SCAPE 2012

Foto: Marte Marie Brynildsen

25th-28th October

Welcome to SCAPE 2012

SCAPE 2012 is organized by the Department of Ecology and Natural Resource Management, Norwegian University of Life Sciences, Centre for Ecological and Evolutionary Synthesis (CEES), Department of Biology, University of Oslo and Sogn og Fjordane University College.

Organising committee

Ørjan Totland (Norwegian University of Life Sciences)

Anders Nielsen (University of Oslo)

Stein Joar Hegland (Sogn og Fjordane University College)

Ronny Steen (Norwegian University of Life Sciences)

Markus Sydenham (Norwegian University of Life Sciences)

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Acknowledgement: The organising committee is very grateful for the financial support from Artsdatabanken (The Norwegian Biodiversity Information Centre). We are also thankful for that Ytre Hvaler National Park is providing use with guides for the field trips.

Our sponsor:

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General conference information

General Enquiries: The conference registration will be open on Thursday 25th October from 15.00, and from 08.00 to 18.00 on Friday and Saturday.

Name Badges: Delegates are requested to wear their name badges at all times during the day. Access to the scientific presentation rooms is limited to registered delegates only. Similarly, the breakfasts, buffet lunches and dinners are only available for registered delegates.

Oral Presenters: Please ensure your talk is pre-loaded onto the conference laptop on the evening prior to your session. For those of you giving talks on Thursday, please pre-load your talk at 18.00. For help, please find our session moderators.

Poster Presenters: Please be available to set-up your poster at 18.00 on Thursday 25th October. Presenters are expected to remain with their poster for the duration of the poster reception on Friday at 20.00, as interested delegates may wish to discuss your research with you. We are able to keep posters on display until 14.00 on Sunday 28th October. Please be available to remove your poster at this time.

Dress Code: There isn't a dress code for any of the conference events.

Fieldtrips: If you have booked onto a conference fieldtrip, please make sure that you are precise, for fieldtrips/activities that require a mini bus drive please ensure you are ready to board the mini bus 5 minutes before departure time. Please also ensure that you have warm and waterproof clothing and suitable footwear. The mini bus will depart from the front of the conference building.

Venue: Skjærhalden Sjøbuer (http://www.sjobuer.com/). It is located on the island Kirkøy and is a part of Ytre Hvaler National Park (www.dirnat.no/attachment.ap?id=2150).

Conference Bar: There is one bar in the Conference building. Here there will be sold beverage (both alcohol and non-alcohol).

Internet: There is wireless internet at the venue.

Accommodation: The apartments will room 4- 8 people, with a shared bathroom, small kitchen and living room. Towels and bedding are provided.

Cash machine (ATM): Available close to the venue (walking distance).

Other: Food stores, liquor store and post office are close to the venue (walking distance).

Schedule overview

Time	Thursday (3 talks)
15.00 →	Arrivals
18.00	Poster setup
19.00 – 20.00	Dinner
20.00 -21.20	Scientific programme (session 1)
	Friday (18 talks)
07.30 – 09.00	Breakfast
09.00 – 10.20	Scientific programme (session 2)
10.20 – 10.50	Coffee break
10.50 – 12.10	Scientific programme (session 3)
12.10 – 13.00	Lunch
13.00 – 14.00	Scientific programme (session 4)
14.00 – 14.30	Coffee break
14.30 – 16.10	Scientific programme (session 5)
16.10 – 17.10	Free
18.00 – 19.30	Dinner
20.00 →	Scientific programme (poster presentation)
	Saturday (8 talks)
07.30 – 09.00	Breakfast
09.00 – 09.45	Keynote speaker from NINA
09.45 – 10.15	Coffee break
10.15 – 11.35	Scientific programme (session 6)
11.35 – 12.45	Lunch
12.45 – 13.45	Scientific programme (session 7)
13.45 – 14.00	Coffee break
14.15 – 18.00	Field walk
18.00 →	Dinner and beyond (party)
	Sunday
08.00-09.30	Breakfast
09.30-11.00	Scientific programme (poster presentation)
11.00-11.30	Free
11.30 – 12.30	Lunch
12.30 →	Optional sauna/pool

Registered delegates (sorted by surname)

Name	Position	Affilation
Anne Lene Aase	PhD student	Norwegian University of Life Sciences, Norway
Ignasi Bartomeus	Post doc	Swedish University of Agricultural Sciences, Sweden
Karin Blak	Guest	NA
Vinícius L. G. Brito	PhD student	Universidade Estadual de Campinas, Brazil
Rosalie Burdon	PhD Student	Uppsala University, Sweden
Amots Dafni	Professor	Haifa University, Israel
Achik Dorchin	PhD student	Haifa University, Israel
Johan Ehrlén	Professor	Stockholm University, Sweden
Katrine Eldegard	Researcher	Norwegian University of Life Sciences, Norway
Hecq Florence	PhD student	Trinity College, Dublin
Tucker Gilman	Lecturer	University of Manchester, United Kingdom
Jan Goldstein	PhD student	Warsaw University, Poland
Sofia Gripenberg	Post doc	University of Turku, Finland
Stein Joar Hegland	Researcher	Norwegian Red deer Centre, Norway
Mathias Hoffmeister	PhD student	Heinrich-Heine-Universität Düsseldorf, Germany
Rannveig M. Jacobsen	Master student	Norwegian University of Life Sciences, Norway
Anna Jakobsson	PhD student	Uppsala University, Sweden
Robert R. Junker	Scientific Assistant	Heinrich-Heine-Universität Düsseldorf, Germany
Aphrodite Kantsa	PhD student	University of the Aegean, Greece
Mariken Kjøhl	Adviser	Norwegian University of Life Sciences, Norway
Jonas Kuppler	PhD student	Heinrich-Heine University, Germany
Anne-Marie Labouche	Post doc	University of Lausanne, Switzerland
Carlos Lara-Romero	PhD student	Rey Juan Carlos University, Spania
Anne-Amélie Larue	PhD student	Heinrich-Heine-Universität Düsseldorf, Germany
Tommy Lennartsson	Researcher	Swedish University of Agricultural Sciences, Sweden
Klaus Lunau	Professor	Heinrich-Heine-Universität Düsseldorf, Germany
Rebekka Lundgren	PhD student	Norwegian University of Life Sciences, Norway
Carolin Mayer	Post doc	Earth and Life Institute, Belgium
Marcos Méndez	Assistant professor	Universidad Rey Juan Carlos, Spain
William Morris	Professor	Uppsala University, Sweden
Anne Muola	Post doc	University of Turku, Finland
Quinet Muriel	Post doc	Université catholique de Louvain
Eike Müller	Researcher	The University Centre in Svalbard
Anders Nielsen	Post doc	University of Oslo, Norway
Jeff Ollerton	Professor	University of Northampton, United Kingdom
Aoife O'Rourke	PhD student	Trinity College Dublin, Ireland
Sarah Papiorek	Diplom-Biologe	Heinrich-Heine-Universität Düsseldorf, Germany
Eileen Power	Post doc	Newcastle University, United Kingdom
Adrian Rasmussen	Master student	Norwegian University of Life Sciences, Norway
Andre Rodrigo Rech	PhD student	Campinas University - Brazil
Katarzyna Roguz	Master student	Department University of Warsaw Botanic Garden, Poland
Sergey Rosbakh	PhD student	University of Regensburg, Germany
J.F. (Niek) Scheepens	Post doc	University of Turku, Finland

Nina Sletvold	Assistant Professor	Uppsala University, Sweden
Ingo Stang	Post doc	Address University of Leiden, Netherland
Martina Stang	Post doc	Address University of Leiden, The Netherlands
Dara Stanley	PhD student	Trinity College, Dublin
Ronny Steen	Divisional engineer	Norwegian University of Life Sciences, Norway
Marc Stift	Post doc	University of Konstanz, Germany
Jane Stout	Senior Lecturer	Trinity College, Dublin
Markus Sydenham	PhD student	Norwegian University of Life Sciences, Norway
Erin Jo Tiedeken	PhD student	Trinity College, Dublin
Ørjan Totland	Head of department	Norwegian University of Life Sciences, Norway
Stella Watts	Post doc	University of Haifa, Israel
Renate A. Wesselingh	Assistant professor	Louvain University
Marie Voillemot	PhD student	University of Lausanne, Switzerland
Marcin Zych	Associate professor	University of Warsaw, Poland
Jon Ågren	Professor	Uppsala University, Sweden

Scientific programme

Presentation schedule

Please note that for the sake of convenience we listed the speaker's name first, disregarding roles in authorship.

	Thursday 25th October (3 talks)
15.00 →	Arrival.
19.00-20.00	Dinner.
	Session 1 (Moderator: Anders Nielsen)
20.00-20.20	**Amots Dafni** et al: A pollinator's view of a shelter mimicry system.
20.20-20.40	**Klaus Lunau** & Michaela Krohn: Mono- and polysymmetrical flowers in the same inflorescence: Saxifrages – a study case in flower symmetry.
20.40-21.00	**Andre Rodrigo Rech**: Spatial variation in the pollination system of *Curratella americana* in Brazilian savannahs.
21.00-21.20	**Stein Joar Hegland**: Can the intermediate disturbance hypothesis act as a guide to understand ungulate herbivory impact on forest understory plant richness?
	Friday 26th October (18 talks)
07.30-09.00	Breakfast.
	Session 2 (Moderator: Markus Sydenham)
09.00-09.20	**Achik Dorchin** et al: The effect of fragmentation characteristics on community structure and diversity of native bees in a threatened habitat.
09.20-09.40	**Nina Sletvold** et al: Vegetation height influences the strength of pollinator-mediated selection on floral traits in a deceptive orchid.
09.40-10.00	**Aoife T. O`Rourke** et al: The importance of *Salix repens L.* as a forage resource for spring bees in priority grey dune ecosystems.
10.00-10.20	**Stella Watts**, et al: The endangered *Iris atropurpurea* (Iridaceae) in Israel: honey bees, night-sheltering male bees and female solitary bees as pollinators.
10.20-10.50	Coffee break.
	Session 3 (Moderator: Stein Joar Hegland)
10.50-11.10	**Anne-Marie Labouche** & John R. Pannell: The incidence and selection of multiple mating in plants.
11.10-11-30	**J. F. Scheepens** et al: Pollen dispersal and gene flow within and into a population of the alpine monocarpic plant *Campanula thyrsoides*.
11.30-11.50	**Mark Stift** et al: S-linked genetic load and (potential) evidence for purging in North American *Arabidopsis lyrata*.
11.50-12.10	**Sergey Rosbakh** & Peter Poschlod: Temperature requirements of pollen germination control species' altitudinal distribution.
12.10 – 13.00	Lunch.
	Session 4 (Moderator: Markus Sydenham)
13.00-13.20	**Anna Jakobsson** et al: The invasive herb *Lupinus polyphyllus* increases pollinator visitation to a native herb through effects on pollinator abundance.
13.20-13.40	**Stein J. Hegland**: Scale-dependent interactions for pollination in red clover?
13.40-14-00	**Vinìcius L. G. Brito** et al: Trees as huge flowers and flowers as huge floral guides: the role of floral colour change in *Tibouchina pulchra*.
14.00 – 14.30	Coffee break.
	Session 5 (Moderator: Anders Nielsen)
14.30-14.50	**Carolyn Mayer** et al: Are nectar robbers really that bad?
14.50-15.10	**Erin Jo Tiedeken** et al: Determining the threshold of detection of the buff-tailed bumblebee, *Bombus terrestris* (Apidae), for potentially toxic compounds in floral nectar.

15.10-15.30	**Mathias Hoffmeister** et al: Corrupted communication – How herbivores affect plant-insect interactions.
15.30-15.50	**Robert R. Junker**: Invisible flower visitors – diversity, distribution and potential functions of epiphytic bacteria colonising flowers.
15.50 – 16.10	**Sara Papiorek** et al: Underlying mechanisms of sensory exclusion of bees by flowers adapted to the pollination by birds: The role of colour, epidermal cell shape and gloss.
16.10 – 17.10	Free.
18.00 – 19.30	Dinner.
20.00 →	Poster session.
	Saturday 27th October(7 talks + 1 keynote speaker)
07.30 – 09.00	Breakfast.
09.00 – 09.45	**Jan Ove Gjershaug**, keynote speaker (the Norwegian institute for nature research, NINA).
09.45 – 10.15	Coffee break.
	Session 6 (Moderator: Anders Nielsen)
10.15-10.35	**Carlos Lara-Romero** et al: Differences in the diversity and composition of the pollinator assemblage of congeneric alpine plants in three mountain regions of the Iberian Peninsula (Spain).
10.35-10.55	**Jan Goldstein** & Marcin Zych: What if we lose a hub? Experimental study of a pollination network.
10.55-11.15	**Anne Lene T. O. Aase**: Could cow parsley (*Anthriscus sylvestris L. Hoffm*.) be an indicator of poor bumblebee (*Bombus*: Apidae) habitat in an agricultural landscape in Southeastern Norway?
11.15-11.35	**Sofia Gripenberg** et al: Insects and plant pathogens as agents of density-dependent seedling mortality in tropical forests.
11.35 – 12.45	Lunch
	Session 7 (Moderator: Stein Joar Hegland)
12.45-13.05	**Dara A. Stanley** & Jane C. Stout: Pollinators and pollination in changing agricultural landscapes: investigating the impacts of bioenergy crops.
13.05-13.25	**Ignasi Bartomeus** & Riccardo Bommarco: When is pollination the limiting ecosystem service for crops?
13.25-13.45	**Quinet Muriel** et al: Balance between pollination and parthenocarpy in the pear (*Pyrus communis*) variety conference.
13.45 – 14.00	Coffee break
14.15 – 18.00	Field walk
18.00 →	Dinner and beyond
	Sunday (3 talks)
08.00-09.30	Breakfast
09.30-11.00	Poster session
11.00-11.30	Free
11.30 – 12.30	Lunch
12.30 →	Optional sauna/pool
12.30 →	Departure

Scientific programme
Poster presentations

Willem Coetzer: Towards semantic integration in biodiversity- and ecosystem informatics.

Willem Coetzer: Integration of African solitary bee biodiversity information and –literature.

Hecq Florence: Effects of scale and landscape structure on pollinator diversity and the provision of ecosystem services in agricultural landscapes.

Anna Jakobsson: What does determine visitation rates and plant fecundity at the community level? Species´display traits vs. community context.

Aphrodite Kantsa: From dusk till dawn: The effect of pollen deposition and nectar availability on floral volatile emissions of the night blooming *Capparis spinosa L*.

Anne-Amélie C. Larue: Augmentation of floral scent bouquets – the effect of volatiles on the partitioning of flower-visitors.

Jonas Kuppler: Inferring from variation and covariation of leaf, flower, and fruit traits to the evolution plant-arthropod interactions.

Anne Muola: Effects of population size, age, isolation and plant-herbivore interactions on mating system of the perennial herb, *Vincetoxicum hirundinaria*.

Katarzyna Roguz: Reproductive biology of the red listed species Polemonium caeruleum L. (Polemoniaceae).

Ronny Steen: Video surveillance system for remote long-term *in situ* observations of Orchids: registration of pollinators and their behaviour.

Ronny Steen: The use of a low cost high speed camera to record fine-scale behavior in flower-visiting animals: hummingbird flight during nectar-feeding as an example.

Markus Sydenham: Phenologically restricted responses of solitary bees to habitat and landscape context.

Marie Voillemot: Loss of self-incompatibility in the toadflax *Linaria cavanillesii*: causes and consequences.

Marcin Zych: Geographic pattern of specialization/generalization in the pollination system of a protandrous umbellifer.

Abstracts

The incidence and selection of multiple mating in plants

Anne-Marie Labouche and John R. Pannell
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Polyandry, where females mate with more than one male, is probably ubiquitous in plants, both when different fathers sire the seeds of different fruits of the same mother, and when more than one father exports pollen to the same stigma. This mating behaviour may confer fitness advantages on the female fitness of plants by alleviating pollen limitation, by affecting the genetic diversity of offspring (multiple paternity) and, when it occurs at the fruit scale, by allowing potential mate selection through pollen competition and eventual female choice. In this presentation, I will present results of a literature review to assess the frequency of polyandry among plants, in which we asked whether traits exist that are particularly associated with multiple mating. We find little evidence for such traits. Indeed, many floral traits, such as attractiveness and pollen-dispensing mechanisms that lead to polyandrous pollination, have probably evolved in response to selection to promote male siring success in general. In other words, polyandry is likely to be a by-product of selection to enhance outcross siring success, rather than a mechanism for enhancing pollen competition. Whether females ever benefit from polyandry through enhanced female choice among pollen grains is still an open question.

Can the intermediate disturbance hypothesis act as a guide to understand ungulate herbivory impact on forest understory plant richness?

Stein J. Hegland
Norwegian Red deer Centre and University College of Sogn and Fjordane

Herbivory is one of the most important biotic disturbance types globally. In northern forest ecosystems the population densities of wild-ranging ungulates have reached historical heights and they are potentially a major determinant of plant diversity. Ungulate density and hence disturbance intensity are partly controlled by management.

We monitored the ungulate herbivory intensities and performed a detailed sampling of the forest understorey vegetation at 12 Pinus-Vaccinium forest sites on the island Svanøy across a ten-year period. Our aim was to test whether the intermediate disturbance hypothesis (IDH) can act as a guide for ecosystem management of red deer, for example to optimize plant species richness.

Diversity-herbivory disturbance relationship for the total plant species richness did not follow the peaked curve predicted by the IDH. Instead species richness showed a steady increase up to herbivory intensities far above levels found in natural systems.

In line with general expectations the richness of low-growing functional groups as bryophytes, grasses and herbs increased with herbivory intensity and the relationship was linear. The richness of the tallest growing species of the forest understorey, dwarf-shrubs and young trees, decreased linearly. The juvenile tree richness showed a u-shaped relationship with herbivory intensity indicating that tree species recruitment rates may be highest at both low and high ungulate grazing.

Abundance-herbivory disturbance relationships in total and for herbs and grasses, showed peaked curves indicating that biomass production may increase to an intermediate herbivory level before it decreases when disturbance intensity becomes too pronounced. Abundance of bryophytes increased linearly with increasing disturbance levels, whereas abundance of dwarf shrubs decreased linearly.

Our study show that the highest richness of forest understorey plants was found at moderate to very high densities of red deer, whereas plant abundance generally peak at intermediate disturbance levels. Management for relatively high deer densities may thus benefit plant richness of the forest floor. Targeting richness of low-growing species may require the highest densities of deer, whereas aiming at conserving richness of shrubs and trees require lower densities of deer.

Scale-dependent interactions for pollination in red clover?

Stein J. Hegland
Norwegian Red deer Centre and University College of Sogn and Fjordane

Interactions for pollination have interested researchers in plant-animal interactions ever since Darwin. There have been many studies both showing that pollinator attraction and subsequent reproductions in plants may be affected by facilitation and competition from the intra- and interspecific flowering neighbourhood. The traditional view has been that facilitation (in the form of commensalism: 0/+ interaction) mainly occur between rewarding and non-rewarding species, whereas competition (0/- or -/- interactions) occurs between rewarding and less attractive species, or alternatively alien and native species. This view has been modified the last years since facilitation appear to be at least as important as competition in structuring communities.

However, few have investigated whether interactions for pollinator attractions and subsequent reproduction may be scale-dependent, for example that flowering neighbourhood of a focal plant species may have facilitative effect at small spatial scale and competitive effect at larger scale. The logic behind this is that having many flowers close to you should attract more pollinators to that spot and to your flowers which subsequently affects reproduction positively. Opposite, having many flowers say 10-20 m away, should potentially draw pollinators away from your flowers.

I tested whether such scale-dependent interactions occurred in semi-natural grasslands in a landscape in Kaupanger, West-Norway. I collected data on pollinator activity on red clover, *Trifolium pratense*, in 12 circular plots of 5 m diameter repeatedly during the flowering season, and collected reproductive data at the end of season. I related this data to flowering densities obtained at 2.5, 10 and 25 radii scale from centre of the 12 circular plots. I specifically tested whether the relationships between pollinator visitation and both intra- and interspecific flower densities changed dependent on the scale investigated, and repeated such analyses with reproductive data.

Trees as huge flowers and flowers as huge floral guides: the role of floral color change in *Tibouchina pulchra*.

Vinícius L. G. Brito[1], Kevin Weynans[2], Klaus Lunau[2] & Marlies Sazima[1]

1- Department of Plant Biology, Institute of Biology, Unicamp, Campinas, São Paulo, Brazil
2- Institut für Sinnesökologie, Heinrich-Heine Universität Düsseldorf, Düsseldorf, Germany

Maintenance of old flowers and colour changes of floral guides are frequently combined phenomena. Maintenance of old flowers is thought to increase the attractiveness of inflorescences over long distances and floral guide color changes are thought to direct the pollinators towards the rewarding flowers on short distances. However, in *Tibouchina pulchra*, a massive flowering tree of Atlantic Rainforest, the whole flower changes during its anthesis. On the first day, the flowers are white-UV absorbing and on the next three days they change their color to pink. This creates a new pattern in which the white pre-change flowers contrast against the pink post-change ones over the whole tree. This color change does not affect the colour purity but is correlated with decreasing green contrast. In experiments with bumblebees, we simulated long and short distances approaches towards this colour pattern by manipulating visual angles in a Y-maze. We tested their preference for simulated trees with green leaves and pink flowers (ancestral condition) and trees with pink background and white flowers (recent condition). We also tested the ancestral condition (four pink flowers with white guides) against the recent condition (three pink flowers and one white flower) in a short distance approach. Bumblebees preferred the simulated recent condition in both approaches indicating that in *T. pulchra* the color change and maintenance of old flowers enhance the attractiveness in long and short distances. We discuss the evolution of *T. pulchra* color change with respect to the attractiveness of flowering trees and rewarding flowers for pollinators.

Vegetation height influences the strength of pollinator-mediated selection on **floral traits in a deceptive orchid**

N. Sletvold, J. M. Grindeland, J. Ågren

Floral display should be more important for pollination success in tall than in short vegetation. We manipulated vegetation height (tall vs. short) and pollination regime (open-pollinated control vs. supplemental hand-pollination) of the deceptive orchid *Dactylorhiza lapponica* in a factorial design, to test whether pollinator-mediated selection on floral traits is stronger in tall than in short vegetation, and whether effects of vegetation are stronger for visual traits affecting pollinator attraction than for traits affecting pollinator effectiveness. In tall (intact) vegetation, there was strong selection for taller plants (β = 0.37), more flowers (β = 0.75), and longer spurs (β = 0.37), and a considerable proportion of this selection was mediated by pollinators (89%, 45%, and 100%, respectively). In short vegetation, there was no significant selection on plant height. In addition, compared to tall vegetation, pollinator-mediated selection on number of flowers was 52% weaker, and pollinator-mediated selection on spur length 25% weaker. The results experimentally demonstrate that vegetation context can markedly influence the strength of pollinator-mediated selection on visual display traits, and also support that effects are weaker for traits affecting pollinator effectiveness.

From dusk till dawn: The effect of pollen deposition and nectar availability on floral volatile emissions of the night blooming *Capparis spinosa* L.

Aphrodite Kantsa[1], Robert Raguso[2], Thomas Tscheulin[1], Olga-Ioanna Kalantzi[3] and Theodora Petanidou[1]

[1]Department of Geography, University of the Aegean, Greece

[2]Department of Neurobiology and Behavior, Cornell University, USA

[3]Department of Environment, University of the Aegean, Greece

Post-pollination changes in floral odor emissions may have a dual adaptive value for plants by reducing both energy costs related to their biosynthesis and release, and the chance of herbivore attraction by superfluous floral advertisement. In addition, such changes may affect pollinators by guiding them to flowers that still have rewards to offer or have not been pollinated.

In this study, we explore the changes in floral volatile emissions of *Capparis spinosa*, following pollen deposition on the stigmas after pollination treatments, and following nectar extraction. We hypothesize that flowers that have been outcrossed or those that have been depleted of their nectar show measurable changes in the emission patterns compared with unvisited flowers.

Capparis spinosa is a night blooming andromonoecious shrub, which offers both pollen and nectar as floral rewards to pollinators. Flower lifespan is ca. 14h, from dusk to dawn. Field experiments were carried out in two wild populations on Lesvos Island (NE Aegean, Greece). We investigated temporal variation of floral volatile emissions with repeated samplings during the anthesis of (i) pollinator-excluded and (ii) hand-crossed flowers. Moreover, nectar availability as a source of variation for floral emissions was tested by measuring the scent of pollinator-excluded flowers after manual nectar depletion.

Our preliminary findings indicate that *Capparis spinosa* has a complex odor bouquet that is emitted by mainly by pollen. Emissions in unvisited flowers peak after midnight, while different chemical groups show variations in their emission patterns. Further implications are discussed.

Differences in the diversity and composition of the pollinator assemblage of congeneric alpine plants in three mountain regions of the Iberian Peninsula (Spain).

Carlos Lara-Romero, Marcos Méndez, Jose María Iriondo, Silvia Santamaría, Javier Morente.

Biodiversity and Conservation Area. Universidad Rey Juan Carlos (Madrid, SPAIN)

Pollination syndromes are floral traits hypothesized to reflect convergent adaptations of flowers to pollen vectors. They are of great utility for organizing the phenotypic diversity of flowers and to provide an explanation for the mechanisms of floral diversification. This concept implies that specialization onto functional groups that exert similar selection pressures is a common occurrence

in plant evolution. However, this conceptual structure has been questioned on the grounds that usually pollination syndromes do not successfully predict the pollinator assemblages of most plant species, but also because interacting species are less specialized than previously thought. We investigated the applicability of the syndrome concept to flowering plants in a suite of pairs or trios of conspecific or congeneric plant populations of similar phenotype located at different latitudes in the Cantabrian, Central and Baetic ranges of Spain by assessing the differences in diversity and composition of the pollinator assemblages. We found different degrees of generalization on studied plant species along the latitudinal gradient. The assemblages were consistently different between the studied conspecific or congeneric population pairs or trios. Differences in pollination assemblages were not related to floral traits or to the location of the plant populations along the latitudinal gradient. Our results do not support the existence of consistent floral syndromes across broad-scales. To further progress in the understanding of the distribution of plant-pollinator interactions it would be interesting to test if the spatial differences in pollinator assemblage may cause a mosaic of pollinator-mediated selective regimes which, in turn, generate differences in evolutionary dynamics across populations (The Geographic Mosaic Theory of Convolution, GMTC).

When is pollination the limiting ecosystem service for crops?

Ignasi Bartomeus & Riccardo Bommarco

Up to 75 % of crop species are beneficiated by animal pollination to some degree. Pollinators are affected by the surrounding landscape and hence, pollinator friendly landscapes are likely to deliver more pollination services. However, the link between land use change and pollination community diversity is not well understood, as different species may have different responses. Moreover, despite richer pollinator communities are assumed to increase crop yield, this relationship is likely to be non linear and depend on the crop studied. We present a pan european study using four different important crops to relate land use change to pollinator community composition, and its effects on crop yield. We show that the degree of pollination dependance change among crops and discuss its implications for management.

The invasive herb *Lupinus polyphyllus* increases pollinator visitation to a native herb through effects on pollinator abundance

Anna Jakobsson[1], Benigno Padrón Méndez[2], Jon Ågren[1]

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Invasive flowering plants may disrupt interactions between native plants and pollinators. So far, studies exploring how invasive flowering plants affect the pollination of natives have focused on pollinator behaviour. However, if an invasive plant provides resources utilized by native pollinators this could positively affect pollinator population sizes and thereby indirectly the pollination success of native plants. We examined the effects of the invasive *Lupinus polyphyllus* on wild bee abundance and pollination success of the native herb. We quantified abundance of wild-bees in *Lotus*

corniculatus, before and after flowering of the invasive at un-invaded and invaded sites. Before the flowering of *Lupinus* there was no difference in wild-bee abundance or visitation to *Lotus* between invaded and un-invaded sites, whereas after the flowering period the number of wild-bees was 3.1 times higher and visitation to Lotus 5.9 times higher at invaded compared to un-invaded sites. Seed production per *Lotus* flower was higher before the flowering of *Lupinus* at both invaded and un-invaded sites, and was apparently not affected by the presence of the invasive species. The results suggest that the invasive *Lupinus* can boost resource availability for wild-bees and thereby contribute to higher pollinator abundance and increased visitation to native bee-pollinated plants.

How do pollinator visitation and seed set relate to species' floral traits and community context?

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Differences among plant species in visitation and fecundity within a community may be explained both by the species' floral traits and the community context. Additionally, the importance of species' floral traits vs. community context on visitation and fecundity may vary among communities. In communities where the pollinator-to-flower ratio is low, floral traits may be more important than community context, as pollinators may be choosier when visiting plant species. Here we investigated the relative importance of species' floral traits (flower shape, size and number, and flowering duration) and community context (conspecific density, total abundance of flower units and pollinator abundance) in explaining among-species variation in visitation rates and seed set within two communities of southern Norway which differ in pollinator-to-flower ratio. Differences among species in visitation and seed set within a community could be explained by similar variables as those explaining visitation and fecundity within species. As expected, floral traits were more important than community context in the community with the lowest pollinator-to-flower ratio; whereas in the community with the highest pollinator-to flower ratio, community context played a bigger role. Our study gives significant insights into the relative importance of species' floral traits depending on the abundance of pollinators in a community, and contributes to our understanding of the role of the community context on the fitness of plant species.

What if we lose a hub? Experimental study of a pollination network

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Resilience and stability of pollination networks is considered to be important for ecosystem functioning. Recent studies indicate that networks are variable in time in terms of species lists but quite stable in terms of their structure. Some theoretical investigations present a key role of highly linked nodes for network resilience and show that losing hub-nodes can cause coextinctions. However, the only experimental examination of this effect, known to us, showed no significant difference between networks studied before and after disturbance, as insect visitors of the removed plant shifted to other hub plant species which was similar in term of floral morphology, and network characteristics remained relatively unaltered.

In years 2009–2010 we studied plant-pollinator interactions in a wet lowland meadow complex in NE Poland, where we found 299 insect taxa visiting 40 plant species, including such plant hub nodes like *Anthriscus sylvestris, Polemonium caeruleum* and *Polygonum bistorta*. Here we present results of our experiment performed in June 2012 in two separated meadows with similar environmental conditions, where we manipulated the network structure by removing all *P. bistorta* flowers from one of the meadows, and analysed the resulting networks for their modularity and nestedness features.

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Pollinators and pollination in changing agricultural landscapes: investigating the impacts of bioenergy crops

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Pollinators and the services they provide are increasingly threatened by many human activities including land use change and agricultural intensification. A major shift in agricultural land use is beginning with the widespread promotion and cultivation of bioenergy crops as an alternative fuel source to combat climate change, with potentially major implications for biodiversity. This study focuses on the impact of two bioenergy crops – the annual, high-input, mass-flowering oilseed rape

(**Brassica napus**) and perennial, low-input, non-flowering **Miscanthus giganteus**, on pollinators and pollination. We find no decreases in pollinator abundance and diversity when bioenergy crops replace conventional ones at the field scale, and benefits for beta diversity of some groups such as solitary bees with increased heterogeneity of crop types. Plant pollinator network structure is affected by bioenergy production, but also by the composition of the landscape surrounding the crops. Large numbers of colonies of the cryptic *Bombus sensu stricto* complex of bumblebees are found foraging in spring oilseed rape, and species within the complex respond differently to landscape composition suggesting different ecological requirements. Lastly, pollinators in mass flowering oilseed rape fields also use wild plants for forage resources when the crop is in flower, although little crop pollen is deposited on wild stigmas. Bioenergy production in its current form in Ireland has limited impacts on pollinators and pollination, but benefits for some groups such as solitary bees and colony numbers of bumblebees. Elements such as field margins and hedgerows provide important nesting and floral resources and should be maintained to sustain pollination services in farmland. However, predictions for bioenergy production in the future suggest changes in crop cultivation patterns which may deserve further investigation.

Could Cow Parsley (*Anthriscus sylvestris* L. Hoffm.) be an indicator of poor bumblebee (*Bombus: Apidae*) habitat in an agricultural landscape in Southeastern Norway?

Anne Lene Thorsdatter Orvedal Aase

Cow Parsely*, Anthriscus sylvestris* (L.) Hoffm., is a monocarpic, rosette-forming plant, known to have increased in abundance the last few decades due to the same factors believed to threat floral diversity and non-competitive plant species important to bumblebees. Although the effect of *Anthriscus sylvestris* on other plants is well documented, the indirect effect on bumblebees was, until now, largely unknown.

We wanted to investigate how abundance of *Anthriscus sylvestris* correlates to bumblebee abundance, diversity and preferred nectar sources in an agricultural landscape in Southeastern Norway. We also wanted to discuss if this plant could function as indicator species of poor bumblebee habitat. We found that for all but one morphological group of bumblebees, *Anthriscus sylvestris* correlated negatively. *Anthriscus sylvestris* is very seldomly visited by bumblebees. Although insects can frequently been seen in the rosettes, the low quality pollen and low amount of nectar are likely to make *Anthriscus sylvestris* a less preferred plant species. Furthermore, *Anthriscus sylvestris* might outcompete preferred plant species and lower bumblebee habitat quality. Of the 10 most preferred plant species in this study, 8 correlates negatively with *Anthriscus sylvestris*. Considering how frequently *Anthriscus sylvestris* occur in fragmented agricultural land, this plant might represent an important stress factor on the bumblebee populations in these areas, and might also be a good indicator of poor habitat quality for bumblebees.

Spatial variation in the pollination system of *Curatella americana* in Brazilian savannahs

André Rodrigo Rech, Jeff Ollerton & Marlies Sazima

Across time, populations of flowering plants isolated into disjunct areas should experience different selective scenarios. Usually, when the variation occurs on effectiveness of different pollinator groups, the expected outcome should appear as differences in flower morphology. We studied the pollination of *Curatella americana*, a small open flowered savannah species whose populations became separated by the Amazon forest enlargement since the last glacial maximum. Although the populations were spatially isolated, previous observations indicated that flower morphology remains very similar. If this is actually the case, assuming pollinators play a role in the evolution of flower morphology, we hypothesized functional equivalence of pollinator groups in all populations. Therefore, our objectives were to describe flower morphology and identifying the pollinators of *C. americana* in different isolated populations in Brazil.

Morphometric analysis indicated no differences in flower morphology among populations. However, richness and abundance of pollinators were strongly different and there was a positive correlation with latitude on both parameters. In order to understand how the populations with low pollinator availability reproduce we carried out tests on the reproductive system (cross-pollination, self-pollination, geitonogamy and hand self-pollination) and also recorded the natural rate of pollination. Isolated populations with low pollinator availability produced less fruit under natural conditions and were more often self-pollinating. Our results corroborate the idea that the reproductive system is not a always a species attribute but rather a population-level attribute. We also showed that strongly different pollinator regimes do not necessarily mean differential selection on flower morphology.

The Value of Urban Allotments for Pollinators: Floral Resource Quantity and Quality

Dr Eileen F. Power, Charlotte A. Urwin, Dr Geraldine A. Wright

Urban gardens can provide important food resources for pollinators. In the UK, allotment gardens are increasing in number and often contain crops which are dependent on insect pollination to increase yields. Therefore, allotment owners plant native and ornamental flowering plants in the hope of attracting pollinators. However, research is limited as to which native and ornamental species provide the best quantity and quality floral resources for pollinators. We surveyed plant and pollinator diversity and insect-flower interactions at five allotment sites. At each site we also analysed the quantity and quality of up to 41 native and ornamental floral nectars in terms of nectar volume per flower and the concentration of carbohydrates and amino acids. Pollinator diversity was not strongly related to floral abundance at sites as some ornamental flowering species were unvisited by insects despite containing nectar. Insect visitation was skewed towards a minority of plant species which produced the best quality and most easily accessible nectar. We discuss results in the context of improving urban floral resources for pollinators.

Effects of scale and landscape structure on pollinator diversity and the provision of ecosystem services in agricultural landscapes

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Abstract

Biodiversity is rapidly declining worldwide, with complex consequences for ecosystem functioning and services. Pollination is an essential ecosystem service in agricultural landscapes, with the majority of this service provided by a diverse fauna of wild species. Spatial heterogeneity affects ecological systems and responses, including animal movement, population persistence, species interactions and ecosystem function. These ecological responses are dependent on scale as species interact with environmental variation at different scales. However, little is known about the optimum scale of management for the majority of pollinating insects in managed landscapes.

The aim of this research is therefore to investigate the effect of scale and landscape context on pollinator diversity and provision of pollination services. Using a multi-scale hierarchical sampling design, the effect of land use and landscape complexity at multiple spatial scales (field, landscape and regional) on pollinator diversity and pollination services will be assessed. Pollination efficiency will be characterized for model plant species using indicators such as fruit and seed set, visitation rates, and pollen deposition. The structure of agricultural landscapes will be characterised using remotely sensed data and habitat survey, combined with GIS based landscape metrics (e.g. habitat/land-use proportion, patch size, shape, isolation) providing an overall measure of landscape complexity. Knowledge of these relationships is crucial for a better understanding of pollinator diversity patterns and should be helpful for future conservation management decisions.

S-linked genetic load and (potential) evidence for purging in North American *Arabidopsis lyrata*

Marc Stift, Brian David Hunter, Benjamin Shaw, Aileen Adam, Peter N. Hoebe, Jens Joschinksi, Barbara K. Mable

Newly formed selfing lineages may suffer inbreeding depression, which is thought to form one of the main barriers for the evolution of selfing. Inbreeding depression can have a genome-wide genetic basis, or be due to loci linked to genes under balancing selection. Understanding the genetic architecture of inbreeding depression is important in the context of the maintenance of self-incompatibility and understanding the evolutionary dynamics of *S*-alleles.

Our experiments disentangled *S*-linked genetic load from genomic-wide load and assessed if selfing populations still suffer reduced performance in the North American subspecies of *Arabidopsis lyrata.* This species is of interest for mating system evolution because some populations have undergone a transition to selfing.

In enforced selfed progeny, we found significant inbreeding depression for early seedling survival (δ = 0.45) and growth (δ = 0.07). PCR based genotyping of selfed progeny revealed significant *S*-linked load (under-representation of *S*-locus homozygotes in selfed progeny) for 2/4 *S*-alleles in our design, among which the most recessive allele. These results differ from findings in the related species *A. halleri*, in which the degree of S-linked load also varied among alleles, but was related to the dominance level of S-alleles. We suggest that not dominance, but the random nature of the mutation process may explain differences in the deleterious load among S-alleles. Performance of selfing populations did not differ from outcrossing populations, with the exception of germination rate. This is in line with expectations that deleterious load can be purged with multiple generations of selfing.

Towards semantic integration in biodiversity- and ecosystem informatics

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Biodiversity information is rich and complex. Whereas much has been achieved in the integration of online biodiversity information and its accessibility through the use of relational databases in the last decade, semantic constraints limit the discovery of new knowledge.

For example, in the fynbos biome of South Africa there are guilds of plant species that have evolved highly specialised pollination systems. One such guild consists of 20 plant species that are pollinated by a single fly species, *Moegistorhynchus longirostris*, which has a proboscis that is between 60mm and 100 mm in length, the longest of any known fly. The plants pollinated by this fly have correspondingly long and narrow corolla tubes. Importantly, the plants flower only during the few weeks of the year when this fly is active.

Examples of questions that can be asked:

a) How many / by which pollinators is this plant pollinated?
b) How many / which plants does this pollinator pollinate?
c) How resilient is pollination in this ecosystem?

We propose to:

1) Develop a Description Logics-based (DL), Web Ontology Language (OWL) ontology to model the concepts and properties of pollination systems;

2) Link the ontology to specimen records exported to a common standard from biodiversity databases;

3) Use DL reasoners, and if necessary, extend DL reasoners, to discover new knowledge about pollination;

4) Integrate information about pollination with other information, such as abiotic environmental information.

Integration of African solitary bee biodiversity information and –literature

Willem Coetzer

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This project will build on another project, funded by the South African Biodiversity Information Facility in 2010, in which about 500 000 specimen records from three South African museums were cleaned and migrated to Specify6. We are trying to develop capacity for (Specify-based) biodiversity information management in South Africa and Africa.

One of the main objectives of the current JRS Biodiversity Foundation-funded project is to make available online the Catalogue of Afrotropical Bees (Eardley and Urban, 2010). This catalogue lists 2755 valid bee names and 6989 invalid bee names in 26 671 citations of 1229 literature references. The catalogue has already been imported into Specify6 and thence exported as a DarwinCore Archive and registered with GBIF Checklist Bank. The catalogue is interesting because it represents a 30-year effort to tag legacy biodiversity literature semantically, on the theme of bees in Africa, even though the authors didn't necessarily foresee the recent developments in biodiversity informatics. The catalogue also includes 6194 mentions of 59 countries where bees occur, 4005 mentions of 1219 visited plant species, 182 mentions of 115 plant species that bees nest in, 93 mentions of 66 parasite species hosted (some parasites are themselves bees) and 50 mentions of 37 hosts parasitised by parasitic bees.

How do we make the literature text itself available online?

Information on bees and pollination is very important in conservation and agriculture, particularly in the face of global change. There are excellent networks and collaborations on bee taxonomy and pollination ecology in Africa, which would benefit immensely from easier, integrated, structured and enriched access to bee biodiversity information and literature.

URL: http://www.africanpollination.org

Are nectar robbers really that bad?

Carolin Mayer, Charles Dehon, Olivier Naveau, Cyrielle Rigo, Anne-Laure Jacquemart

One would assume that nectar robbery is simply loss of resources for a flower and of no use or even detrimental for the reproductive success of a plant. However, robbery or theft might change the behaviour of (other) pollinators: if nectar is limited, pollinators will visit fewer flowers per plant and may fly further in between different plants. As a consequence, self-pollination (geitonogamy) or pollination among close relatives may be reduced. A species that could profit from higher amounts of outcross pollen is *Aconitum napellus* spp*. lusitanicum* (Ranunculaceae), a species suffering from inbreeding depression in small populations. We tested whether nectar depletion would influence flower visitor behaviour and the distance and amount of possible pollen transport marking flowers with fluorescent dye. Indeed, preliminary results showed that more dye (simulating pollen) was dispersed over longer distances from the source when nectar had been depleted. This might indicate that flower visitors left the unrewarding patch earlier and flew farther thereby depositing more "outcross" dye (pollen). Results from experimental and natural populations will be compared.

Loss of self-incompatibility in the toadflax *Linaria cavanillesii*: causes and consequences

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ABSTRACT—Flowers display an amazing variety of forms, shapes and colours. One striking contrast is between flowers that obligately outcrossing and those that can self-fertilize. Evolution toward selfing is one of the most common transitions in flowering plants, but its causes, mechanisms and consequences continue to be the focus of much interest. *Linaria cavanillesii (*Scrophulariaceae) is a toadfloax species endemic to south-eastern Spain. This insect-pollinated species exhibits variation in its mating system, with most populations possessing functional gametophytic self-incompatibility (SI), but with northern populations having lost SI (being self-compatible, SC). Typically, the loss of SI leads to the evolution of a 'selfing syndrome', with smaller flowers that produce less nectar, and lower pollen:ovule ratios. In contrast, there are no obvious morphological differences in flowers between SI and SC populations. The aim of this project is to determine what might have caused transition between SI and SC in this species, to ascertain its effect on the mating system and pollination biology, and to characterize its population genetic consequences, both at the self-incompatibility locus, at fitness-determining loci, and broadly across the genome. We are particularly interested in how and why an outcrossing syndrome appears to have been maintained despite the loss of SI. The poster will summarize the background and aims of the project and the approached that are being adopted.

Underlying mechanisms of sensory exclusion of bees by flowers adapted to the pollination by birds: The role of colour, epidermal cell shape and gloss.

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Coloured flower petals are signalling structures that attract pollinators, but at the same time prevent frequent visits by non-pollinating visitors. In this study we reveal the underlying mechanisms of our recent finding that flowers adapted to the pollination by hummingbirds display colours of lower spectral purity as compared to flowers adapted to the pollination by bees with the same colour for the human eye. As a potential physical mechanism, we investigated the epidermal cell structure of these flowers. Incident light is less likely to enter the pigment-containing tissue in flowers with flat- as compared to conical-shaped epidermal cells, resulting in higher gloss. In contrast, conical-shaped epidermal cells function as lenses, trapping the light into the pigment-containing plant tissue. This results in a higher probability of absorption of light by the pigments, thus increasing the spectral purity, which is an important colour feature for foraging bees.
We examined the epidermal cell shape of 29 bird- and 29 bee-pollinated flowers and found that melittophilous flowers always have conical cells, whereas ornithophilous flowers mostly have flat

epidermal cells. Our results suggest that floral cell shape and its effect on flower colour may have been evolved to either invite bees (conical cells) or to avoid frequent bee-visits to bird-pollinated flowers (flat cells). Cell shape may thus be an important trait to partition flower visitor with differing colour vision systems.

Inferring from variation and covariation of leaf, flower, and fruit traits to the evolution plant-arthropod interactions

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Over the last decade, the understanding of complex plant-animal interactions has qualitatively improved thanks to the use of network analysis. Studies on ecological networks are mostly restricted to interactions at individual plant organs, e.g. flower-visitor or leaf-herbivore interactions. However, those actions do not occur in isolation. Different parts of plants require contrasting services: vegetative plant-parts avoid interactions with herbivores, flowers and fruits advertise interactions with mutualists, while antagonists should be deterred from these valuable tissues. Therefore, different organs evolved adaptations to its specific (potential) interaction partners leading to phenotypes with highly complex patterns of variation. Traits can vary individually or in concert with other traits resulting in a pronounced covariation maintaining certain functions, *sensu* phenotypic integration.

Here we introduce a study linking intra-specific variation of morphological, visual, and olfactory leaf, flower, fruit and seed traits from three plant species with their multiple interactions with arthropods, adopting a network approach. This data set will be complemented with evaluations of reproductive success of individual plants. We are planning to test (a) whether and how the interactions are shaped by traits and (b) whether (co-)variation results from adaptations to mutualists and antagonists or by developmental constraints. These results will further our understanding of the evolution of plant traits and their link to plant fitness via biotic interactions.

Balance between pollination and parthenocarpy in the pear (*Pyrus communis*) variety Conference

Muriel Quinet, Titlan Van der Veken, Anne-Laure Jacquemart

Pear is the second fruit growing in Belgium and the variety Conference represents 90% of the Belgian production. Pear tree (*Pyrus communis*) is a self-incompatible species and requires inter-variety cross-pollination to develop fruits. Hives are often settled in the orchards to facilitate pollination and allow a better fruit size production. However honeybees seem not really attracted by pear flowers and no accurate study of pear tree pollination by insects has been conducted. Moreover, pear tree blooming occurs early in the spring and could be subjected to frost events. Parthenocarpy induction by spraying plant hormones, mainly gibberellins, is a common practice in orchards and allows achieving sufficient yield even under climatically unfavorable spring conditions. No precise study has

been carried on to determine the most efficient hormones (gibberellins, cytokinins,…), the moment of their application and the required amounts to apply. Our work aims to better highlight the pear tree reproduction and focuses on the pollination and parthenocarpy processes in the Conference variety.

Spatio-temporal variation in an alpine pollination network

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Small scale heterogeneity in vegetation can entail differences in interactions with pollinators. Information about how pollination networks are assembled in heterogeneous habitats is important to understand the impact of future vegetation changes such as expansion or disappearance of some of these habitats. We explore the differences in pollination network structure between adjacent high mountain habitats, grassland and scree, where pollinators can freely move and chose among plants and where some plants are common to both habitats. Even at this small scale (20-40 m) we found differences among habitats in the relative importance of pollinator guilds and the plant species present in both habitats were visited by different pollinators. On the other hand, some pollinators (e.g., *Bombus terrestris*) visited plants in both communities and were important as "connectors" among both sub-networks. We predict that, in a hypothetical scenario of increased grassland, those pollinator species able to use both scree and grassland plants as nectar or pollen sources will have better chances to persist in the overall network.

Determining the threshold of detection of the buff-tailed bumblebee, *Bombus terrestris* (Apidae), for potentially toxic compounds in floral nectar

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Members of the family Apidae feed exclusively on nectar and pollen which can contain plant secondary compounds usually associated with defence against herbivores. These compounds tend to occur at low concentrations which may be below the threshold of detection for most flower-visitors.
The aim of this study was to determine whether the generalist pollinator, *Bombus terrestris*, can taste naturally occurring concentrations of toxic compounds in floral nectar. We focused on five plant secondary compounds and one toxic systemic insecticide. In paired choice experiments we presented free-flying *B. terrestris* individuals with i.) a sucrose solution and ii.) a sucrose solution containing a toxic compound at one of four concentrations. After twenty-four hours the difference in the amount consumed from each solution was calculated in order to find the taste threshold: the

concentration at which the bees fed preferentially from either of the two solutions. A taste threshold was found for five of the six compounds tested. We found that the threshold of detection varied for the six toxic compounds so that whether the natural concentrations of the compounds in floral nectar were able to be detected by *B. terrestris* individuals depended on the identity of the compound. We also found that *B. terrestris* individuals did not prefer any of the compounds at any concentrations, contrary to similar studies carried out on *Apis mellifera*. The implications of the results for foraging decisions by *Bombus* workers and for the selection of secondary compounds in nectar are discussed.

Mono- and polysymmetrical flowers in the same inflorescence: Saxifrages – a study case in flower symmetry

Klaus Lunau & Michaela Krohn

The genus *Saxifraga* shows a large diversity in flower symmetry including species with radially symmetrical flowers like *Parnassia palustris* (Marsh Grass-of-Parnassus) and species with monosymmetrical flowers like *Saxifraga stolonifera* (Aaron´s Beard). Some Saxifrages have monosymmetrical and radially symmetrical flowers in the same inflorescence like *Saxifraga stellaris* (Starry Saxifrage) and *Saxifraga rotundifolia* (Round-leaved Saxifrage). We have tested several hypotheses about the development of floral symmetry in these saxifrages. We found that the development of the floral symmetry is dependent of the branching and position within the inflorescence and from the exposure to gravity. In *S. rotundifolia* and *S. umbrosa* exposure to gravity impacts the angle between petals, the position of the symmetry axis, the arrangement of the petals, the petal length, the pigmentation of petals and the sequence of stamen movements. Floral symmetry also influences the flower visitor`s landing position. We discuss how the manipulation of the flower visitor`s landing position might affect pollination success. We defined three flower symmetry axes, the flower-visitor´s visual symmetry axis, the morphological within-flower symmetry axis, and the perpendicular axis and found that the missing congruence of these symmetry axes helps to understand the variation in the saxifrages´ floral symmetry.

Insects and plant pathogens as agents of density-dependent seedling mortality in tropical forests

Sofia Gripenberg, Robert Bagchi, Rachel Gallery, Lakshmi Narayan and Owen Lewis

The coexistence of plant species in diverse tropical forests can be promoted by specialised enemies that act in a density-dependent manner. While the survival of tropical tree seedlings is often negatively density-dependent, the causes of density-dependence have rarely been identified. We tested whether insects and plant pathogens cause density-dependent seedling recruitment and survival, focusing on five forest tree species in Belize, Central America. We manipulated densities of seeds or newly germinated seedlings in small (1 m^2 or 0.25 m^2) plots next to fruiting trees. In a factorial design, we excluded enemies from a subset of the plots using fungicides and insecticides. Seed germination (for two species) and seedling survival (for all species) were monitored at approximately weekly intervals for up to 8 weeks. Although we did detect effects of both pesticide application and density manipulation, the effects were generally small and we found no evidence for enemy mediated negative density-dependence. Our study illustrates the challenges of conducting

experiments testing for enemy-mediated negative density-dependence. The outcomes of such experiments will differ among study species, and are likely to vary depending on the spatial scale at which the principal enemies forage, and timescale over which they act. I will discuss some of the challenges associated with experiments of this type and propose new ways forward.

Temperature requirements of pollen germination control species' altitudinal distribution

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The major factor controlling altitudinal distribution of plant species is climate, with temperature being the most important component. However, an ecophysiological mechanism with high predictive efficiency in defining of species elevation ranges is still missing.

In the present study we tested the hypothesis that altitudinal distribution of plants is controlled by specific temperature requirements of the progamic phase (pollen germination and tube growth). In the experimental part of the study we identified cardinal temperatures of the pollen germination and the pollen tube growth for 26 plant species with different altitudinal distribution in Southern Bavaria (Germany). Statistical analysis showed that initial temperatures of both processes as well as optimal temperature for pollen tube growth rate are strongly negatively correlated to altitude ($r^2 = 0.49$, $p<0.001$; $r^2 = 0.57$, $p<0.001$ and $r^2 = 0.57$, $p<0.001$ respectively). We conclude that increasing negative temperature stress along altitudinal gradient limits upward distribution of species with high temperature requirements of the progamic phase.

Effects of population size, age, isolation and plant-herbivore interactions on mating system of the perennial herb, *Vincetoxicum hirundinaria*

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Plant mating system (i.e. self-fertilization versus cross-fertilization) is a fundamental factor affecting genetic variation and genetic structure of plant populations. Because variation in plant responses to herbivores often has a genetic basis, self-fertilization may indirectly affect plant fitness by altering the suitability of a plant to herbivores or by altering resistance to or tolerance of herbivore damage. Our study species, the perennial herb, *Vincetoxicum hirundinaria* (Apocynaceae), has a mosaic-like

distribution on the islands of the SW archipelago of Finland. In our study area, *V. hirundinaria* has a mixed-mating system with relatively high levels of self-fertilization. Populations vary in size, age, and isolation. Moreover, the amount of herbivory by three specialist herbivores varies both spatially and temporally. The aim of this study, currently underway, is to estimate the effects of herbivory and population characteristics on plant mating system. Self-fertilization is assumed to be favored in small, young, and isolated populations to facilitate colonisation. In this plant species, inbreeding depression is expressed as decreased resistance against specialist herbivores. Therefore, herbivory is assumed to select for outcrossing, contrast to selection imposed by population size, age, and isolation that are likely to favor self-fertilization. We therefore expect to find positive associations between herbivory and outcrossing rate, and negative associations of population size, age, and isolation and outcrossing rate. Additionally, we suggest that these potentially opposite selection pressures might then contribute to the maintenance of the mixed-mating system of *V. hirundinaria.*

The importance of *Salix repens* L. as a forage resource for spring bees in priority grey dune ecosystems

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Grey dunes, the mature section of a dune system characterised by a practically complete carpet of vegetation, are a priority habitat under the EU Habitats Directive (EU, 1992). They are a florally diverse section of the dune system, which accompanied by their areas of open ground and favourable microclimate, make this habitat ideal for meeting the demands of pollinating insects. One of the resources in this system in early season is *Salix repens* (Creeping Willow) (Salicaceae). Researchers have often highlighted the importance of *Salix* spp. as an early season resource for spring bees. However, few studies examine the relationship between *S. repens* and native spring bee species in dune systems.

This study investigates the relationships between spring bees and their forage plants in the grey dune habitat. We examined whether *S. repens* receives more visits from spring bees than co-flowering plant species. We also explored the relationship between foraging preference and floral nutritional properties.

Eight sites distributed along the east and south of Ireland were chosen for the study: 4 containing *S. repens* and 4 adjacent sites without *S. repens*. Timed observations, floral abundance surveys, pan-trapping, and pollen and nectar sampling were employed at all sites during April 2012.

Results indicate that *S. repens* receives greater visitation rates than co-flowering plant species, and sites containing *S. repens* have a significantly richer pollinator community, than adjacent sites. These

results suggest that encouraging native *S. repens* in grey dune habitat should form part of dune management to promote native pollinator species.

Pollen dispersal and gene flow within and into a population of the alpine monocarpic plant *Campanula thyrsoides*

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Gene flow by seed and pollen largely shapes the genetic structure within and among plant populations. Seed dispersal is often strongly spatially restricted, making gene flow primarily dependent on pollen dispersal within and into populations. We studied gene flow within and into a population of the alpine monocarpic perennial *Campanula thyrsoides*. A paternity analysis was performed on sampled seed families using microsatellites, genotyping 22 flowering adults and 331 germinated offspring to estimate gene flow. The focal population was situated among 23 populations on a subalpine mountain plateau (<10 km^2) in central Switzerland. Since these populations were previously found to be genetically differentiated, we hypothesised that gene flow is restricted. Paternity analysis assigned 110 offspring (33.2 %) to a specific pollen donor in the focal population, whereas multiple potential pollen donors were assigned to each of 186 offspring (56.2 %). Mean pollination distance was 17.4 m for these offspring, and the pollen dispersal curve based on positive LOD scores of all 331 offspring was strongly decreasing with distance. The paternal contribution from 20–35 offspring (6.0–10.5 %) originated outside the population, probably from nearby populations on the plateau.

The high gene flow into the focal population was apparently not strong enough to prevent the previously described substantial among-population differentiation on the plateau. To explain this, we suggest that the monocarpic perenniality of this species leads to restricted gene flow, since each year only a portion (ca. 10%) of the population participates in crossing.

The endangered *Iris atropurpurea* (Iridaceae) in Israel: honeybees, night-sheltering male bees and female solitary bees as pollinators

Stella Watts, Yuval Sapir, Bosmat Segal and Amots Dafni

The coastal plain of Israel hosts the last few remaining populations of the endemic *Iris atropurpurea*, a species of high conservation priority. The flowers have no nectaries and thus offer no nectar reward. We compared the effectiveness of honeybees with that of night-sheltering solitary male bees on both male and female fitness components. Results indicated that the main natural pollinators of this plant are male Eucerine bees, and to a lesser extent, female solitary bees. Honeybees were frequent diurnal visitors; they removed large quantities of pollen and were as effective as sheltering bees at pollinating this species. The low density of pollen carried by male solitary bees was attributed to grooming activities, pollen displacement and pollen depletion by honeybees. In the population free of hives, male bees carried significantly more pollen grains on their

bodies. Results from pollen analysis and pollen deposited on stigmas suggest that inadequate pollination may be an important factor limiting fruit set. In the presence of honeybees, Eucerine bees were low removal–low deposition pollinators, whereas honeybees were high removal–low deposition pollinators, because they wasted pollen by removing considerable amounts and deposited relatively little on receptive stigmas. The presence of honeybees appears to have disrupted the interaction between *I. atropurpurea* and its natural pollinators. The results have important implications for the conservation of this highly endangered plant species if hives are located in or adjacent to conservation areas where *Oncocyclus* irises are protected. We suggest that honeybees have the potential to reduce the pool of resources available to solitary bee communities.

Augmentation of flower scent – the impact of floral volatiles on flower partitioning among visitors

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Flowers use visual and olfactory cues to communicate with their visitors. The existence of a diversity of insects interested in the consumption of nectar and pollen, forces the plant to discriminate between mutualists and antagonists. One way of selecting the most beneficial visitors is the emission of floral scent bouquets that are able to function as both attractants and repellents, i.e. as floral filters. We selected three plant species (*Achillea millefolium*, *Cirsium arvense* (both Asteraceae) and *Daucus carota* (Apiaceae)) with a distinct but also overlapping flower visitor spectrum. We compared the visitor composition of untreated flowers with the composition observed on flowers whose floral scent bouquet had been augmented with floral scent extracts from another species. Despite pronounced inter-specific differences in floral colour and morphology, the scent bouquet mostly determined the visitor spectrum of the flowers observed. The augmentation of flower scents with floral extract of other species caused visitor spectra more similar to each other because some visitors of untreated flowers stayed away while others not observed on untreated flowers complemented the spectrum. This result is explainable by attractive and repellent functions added to the natural bouquet, which was confirmed in olfactometer trials testing the behavioural responses of naïve and experienced flower visitors to the scents emitted by our study species. Our data clearly demonstrate that flower scents with their attractive *and* repellent properties have a pronounced impact on flower partitioning among visitors.

Corrupted communication - How herbivores affect plant-insect interactions

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Herbivory has been shown to induce indirect defense reactions in leaves such as scent-mediated communication with the herbivores' enemies. However, if flowers and pollinator attracting signals are also affected has rarely been considered. Moreover, further organisms may eavesdrop alterations in the whole plant's scent bouquet with potentially negative effects on the plants. We tested whether herbivory by *Aphis fabae* and simulated herbivory (jasmonic acid (JA)) affect (1) the olfactory foliar traits of *Vicia faba* and the behavior of ants tending aphids (*Lasius niger*) and (2) the olfactory and visual floral traits of *V. faba* and the behavior of pollinating bumblebees (*Bombus terrestris*). In dual choice tests ants preferred aphid-infested over control plants, but showed no preference in tests with simulated herbivory. Aphid-infested and control plants differed in their floral headspace volatile composition, which was reflected in Y-maze olfactometer choice tests where bumblebees preferred scents of control plants over scents of aphid-infested ones, but revealed no preference in tests with JA-treated plants. Bioassays with unscented flower dummies showed the sensitivity of naïve bumblebees towards varying visual display in dark-spotted *V. faba* flowers. Foragers innately preferred dummies with larger spots and were able to discriminate minimal differences in spot sizes in learning experiments. However, JA-treatment did not change spot size compared to control plants. In dual choice experiments bumblebees' decision between JA-treated and control plants was balanced, confirming our findings that JA-treatments had no consistent effect on floral traits. Contrary, ongoing experiments using aphids as herbivores suggest that interactions at vegetative plant parts modulate interactions at reproductive plant parts.

Invisible flower visitors – diversity, distribution and potential functions of epiphytic bacteria colonising flowers

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The distribution of flower-visiting arthropods, birds, and mammals, their responses to flower signals, and the effects of their visits on the plants' reproduction are well known. This kind of information is virtually unavailable for microorganisms dwelling on flowers of non-crop plants (with the exception of yeast found in nectar). However, the omnipresence and the nearly endless biochemical abilities of bacteria suggest that microorganisms are also frequent and abundant floral colonisers and may have profound effects on flower-visitor interactions and plant reproduction, too.

Colleagues and I found that flowers of two naturally growing plant species had comparable epiphytic bacterial communities that were significantly different from the communities found on leaves of the same species. Volatiles emitted by flowers and leaves contributed to the distinct communities by growth inhibiting effects of flower scents. Furthermore, preliminary experiments revealed that bumblebees and other insects disseminate bacteria between flowers, which may contribute to distinct communities, too. Additionally, we dissected flowers of *Lamium maculatum* (Lamiaceae) and found that bacterial communities were most diverse on petals, while the density of bacteria was highest in nectar. Less diverse and dense were bacteria isolated from anthers and stigmas of the flowers. Ongoing experiments suggest that bumblebees perceive scents emitted by bacteria and avoid contact and consumption of sugar water contaminated with bacteria isolated from nectar and other plant parts of *L. maculatum*. The results presented here suggest that bacteria represent and important but neglected factor in floral and pollination biology that may have strong effects on the ecology and evolution of flowers and their eukaryotic interaction partners.

The effects of fragmentation characteristics on community structure and diversity of native bees in a threatened habitat

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Loss and fragmentation of natural habitats have been identified as the main drivers for the decline of both pollinator and plant communities in overly developed countries. Recent studies documented the adverse effects of different fragmentation factors on bee communities but their combined impact is still poorly known. We evaluated the effects of various fragmentation characteristics on the structure and diversity of native bee communities in a highly diverse and threatened habitat along the coast of Israel. Extensive field surveys were performed during 2009-2010 in 11 habitat fragments of varying sizes (7000-657800 m^2) in which over 190 bee species and more than 180 entomophilous plant species were found. Using ordinations we found an additive effect of fragmentation characteristics including the availability of floral and nesting resources and landscape variables, together significantly explaining 30-35% of the variance of bee community structure. The most important fragmentation factors over time were flower diversity, abundance of empty snail shells (a resource of shell nesting bees) and land use within 100 m radii around the fragments. An ordination model with bees divided into ecological groups explained 75% of the community structure and revealed further association between bee groups and their essential resources. Contrary to other studies, bee diversity did not correlate with the size of habitat fragments and no significant response was found among specialized taxa. These results may be explained by the high availability of resources within the surrounding landscape and the high diversity of species that each exhibits a combination of ecological traits. Additional tests using cluster analysis showed similarity in bee community composition in geographically related sites but some sites had unique bee communities regardless of geographical distance. The results indicate a complex cumulative effect of fragmentation factors on bee community structure and suggest that availability of resources may be particularly important. We recommend the protection of the remaining habitat fragments independent of their size or geographical location for the conservation of bee and plant communities in severely fragmented habitats.

A pollinator's eye view of a shelter mimicry system

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Abstract. "Human-red" flowers are traditionally considered to be rather unpopular with bees, yet some species in the section *Oncocyclus* of the genus *Iris* (Iridaceae) have evolved specialised interactions with a narrow range of male solitary bees. The dark red, tubular flowers of these irises do not produce nectar and they are usually visited primarily by male solitary bees, particularly by Eucerine bees (Apidae, Eucerini), that pollinate the flowers during periods of overcast weather or late in the afternoon while looking for an overnight shelter. Here, we combined field surveys of pollinators, pollinator preferences for shelters with different spatial parameters and quantitative analyses of both floral colours (by spectrophotometry) and floral scents (by gas chromatography-mass spectrometry) to test the hypotheses that (i) pollinators significantly prefer floral tunnels facing the rising sun (floral heat reward hypothesis), and that (ii) flowers pollinated predominantly by male solitary bees produce significantly larger amounts and larger numbers of unsaturated cuticular hydrocarbons (*n*-alkenes) in their floral scent (preadaptation to sexual deception hypothesis). Our study provides a detailed characterisation of pollinators associated with a plant species pollinated by shelter mimicry, and our results demonstrate that male bees do not significantly prefer shelters facing the rising sun or with specific floral scent signature (absolute and relative amounts of compounds in the total blends). Furthermore, our results challenge the view that the specialised attraction of male bees requires the presence of high absolute/relative amounts and numbers of *n*-alkenes in the floral scent. Collectively, we suggest that the large, tunnel-like, dark red flowers of *I. atropurpurea* likely evolved by pollinator-mediated selection acting primarily on floral colours to mimic large achromatic ("bee-black") protective shelters, and that the floral visits are presumably not the result of an odour-based sexual stimulation or motivated by an increased morning floral heat reward in tunnels facing the rising sun.

Video surveillance system for remote long-term in situ observations of Orchids: registration of pollinators and their behaviour.

Ronny Steen

Documenting species interactions is a time consuming enterprise, in particular for rare interaction events and interactions taking place at night. Pollinators foraging on orchids have traditionally been monitored by discovering pollen vectors on collected insects, recording traces left by moths on the orchid, direct observations and recently by continuous video monitoring. Direct observations in the wild of orchids with low visitation rates is time demanding. In the Orchidaceae family, many species have a highly specialized floral structure and floral fragrance due to interactions with specific pollinators. I have successfully monitored greater butterfly-**orchids (***Platanthera chlorantha***), by** using an event triggered video monitoring system. A total of 23 nights of monitoring were conducted, whereas only 6 nights had visits by one moth species, namely the pine hawk-moth (*Hyloicus pinastri*). The total numbers of pine hawk-moths registered were 18. In addition to species identification, the

video recordings also enabled detection of pollinaria on the pine hawk-moths. Most of the pine hawk-moth visits took place around midnight. The visit lasted on average for 38.0 sec and the average number of flowers visited was 9.6. In future studies, this video system could give more details on interactions between orchids and insects and even link it to environmental factors (e.g. varying weather conditions).

The use of a low cost high speed camera to record fine scale behaviour in flower visiting animals: hummingbird flight during nectar-feeding as an example.

Ronny Steen

Recent development in video monitoring technique has allowed efficient sampling of data on nectar feeding and pollinating animals, whereas high speed movie has revealed detailed information about flight dynamics. High speed movie equipment has been very expensive, although budget compact cameras with a high speed movie function has become available during the last years. For comparison a budget high speed camera cost about 200–1000 $, whilst medium to high end cost c. 25 000 to more than 100 000 USD.

I used a budget camera, which captured 220 frames per sec (fps), to film hummingbirds to quantify wing beat frequency under natural conditions in Costa Rica. With this equipment I was able to achieve detailed information about stationary hovering flight in three different species. Hopefully, this study may inspire future usages of budget high speed cameras to reveal more information about flight dynamics and fine-scale behaviour of flower-visiting animals under natural conditions, which are not constrained by costly equipment or requirements to be used in the laboratory.

Corrupted communication - How herbivores affect plant-insect interactions

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