediated by pollinators. In *I. lutescens*, we found no pollinator-mediated selection for size and evidence for divergent selection on color, different in direction between the two color morphs. Despite evidence for strong pollen limitation, we found only limited support for pollinator-mediated selection in these three species of *Iris*. We propose that pollinator-mediated selection is only partially responsible to the evolution of floral traits, and other selection agents, or random processes, may shape flowers.

POLLINATION ECOLOGY OF SHEA (*VITELLARIA PARADOXA*) IN WEST AFRICA

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Vitellaria paradoxa (shea) is a socially and economically valuable tree which is indigenous to the dry savanna belt of West Africa. It and other indigenous tree species provide multiple economic, medicinal, cultural, nutritional and ecological benefits that contribute to rural livelihood and national economies. Shea butter is the most valued product, extracted from the dried seed kernels. However, recently, concerns have been raised regarding shea yields, their dependence on animal pollinators, and habitat degradation which is potentially contributing to pollinator loss. The aim of this project was to assess pollinator dependency in *V. paradoxa*, determine whether trees are currently pollinator limited and to determine which taxa are acting as pollinators. Fieldwork was conducted in four sites in northern Ghana and two sites in southern Burkina Faso. Pollinator exclusion and sweep netting were used to assess dependency and limitation, and to catch flower visitors. Honeybees and stingless bees were the most common flower visitors, and initial analysis suggests that fruit set is both pollinator dependent, and that in some sites, pollen-limited. Future work will examine how landscape context influences pollinator populations and pollination services, with the aim of developing a sustainable habitat management plan with local communities.

VARIATION IN SEX RATIOS AND SEX ALLOCATION IN TRIOECIOUS POPULATIONS OF THE HERB *MERCURIALIS ANNUA*

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The evolution and maintenance of male sterility in plant populations has been a field of interests for decades. Indeed, the transition from hermaphroditism to dioecy, one of the most important evolutionary transitions in plant sexual system, is predominantly attributable to mutations impairing sex expression. The spread of such mutations leads to the evolution of gynodioecious or, much more rarely, androdioecious populations (where male-sterile or female-sterile individuals, respectively, co-exist with hermaphrodites) two sexual systems that may constitute an intermediate step between hermaphroditism and dioecy. Many empirical and theoretical studies have attempted to understand the conditions under which male or female sterility mutations may spread in populations, but very little is known about the spread a second sterility mutation of the opposite gender, a key way in which dioecious might evolve. Here, we describe meta-populations of an otherwise androdioecious species, *Mercurialis annua*, in which the expression of male-sterility mutations may be found in up to 30% of the individuals, including occasionally in males themselves. We will present preliminary data on the spatial and temporal variation of male and male-sterile individuals in these populations. We aim to understand the conditions under which male-sterility mutations may spread in androdioecious populations, and to uncover the genetic basis of this variation in natural populations. Our research may have implications for an understanding of why males and females are so rarely found with hermaphrodites at the same time.

SEXUALLY ANTAGONISTIC EVOLUTION CAUSED BY MALE-MALE COMPETITION IN THE PISTIL

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Sexual selection and sexual conflict are important evolutionary forces that can lead to rapid adaptation of reproductive traits in animals. However, the significance of these forces in plant reproductive trait adaptation is uncertain. We performed experimental evolution, involving lines that were crossed with either one or two pollen donors (monogamous or polyandrous lines), in a plant (*Collinsia heterophylla*) where early fertilizations are associated with female fitness costs. Artificial polyandry for four generations resulted in enhanced pollen performance and increased female fitness costs compared to the monogamous and source (starting material) lines, showing that pollen competition leads to rapid sexual antagonistic evolution in a plant. In a separate pollen competition experiment we show that high siring success of early-arriving pollen is indeed associated with female fitness costs (reduced seed set), consistent with a sexual conflict. Additionally, in the polyandrous line we found evidence for a correlated response on timing of anther-stigma contact, a trait that determines timing of self-pollination. Our study provides evidence for the importance of sexual conflict in shaping evolution of plant reproductive strategies.

PERSISTENCE OF FEMALES IN POPULATIONS OF GYNODIOECIOUS *SILENE VULGARIS*: THE ROLE OF DIFFERENTIAL PREDATION BY *HADENA* NURSERY POLLINATORS

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In gynodioecious sexual systems, female individuals coexist with hermaphrodite individuals in a population. Femaleness is due to a male-sterile mutation, and a lot of theoretical and empirical attention has been given to the conditions allowing such mutation to invade hermaphroditic populations. Two main factors have been considered: inbreeding depression in hermaphrodites and fecundity compensation in females. Fecundity compensation involves a higher seed production by females, compared with hermaphrodites. Abundant empirical evidence confirms fecundity compensation. In recent years, ecological factors tempering this advantage of females have started to get attention. Among the most studied is frequency-dependent pollen-limitation of female reproductive success. Differential costs of reproduction are also being explored. Here, we focus on *Silene vulgaris* and its nursery pollination interaction with *Hadena*. These moths pollinate flowers but also lay eggs on them to feed their larvae. We hypotesize that when females are more frequent, they will be more heavily predated by *Hadena* and this will reduce their fecundity advantage with respect to hermaphrodites. Using nine populations, we explored sex ratio (% females) and differential loss of sexual structures (flowers and fruits) to predation by *Hadena* moth larvae. Sex ratio ranged 3.5-61.7% across populations. Sex ratio did not influence the overall percentage of individuals or sexual structures predated. Sex ratio did not influence the percentage of hermaphrodite individuals predated. However, the percentage of females predated significantly increased with sex ratio. In addition, the percentage of sexual structures predated significantly increased with sex ratio for both females and hermaphrodites, but predation was higher for females. All together, these results indicate that frequency-dependent selection could temper the female advantage when sex ratio is high. Current analyses of sexually dimorphic scent compositon are being performed to assess whether olfactory cues can guide *Hadena* moths preferentialy towards females.

DID LOW GENETIC LOAD FACILITATE THE EVOLUTION SELFING IN NORTH AMERICAN *ARABIDOPSIS LYRATA*?

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Many hermaphrodites are self-incompatible (SI). If SI breaks down, progeny produced by selfing suffer from inbreeding depression, due to expression of recessive deleterious mutations (genetic load). Only if this cost is outweighed by advantages (transmission advantage, reproductive assurance) can selfing evolve. In cases where this happened, two scenarios are thinkable: either ecological conditions favored selfers despite strong inbreeding depression after which purging removed genetic load, or genetic load was relatively low to begin with (lower than the theoretical threshold of 50% for preventing the evolution of selfing). We quantified genetic load in North American *Arabidopsis lyrata*, in which most populations are self-incompatible and outcrossing, but selfing has evolved in some populations. By comparing performance of selfed and crossed progeny for plants from six outcrossing and six selfing populations, we assessed inbreeding depression under benign and stressful (drought, induced defense) greenhouse conditions. In a second experiment, we imposed direct competition between siblings produced by crossing and selfing. Under benign conditions, inbreeding depression tended to be much lower than 50%, with some evidence for purging in selfing populations. Unexpectedly, none of the stress treatments magnified inbreeding depression. The low inbreeding depression estimates are in strong contrast with previously published inbreeding depression estimates of >50% for European *A. lyrata* populations (that are exclusively outcrossing). The difference in genetic load may explain why selfing could evolve in the North American subspecies, and not in the European subspecies.

On the loss of outcrossing mechanisms under mate limitation

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The majority of plants have evolved mechanisms that prevent inbreeding and promote outcrossing. These include self-incompatibility (SI) systems, which prevent self-fertilization in hermaphrodites, and dioecy, the full separation of male and female function onto different individuals, in which outcrossing is also obligate. But outcrossing mechanisms such as SI and dioecy can break down and have often done so, resulting in derived hermaphroditic populations that may be partially or fully self-fertilizing. Here, I will highlight recent theoretical work that shows how colonisation and range expansions can lead to the breakdown of SI and dioecy either as a result of selection under mate limitation, which has been thoroughly studied previously, but also through changes in the level of inbreeding depression. I will illustrate the models by drawing upon data from two plant species in which the breakdown of SI and dioecy, respectively, has resulted in populations in which substantial outcrossing is nevertheless maintained.

EFFECT OF FLOWERING PLANT DENSITY AND VARIATION OF FLOWER NUMBER ON POLLINATOR VISITATION TO A BEE SPECIALIST PLANT, *DRACOCEPHALUM MOLDAVICA*

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Plants are often distributed in patches of various sizes and have a variable number of flowers per inflorescence. This spatial patchiness affects insect foraging strategies and plant reproduction through its effects on pollination rate. In our study we aimed to determine how visitation rate of pollinators depends on the number of flowers and on patch size in a plant *Dracocephalum moldavica* (Lamiaceae). We measured the pollinator visitation rate per flower by observations of insects visiting single plants with different number of flowers and patches with different number of plants. Data on foraging behaviour within patches of different size were gathered for *Apis mellifera*, the most abundant flower visitor at our study site. We found that the number of flower visitors increases with the increasing number of flowers on individual plants and with increasing number of plants in a patch, but less then proportionally. Also, plants with few flowers were either missed by insects because of low detectability or ignored because they provided a low amount of resources. Detailed observations and video recordings of individual honeybees showed that the rate of flower exploitation did not differ between patches of different sizes; i.e. bees visited approximately the same number of flowers per minute irrespective of the size of the patch. Although individual bees visited more flowers in larger patches, they visited a smaller proportion of flowers in a patch before leaving as has been previously observed. We evaluate the implications of these patterns for both insect foraging and plant reproduction.

POLLINATOR ACTIVITY ON SOYBEAN (*GLYCINE MAX*) IN ARGENTINA

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The soybean (*Glycine max*) is one of the world's most commercially important legumes. The great variety of products that are derived from the plant gives the soybean its alias "the wonder bean". Even though the soybean is able to self-pollinate, several studies indicate that the presence of pollinators will increase crop yield. Though wild bees can be effective pollinators, supplementing with domesticated honey bees (*Apis mellifera*) has been shown to enhance crop size even further. From a conservational point of view, such increment of production can help decreasing deforestation for expanding soybean fields. Earlier this year I carried out some field work in Argentina, the third largest exporter of soybean in the world. To assess the potential effect of global warming on the pollination of soybean, I observed flower visits along a latitudinal gradient spanning almost 200 km. This, however, proved itself to be rather difficult. First, there were very few pollinators to be found both in the soybean fields and in the surrounding vegetation. Second, it was challenging to find a suitable observation method, given the high number of flowers compared to the extremely low number of flower visitors. Some of the experiences I made will be shared in this talk. Ideas and suggestions are warmly welcome.

PREDICTING THE CONSEQUENCES OF POLLINATOR LOSS: THINGS ARE GETTING HAIRY

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The response and effect trait framework, if supported empirically, would provide for powerful and general predictions about how biodiversity loss will lead to loss in ecosystem function. This framework proposes that species traits will explain how different species respond to disturbance (i.e. response traits) as well as their contribution to ecosystem function (i.e. effect traits). However, predictive response and effect traits remain elusive for most systems. Here, we present detailed data on crop pollination services provided by native, wild bees to explore the role of six commonly used species traits in determining how crop pollination is affected by increasing agricultural intensification. Bee species traits did not strongly predict species' response to any agricultural intensification process, and the few traits that were weakly predictive were not consistent across crops. Similarly, no trait predicted species' overall functional contribution in any of the three crop systems, although body size and pollinator hairiness was a good predictor of per capita efficiency in two systems. Given that pollinator systems are dominated by a few abundant species, we find that in order to predict pollinator loss, characterizing the responses of the dominant species is easier and more predictive than using a trait approach.

CONSEQUENCES OF PLANT LOSS ON THE POLLINATION OF PLANT-POLLINATOR NETWORKS

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Plant-pollinator communities are expected to be robust against species loss. Consequences of species loss have been assessed by simulation models, but it is still not so clear how mutualistic networks react when species are lost in a natural environment. We studied their robustness by experimentally removing flowers of several of most visited plant species. We tested how such plant loss affected pollination in terms of flower-visitation rate, nectar production and pollen deposition in the surviving community. Our experiment improves our understanding of direct and indirect effects of species loss in pollination and in mutualistic networks.

ODOUR RESPONSES TO HOST-PLANT ODORANTS IN SPECIALIZED ANDRENA BEES

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Specialized (oligolectic) bees rely on a small range of host plants for their pollen collection, in strong contrast to bees like honeybees which forage on a broad and generalized flower spectrum. As compared to generalists, the specialists might have evolved neural adaptations allowing them to effectively locate their specific host flowers. We performed bioassays with specialized *Andrena vaga* bees to identify the relative importance of visual versus olfactory cues to locate *Salix* (willows) host plants. To investigate how host odours are processed in their brains, we used calcium imaging experiments and recorded odour-evoked activity patterns in the antennal lobe for the specialist *A. vaga* and, for comparison, in the generalist honeybee *Apis mellifera*. We recorded responses to synthetic compounds in serial solutions as well as to volatile compounds of the odour bouquet of *Salix* flowers that were separated by a gas chromatograph. Our behavioural experiments showed that *A. vaga* bees orientate mainly on olfactory cues to locate host flowers. In our physiological experiments, *A. vaga* bees, but not the honeybee *A. mellifera*, had a particularly high sensitivity for 4-oxoisophorone and 1,4-dimethoxybenzene, two characteristic components of the host-flower odour. Our experiments suggest that *A. vaga* females show correlates between neural organization and host-plant finding behaviour.

VARIABLE POLLEN FERTILITY AND EFFECTS OF POLLEN LOAD SIZE ON SEED SET IN CULTIVARS AND FERAL POPULATIONS OF OILSEED RAPE

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Pollination success is important for crop yield, but may be cultivar dependent, such as in oilseed rape (*Brassica napus*). Less is known about which floral traits influence pollination success and also contribute to gene flow via pollen, the latter being of particular importance in oilseed rape where transgenic cultivars are grown. We therefore investigated the relationship between pollen load size and seed set in winter oilseed rape, and variability in pollen-fertility traits and sporophytic fitness among both cultivars and feral populations (plants in field margins of arable land) under controlled conditions. Both seed quantity and quality were saturated at relatively low pollen loads. This suggests that the tested cultivar may be less dependent on insects as a pollen vector for high yield than is generally expected for oilseed rape. Pollen fertility and flower production differed among cultivars, indicating that these traits could contribute to yield variability. Moreover, seed weight per silique, but not pollen traits, was lower in ferals compared to cultivars. Thus, lowered sporophytic fitness in ferals, in terms of seed weight, does not necessarily reduce their contribution to gene flow via pollen. This study points to the importance of learning about floral traits influencing pollination success as a possible target for increasing crop yield, but also for better predicting gene flow to feral populations.

PLANT-POLLINATOR INTERACTIONS ALONG AN ELEVATION GRADIENT IN NORTHERN NORWAY

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Climate change effects are expected to be larger at high latitudes. However, there has so far been done little research on plant-pollinator interactions in arctic regions. To investigate how future climate change might affect plant-pollinator interactions in the far north I therefore observed flower visitation and seed set along an elevation gradient at Reinøya (Troms County, Northern Norway). Reinøya (69°53′33″N) is an island about 20 kilometres north of Tromsø with steep, though relatively short elevation gradients (the tree-line at approximately 360 m a.s.l.). My research was done on the southern part of the island known as Finnkroken. From late-June to late-July I studied the plant communities and pollination activities in an altitudinal gradient from 0 to 300 m using a space-for-time (SFT) substitution approach. My main focus was observing flower visits on two insect-pollinated annuals; the common and small cow-wheat (*Melampyrum pratense* and *M. sylvaticum*, respectively). I also observed other flowering plants in the same area, among them the highly selfing perennial the lapland cornel (*Cornus suecica*). Concluding my field work, I measured the seed production on *M. pratense, M. sylvaticum* and *C. suecica* at the end of the season. In this talk I will share some of my experiences from the field work this summer, as well as the methods I've used and some preliminary results.

COMBINED EFFECTS OF POLLEN VIABILITY AND POLLINATION EFFICIENCY ON SEED SET IN RED CLOVER CULTIVARS

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Clover seed is used in the agricultural sector for animal fodder production and provision of green manure. Availability of organic clover seed is vital for the organic farming sector. However, poor and variable seed set is a persistent problem, particularly among tetraploid red clover cultivars. As clover rarely self-pollinates, pollen transfer by insect pollinators is necessary for good seed set. This in turn, depends on the density and pollination efficiency of pollinators. Long-tongued bumblebees may be most valuable for ensuring a high seed set in red clover, but recent studies have demonstrated dramatic shifts in density and composition of bumblebee communities towards more short-tongued species with higher propensity towards nectar robbing. This could lead to lower pollination rates, especially in tetraploids, which have larger flowers with deeper corolla tubes. In addition, studies suggest that pollen germination and fertilization potential is lower in tetraploid red clover. Pollinator communities will be affected by location and season, and thus there could be a strong interaction between ploidy, geographic locality, and flower phenology, with some cultivars being especially sensitive. In this study we have tried to determine the effects of these factors, including interactions between pollinator composition and clover cultivar, as well as variation in pollen viability among cultivars and its contribution to low seed set. For five red clover cultivars we investigated floral shape, nectar volume, pollen germination success, pollinator behaviour, and amount of pollen deposited on the stigma, as well as seed set, after visitation by different pollinator species.

SEASONAL PATTERNS OF BEE DIVERSITY AND ABUNDANCE IN BT AND NON-BT MAIZE IN RELATION TO SURROUNDING AGRICULTURAL LAND IN SOUTHERN SWEDEN

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We studied bee community, abundance and temporal trends in Bt and non-Bt maize crop in south of Sweden for a duration of three years as part of the AMIGA, "Assessing and Monitoring the Impacts of Genetically modified plants on Agro-ecosystems" research project. Our study was extended to include the possible effect of surrounding agricultural land and the effect of homogenization of the landscape by cultivating maize and other agricultural crops. Honeybees, bumblebees, and wild bees were analyzed separately. We found no effect of the GM maize on bee abundance and diversity, for any of the groups, which is in accordance with previous studies. However, there was a significant positive effect of the percentage of surrounding non-agricultural area at a 500-meter radius on bumblebee and wild bee abundance as well as on bumblebee species diversity certain months of the sampling. Our results illustrate the importance of biodiversity conservation and enhancement of ecosystem services, such as pollination, by diversifying landscapes and protecting natural habitats for bees that are foraging in the surroundings of planted maize.

EFFECT OF LANDSCAPE CHARACTERISTICS AND LOCAL FLORAL COMMUNITY ON THE ECOLOGICAL SPECIALIZATION IN POLLINATION

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The ecological specialization in pollination is largely a contextual attribute that varies in space and time. In managed landscapes, habitat fragmentation and changes in land use might affect the diversity and abundance of plants and pollinators of the natural fragments preserved within them, and therefore, the ecological specialization in pollination in these areas might also be affected. However, the influence of landscape characteristics and composition of the local community on plants' specialization in pollination has not been studied in depth. We use data pollinator visits in 24 fragments of natural forest within an agricultural landscape in southern Norway, to study the effect of landscape variables (fragment size, isolation, complexity of the landscape) and local floral community (diversity and abundance of flowers) on the specialization in pollination of several plant species that differ in floral traits.

GEOGRAPHICAL VARIATION OF FLORAL SCENT IN *ARABIS ALPINA*

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Floral signals are important in shaping plant-insect interactions. Self-compatible plants have a reduced need to attract pollinators, which typically results in a reduction of floral display and scent production (the selfing syndrome). In some species, like the cruciferous plant alpine rock-cress (*Arabis alpina*), some populations are self-incompatible outcrossers, whereas other populations are self-compatible and, at least in the northern European population, highly selfing. These populations have undergone changes in morphological traits such as flower size and herkogamy. As part of my doctoral studies, I explore these differences in floral signalling between multiple self-compatible and self-incompatible populations of *A. alpina*. In addition to measurements of flower morphology and self-compatibility, I study the floral scent composition to investigate whether this important aspect of floral signalling also shows signs of reduction following a shift from outcrossing to selfing. Simultaneous studies of several aspects of floral signalling also allows for investigations of covariation between different types of floral signals and facilitate further studies that test the potential for floral scent emission to have important functions other than pollinator attraction.

ARE THERE ANY LOCAL ADAPTATIONS OF A SUPERGENERALIST UMBELLIFER *ANGELICA SYLVESTRIS* TO ITS LOCAL POLLINATORS?

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In terms of the pollination system Angelica sylvestris L., a common European species of the Apiaceae family, is regarded as supergeneralist, since its dichogamous flowers are visited by over 200 insect taxa representing several taxonomic orders. However, recent studies revealed that some populations within the species range may be effectively pollinated by different pollinator guilds, which indicates that despite apparent generalization on the species level, A. sylvestris populations may be locally adapted to the most effective pollinators. The present paper describes the results of a transplantation experiment conducted to evaluate the performance of the plants from different populations in various pollination landscapes.

IS HIGHER AMOUNT OF NECTAR NOT SO TEMPTING? CASE OF PROTANDROUS FLOWERS OF SUPERGENERALIST UMBELLIFER *ANGELICA SYLVESTRIS*

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Nectar is the most common floral pollinator reward. In dichogamous species with temporally separated pollen presentation and stigma receptivity, floral nectar production rates can differ between sexual phases. One of the angiosperm groups where dichogamy is especially common is the carrot family (Apiaceae = Umbelliferae). We studied nectar production in three populations of the umbelliferous *Angelica sylvestris*, a common European plant species exhibiting strong protandry on the level of the individual flower, the inflorescence and the whole plant. Our study species produced nectar in both floral sexual phases and although nectar composition and sugar concentration varied little between male and female floral phases, nectar production showed a 3-fold reduction during the stigma receptive period (which agrees with the plant sexual selection theory, suggesting that in pollen-unlimited species, such as *A. sylvestris*,floral rewards mainly enhance male reproductive success. Surprisingly these differences in nectar production rate did not alter pollinators visitation to either floral sexual phase. Our paper discusses possible deception mechanisms underlying this phenomenon.

SPATIAL VARIATION IN THE MATING SYSTEM OF A RED-LISTED PLANT, *POLEMONIUM CAERULEUM* L. (POLEMONIACEAE)

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Changing environmental conditions affect the populations' dynamics. In response, the breeding system of some plant species may be modified. *Polemonium caeruleum* L. (Polemoniaceae) is a boreal, red-listed plant species producing predominantly dichogamous, bumblebee- and honeybee-pollinated flowers. In Poland it reaches its SW limit range. Literature data suggests that occasionally the plant may exhibit mixed-mating system. To test its mating strategy in Polish populations of the species, in 2016 we chose 15 *P. caeruleum* populations of varying sizes, and conducted a three-variant pollination experiment (control, autonomous self-pollination and induced [geitonogamous] self-pollination). Our study populations showed various degrees of compatibility: from clearly self-incompatible (SI) to fully self-compatible (SC) ones. In most SI populations, however, self-pollination occurred via geitonogamous pollen-transfer rather than autonomous selfing, since isolated flowers (those with restricted pollinator access) hardly produced any seeds. Our study show that our initial "small-SC vs. large-SI" hypothesis does not adequately explain the resulting variation and our paper discusses other possible solutions of the observed diversity.

OVULE PACKAGING VS. POLLINATORS: IS THERE A CAUSAL RELATIONSHIP?

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The number of ovules varies over several orders of magnitude among the flowering plants. In some plant families it seems to be very conservative, whereas in others it can be very variable across closely related species. Numerous hypotheses try to explain plants strategies in ovule packaging. A large meta-analysis by Burd et al. (2009; Am J Bot 96:1159), showed that there is a strong relationship between ovule number per flower and probability of pollen receipt (assessed by counting stigmatic pollen loads). Since in case of zoogamous plants stigmatic pollen load is a function of flower visitor identity, abundance and efficiency on flowers, we hypothesize that ovule packaging strategy should also be related to the pollination system, in a manner that specialist plants serviced by one or few efficient floral visitors can produce more seeds after a single visit (hence should have more ovules per flower) in contrast to generalists operating in a more stochastic pollinator environment that get fewer seeds per successful visit and therefore producing less ovules per flower. We tested our assumption on literature-derived data for 169 zoogamous plant species representing 59 taxonomic families of the global flora, and, indeed, found a significant negative relationship showing that generalist plants usually have fewer ovules per flower than specialists. When testing our hypothesis against family subsets of species, we found it to be true for Fabaceae, but not for Ranuculaceae or Orchidaceae. To eliminate a significant phylogenetic signal we repeated the analyses after elimination of Orchidaceae and Asteraceae, families with the largest samples (now dataset of 123 species in 57 families), and our results remained statistically sound. Our findings contribute to the timely discussion of specialization/generalization of pollination systems showing that there are some important structural implications of being generalist or specialist.

POLLEN LIMITATION IN BOREAL PINE FOREST IN NORTH-EASTERN POLAND

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According to recent opinions pollen limitation, i.e. a reduction in plant seed set due to inadequate quantity or quality of available pollen, may be an important driver of the evolution of plant reproductive strategies. However, little is known on the extent and variation of pollen limitation levels in many natural populations. Here we present the results of pollen limitation experiments conducted in several populations of two native (*Rubus idaeus* and *Hypericum perforatum*) and one invasive (*Impatiens parviflora*) zoogamous plant species occurring in semi-natural pine forests in Wigry National Park (NE Poland). Our paper discusses the observed variation with regard to population density of focal species and activity of their pollinators.

TOO LONG, TOO SHORT, OR JUST ABOUT RIGHT? – A NEW METHOD FOR STUDYING THE FUNCTIONAL AND ADAPTIVE SIGNIFICANCE OF FLORAL SPUR LENGTH

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In flowers with a spur, the depth of the spur is a critical feature determining the fit between pollinator body parts and floral reproductive organs, and thereby the efficiency of pollen transfer. Several studies have shown a positive correlation between pollinator-tongue length and length of the spur, strong pollinator-mediated selection on spur length, and evidence that differences in spur length contribute to local adaptation. However, to distinguish the effects of spur length on reproductive success from those of other floral traits, an experimental approach is required. We propose that artificial spurs made of elastic transparent surgery tubing can be used to examine the functional and adaptive significance of spur length.

BUTTERFLY SEED PREDATION: EFFECTS ON PLANT REPRODUCTIVE OUTPUT AND CONTEXT-DEPENDENCE

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The intensity of antagonistic interactions and their effects on plant reproductive output might depend on the context of the interaction. Abiotic conditions and the abundance of other members of the community might affect interaction intensities and trait preferences of the interactors. Using the interaction between the butterfly seed predator *Phengaris alcon* and its host plant *Gentiana pneumonanthe* as a model system, we investigated the direct and indirect (predator-mediated) effects of plant traits and context on plant reproductive output in three populations. We found higher predation intensities in plants that flowered earlier, in plants that had more flowers and in plants that had higher shoots. Predation intensity was also related to abiotic conditions and community context; predation intensities were higher at low soil temperatures, at low height of surrounding vegetation, and at high abundances of *Myrmica* ants, the second host of the butterfly. Butterfly seed predation strongly reduced fruit production and reproductive output. Despite increased predation, flowering early, producing high shoots and many flowers was still advantageous in *G. pneumonanthe,* due to direct positive effects of these traits on fruit and seed production. Soil temperature increased fruit production both directly and indirectly (by reducing predation intensity), while community context affected reproductive output only indirectly; higher abundances of host ants close to plants were associated with higher predation intensities and a decreased reproductive output. Our results highlight the importance of taking into account the context when studying the outcomes of antagonistic interactions and their consequences for plant reproductive output.

DRAMATIC EFFECT OF A NEONICOTINOID ON THE SOLITARY BEE *OSMIA BICORNIS*

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Wild bees are very important as pollinators of wild plants and agricultural crops. Bee declines have been observed all over the world, and one of the suggested reasons for the declines is the insecticide group neonicotinoids. Neonicotinoids have in laboratory studies shown sub-lethal effects on honey bees and a in a few examples on wild bees. In this study I have examined the impact of the neonicotinoid "clothianidin" on the cavity-nesting solitary bee *Osmia bicornis*. Three trap nests were placed next to each of 16 oilseed rape (*Brassica napus*) fields. Eight of the fields were sown with clothianidin treated seeds and 8 of the fields were used as controls and sown with untreated seeds. Each trap nest contained cocoons of 9 individuals of *O. bicornis*, 4 males and 5 females. The results showed a dramatic effect of clothianidin on the nesting of *O. bicornis*, as none showed to be nesting at the treated sites. From the results it cannot be told whether the nesting was affected negatively due to lethal or sub-lethal effects, or if it was caused by avoidance of treated fields. More research is needed to further investigate the impact of neonicotinoids on wild beneficial insects, but also on other non-pest insects operating in and around mass-flowering crop fields. Methods need to be developed to control pests without the use of neonicotinoids.

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