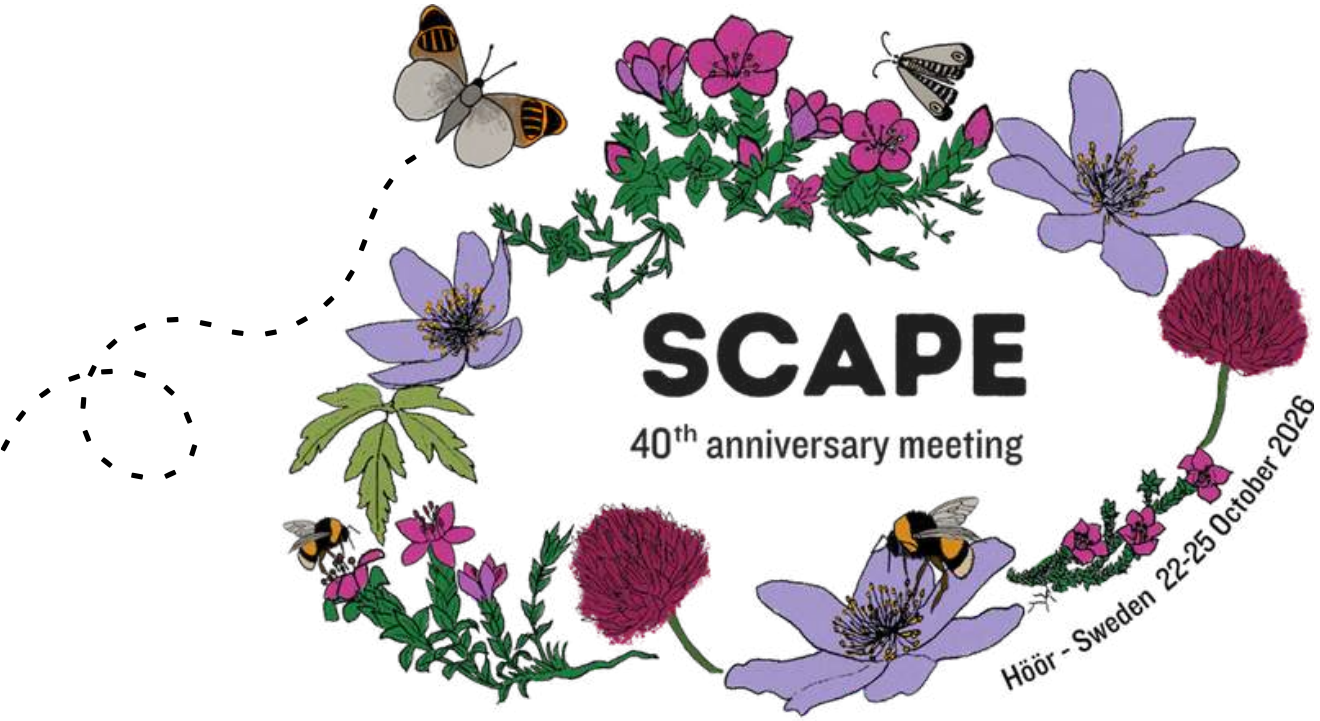
SCAPE

SCANDINAVIAN ASSOCIATION FOR POLLINATION ECOLOGY

Höör - Sweden 22-25 October 2026

ABSTRACT BOOK



THE SCANDINAVIAN ASSOCIATION FOR POLLINATION ECOLOGY

Table of Contents

I **Conference Program**

Pages 2-7

II **List of posters**

Pages 8-11

III **Oral presentation abstracts**

Pages 12-85

IV **Poster abstracts**

Pages 86-135

Conference Program

Thursday

14:00-	**Arrival and check-in**	
18:00-19:15	**Dinner**	
19:15-19:30	Thosteman, Opedal, Olsson, Friberg	Welcome and Introduction
19:30-21:00	**Symposium 1: Floral Function and Evolution**	
	F. Torres-Vanegas, A. Susheel	Introduction
Full - 1	Juliane Nazari-Montazer	Where did my pollen go? How *Pleroma*'s visitors and anthers change across an elevational gradient
Full - 2	Mario Vallejo-Marin	Pollen release during buzz pollination depends on vibration amplitude and floral vibration transmission, but not on spectral composition
Full - 3	Mohamed Abdelaziz	Hybridization reshapes adaptive trajectories across different stages of plant hybrid zones
Full - 4	Macarena Marin-Rodulfo	Functional links between floral traits, pollination performance, and fitness in two heterosylous *Linum* species
Full - 5	Amy Parachnowitsch	Meta-analyses of nectar differences in response to experimental manipulation of abiotic and biotic environments
Full - 6	Yuval Sapir	Flower colour polymorphism in *Anemone coronaria* - molecular drivers and ecological consequences
Flash - 7	Maria Clara Castellanos	Low resilience of floral and nectar traits under acute heat stress
Flash - 8	Julia Andersson	The reproductive role of floral morphs in a distylous hummingbird-pollinated plant
Flash - 9	Benjamin Lazarus	Tips are appreciated: how clever buzz-pollinated stamen morphologies before the pore modulate pollen placement
21:00	**Bar**	





I Conference Program

Friday

Morning

07:45-09:00	**Breakfast**	
09:00-10:20	**Keynote session 2: Allan Ellis**	
	Allan Ellis	Floral trait evolution in generalist daisies
Full - 11	Nina Sletvold	Scent or sight? The adaptive significance of scent and visual signals in floral food mimicry
Full - 12	Aurélien Caries	Unravelling the genetic underpinnings of floral scent variation in *Lithophragma* hybrids
Flash - 13	Carlos Martel	Pollinarium reconfiguration responds to humidity, but it can be controlled by the inflated trap flowers of *Ceropegia* (Apocynaceae)
Flash - 14	Rocío Pérez-Barrales	From pollen placement to pollen tubes: differences in floral function in two distylosus *Linum* species
10:20-10:40	**Coffee break**	
10:40-12:00	**Symposium 2: Ecology and Evolution of Co-Flowering Species Interactions**	
	Yedra García, Pamela Santana	Introduction
Full - 15	Paulo Eugênio Oliveira	Pollination ecosystem services and Cerrado savanna conservation
Full - 16	Yedra García	Co-flowering species interactions influence selection on floral traits
Full - 17	Jakub Štenc	Architecture of stability: fifteen years of pollinator-sharing networks reveal a stable core along a highly dynamic network as driver of system resilience
Full - 18	Jose B. Lanuza	Seasonal variation mediates the importance of species attributes in plant-pollinator interactions
Full - 19	Agnes Dellinger	Exploring bee buzzing behavior across gradients of flower morphology, pollen availability and temperature in the wild
Full - 20	Cesar Augusto Arvelos	Is acceleration enough? Mechanical variation in pollen release from buzz-pollinated flowers
Flash - 21	Richard D. Randriatsitohaina	Shift from bee to vertebrate pollination in the genus *Medinilla* along an elevational gradient in Marojejy National Park, Madagascar: first evidence from african Melatomataceae
12:00-13:15	**Lunch**	





Conference Program

Friday

Afternoon

13:15-14:45	**Symposium 3: Floral Evolution Along the Specialization-Generalization Continuum**	
	A. Susheel, F. Torres-Vanegas	Introduction
Full - 22	Kathleen Kay	Pollinator identify shapes offspring quality and lifetime fitness in *Clarkia*
Full - 23	Felipe Torres-Vanegas	One flower, many pollinators: how pollinator identify shapes reproductive success and selection
Full - 24	Pamela Santana	Fine-scale selection divergence as a component of geographic coevolutionary mosaics
Full - 25	Arjan Engelen	Sexual dimorphism in fly visual function and its influence on flower visitation behaviour and floral evolution in Cape daisies
Full - 26	Johan Esteban Urrea Cardenas	Buzzing and spining: insights into the functional and morphological diversity of pollination in *Pyxidantheae* (Melastomataceae)
Full - 27	Pritee Subhadasrhini	Water availability, rather than pollinators, drives selection on flower size in irises
Flash - 28	Stavroula Stamouli	Floral syndromes and pollinators across mating system shifts in Mediterranean *Linum*
Flash - 29	Beatriz Monteiro	Are plant mating systems associated with pollination systems across the Brazilian flora?
Flash - 30	Sofía Moreno	Co-flowering species interactions and pollination-mediated selection in *Gymnadenia conopea*
14:45-15:15	**Coffee break**	
15:15-16:50	**Symposium 4: Pollination in Agricultural Landscapes**	
	H. Thosteman, A. Karbassioon	Introduction
Full - 31	Äsa Lankinen	Red clover seed production: Impact of pollinators across Sweden and floral scents
Full - 32	Huan Liang	Rainforest conversion reshapes multiple dimensions of stingless bee colony performance
Full - 33	Magda Karlo	Influence of non-native flower strips on pollen transport of native species in an agricultural landscape
Full - 34	Maaike van den Hil	Transplanting ground-nestling sweat bees (Halictidae) into greenhouses: survival, nest architecture, and pollination potential
Full - 35	Niall Walshe	Where do targeted actions for pollinators rank? The cognitive salience of biodiversity-friendly farming practices in a multi-country European study
Full - 36	Sophie Hecht	Evidence for floral trait divergence and potential past selection divergence among human land-use type
Flash - 37	Lisa Wasko DeVetter	Beat the heat: cultivar-specific pollinator responses to overheat cooling in Highbush Blueberry
Flash - 38	Jørund Johansen	Preliminary findings suggest variation in floral scent compound content and composition among apple cultivars: a case for more studies on scent in pollinator-dependent crops
Flash - 39	Tianying Zhang	Elevational patterns of floral visitation on tropical smallholder farms
Flash - 40	Tirza Moerman	Buzz below ground - how does timing of grazing impact soils and pollinators?
16:50-17:10	**Break**	



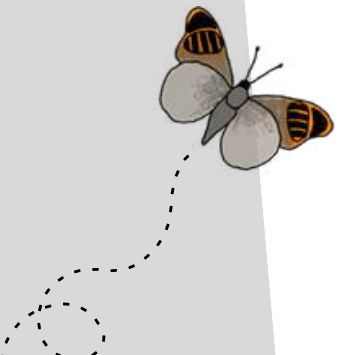


Conference Program

Friday

Evening

17:10-18:00	**Symposium 4: Pollination in Arctic-Alpine Environments**	
	Sissi Lozada-Gobilard	Introduction
Full - 41	Océane Bartholomée	Historical comparison reveals taxonomic and functional community turnover of an Arctic bumblebee community with shifting plant visitation patterns
Full - 42	Elise Dahl	Environmental gradients and season structure bumblebee communities in northern Norway (with focus on bilberry interactions)
Full - 43	Stein Joar Hegland	Flower visitors along an elevational gradient across nine years
Flash - 44	Lalaina Fenosa Ramillarisona	Plant-pollinator interactions of Gravesia across an elevational gradient in Marojejy National Park, Madagascar
Flash - 45	Jarad Mellard	Convergence or partitioning? Seasonal flower use by northern bumblebees
18:00-19:30	**Dinner**	
19:30-20:30	**Poster presentations**	
20:30	**Poster presentations with open bar**	



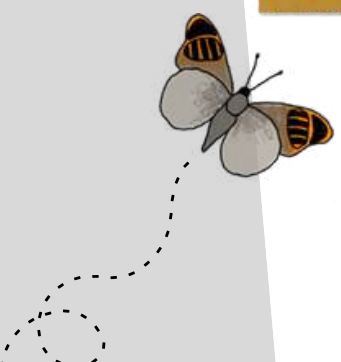


I Conference Program

Saturday

Morning

07:45-09:00	**Breakfast**	
09:00-10:10	**Keynote session 2: Amparo Lazaro**	
	Amparo Lazaro	Plant-pollinator interactions in anthropized landscapes
Full - 47	Johanna Yourstone	Assessing diet overlap and effects of honeybee competition on pollen diet and communities of threatened bumblebees
Full - 48	Pietro Maruyama	Integration of non-native plants on pollination networks across urban ecosystems
10:10-10:30	**Coffee break**	
10:30-12:00	**Symposium 6: Conservation of Pollinators and Pollination**	
	Océane Bartholomee, Ola Olsson	Introduction
Full - 49	Jennifer Rose	Landscape and floral drivers of wild bee reproduction in a montane ecosystem
Full - 50	Richard Walters	Traffic accidents: when do a few dead bees become a population problem?
Full - 51	Gabriella Süle	Effectiveness of pollinator-promoting interventions in European urban habitats
Full - 52	Jacqui James	Does habitat restoration restore plant-pollinator interactions?
Full - 53	Will Glenny	Pollinator and wild ungulate conservation on working lands
Full - 54	Bjørn Arild Hatteland	What do we know about negative effects of competition between honeybees and wild pollinators?
Flash - 55	Hjalte Calberg Ro-Poulsen	Image-based monitoring using deep learning to assess beekeeping impacts on heathland pollinators
Flash - 56	Mae Uniacke	Two hundred years of changes in orchid pollination revealed using herbarium specimens
Flash - 57	Nicholas Balfour	DoPI: The Database of Pollinator Interactions
Flash - 58	Marianne Torvanger	Functional traits modulate solitary bee species turnover along potential dispersal corridors in fragmented grasslands
12:00-13:00	**Lunch**	





Conference Program

Saturday

Afternoon and evening

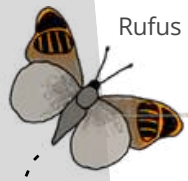
13:00-14:30	**Forest walk-and-talk**	
14:30-15:00	**Coffee break**	
15:00-16:40	**Symposium 7: Open Symposium**	
	Magne Friberg, Øystein Opedal	Introduction
Full - 59	Vinícius Brito	Buzzing insights: using sound to classify bees and understand buzz-pollination dynamics
Full - 60	Karin Gross	The more the smellier? Effects of polyploidization on floral scent
Full - 61	Wilhelm Osterman	Why should pollen limitation be rare or adaptive?
Full - 62	Javier Valverde	Pollen tube-pollen grain relationship as a tool for characterising pollinator effectiveness
Full - 63	Lucía Moreyra	Global patterns of thermogenesis and pollination in plants
Full - 64	Molly Moseley	Do pollinators trust floral repellent more than attracts?
Flash - 65	Gaya ten Kate	Same heat, different flowers: urban heat and flower richness are associated with species-specific changes in floral morphology and rewards
Flash - 66	Anna Wright (Carlos Martel)	Floral scents and temperature affect the behaviour and mortality of bumblebees under silver lime *(Tilia tomentosa*) trees
Flash - 67	Arne Devriese	Taking a step back from plant-pollinator-networks: the role of community structure, trait diversity and spatial heterogeneity
Flash - 68	Emily Baird	Heat impairs bumblebee pollination effectiveness and plant reproduction
Flash - 69	Natalia Timus	Focusing on pollinators: AI-automated vs. transect surveys in Transylvanian semi-natural grasslands
16:40-17:00	**Break**	
17:00-18:00	**Symposium 8: 40th Anniversary**	
	Øystein Opedal, Magne Friberg	Introduction
Full - 70	Maria Clara Castellanos, Carolin Mayer	Journal of Pollination Ecology news
Full - 71	Jon Ågren	Origin and history of the Scandinavian Association for Pollination Ecology (SCAPE): a personal perspective
Full - 72	Casper van der Kooi	Combined sexual and food plant mimicry in *Ophrys*
Full - 73	Øjan Totland	The importance of pollination ecology 35 years ago and now, and in the future
18:00-19:00	Sundowners	
19:00-20:30	Anniversary dinner	
20:30	**Party!**	





II List of Posters

First author	Code	Title
Symposium 1: Floral Function and Evolution		
Jonathan Heinze	S1_Heinze	Flower colour polymorphism along an elevational gradient is shaped by temperature and pollinator dynamics
Daniel Cogolludo	S1_Cogolludo	Floral longevity at the community level: a review of patterns
Kayna Agostini	S1_Agostini	How flower morphology influences pollen explosive release in two *Mucuna* species with different pollination systems?
Akash Gupta	S1_Gupta	Timing and ecological roles of rhythms in floral traits: Is the circadian clock involved?
Symposium 2: Ecology and Evolution of Co-Flowering Species Interactions		
Larissa De Paola	S2_DePaola	Colour and chemistry: how flowers signal reward-quality to pollinators
Marjan Kraaij	S2_Kraaij	Species-specific responses of pollen germination to temperature
Yuping Zhong	S2_Zhong	Towards Automated Plant–Pollinator Monitoring: Optimizing Plant Selection and Rapid Hoverfly Classification
Symposium 3: Floral Evolution Along the Specialization-Generalization Continuum		
Aarushi Susheel	S3_Susheel	Single-Visit Pollination by Functionally-Diverse Pollinators of *Viscaria vulgaris*
Symposium 4: Pollination in Agricultural Landscapes		
Stella Felsinger	S4_Felsinger	Prolonged heatwaves overpower behavioural compensation in greenhouse bumblebees
Anke Dietzsch	S4_Dietzsch	Tree-top heaven - flowering oaks as important food sources for bees
Charlotte Apsey	S4_Apsey	Optimising the pollination of *Vicia faba*
Liam Kendall	S4_Kendall	Seasonal dynamics of pollinator communities and pollination services in strawberries
Sara Rodrigues de Miranda	S4_Rodriguesde Miranda	Biodiversity, screening and risk assesment of field-dose pesticides in hoverflies (Syrphidae) of Hardanger, Norway
Antonio J. Perez-Sanchez	S4_PerezSanchez	Historical trends of bumblebees in Germany: a literature-based overview
Olivia Bernhardsson	S4_Bernhardsson	Pollinator community composition and pollen resource use in calcareous grasslands under different landscape contexts across Europe
Rufus Isaacs	S4_Isaacs	Pesticides on bumble bees across agricultural landscapes and placement of wildflower plantings in farms to reduce exposure

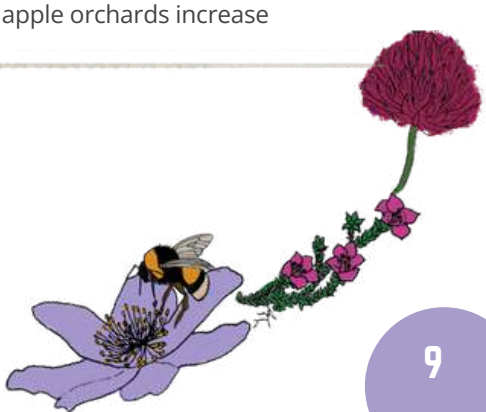




II List of Posters

First author	Code	Title
Symposium 5: Pollination in Arctic-Alpine Environments		
Olivia Boros-Fenyvesi	S5_BorosFenyvesi	Pollination in the Arctic: Effects of land-use change on bumblebee community composition and the reproductive success of ericaceous shrubs
Symposium 6: Conservation of Pollinators and Pollination		
Linnea Sartorius	S6_Sartorius	Satellite monitoring of pasture restoration
Lena Deck	S6_Deck	Developmental requirements for saprophagous hoverfly larvae (*Eristalis tenax*) in cow dung: application for future risk assessment
K. Tsiolis	S6_Tsiolis	How pollinator-friendly are central London and Edinburgh?
Olivia Gardella	S6_Gardella	Climate variability shapes the stability of butterfly communities and their pollination interactions
Stephanie Glendinning	S6_Glendinning	Multi-year manipulative field experiment reveals the impact of road-related urban stressors on plant-pollinator interactions
André Krahner	S6_Krahner	Monitoring bees diversity in agricultural landscapes: insights from four years of piloting
Laura Blas Lussu	S6_BlasLussu	Long-term climatic and landscape changes shape beta and functional diversity of butterfly communities
Andrada Opris	S6_Opris	Buzzing Around SUDS: Pollinators and Sustainable Urban Drainage Systems
Maria Clara Castellanos	S6_Castellanos	Grounding the Buzz: Experts' Insights into Soil-Dependent Pollinators
Carlos Martel	S6_Martel	Mother knows best: sex-biased pollen provisioning in *Osmia bicornis*
Silvia Rönnau	S6_Rönnau	A non-toxic fungicide potentiates a commonly used insecticide in adult hoverflies
Terence Al L. Abaquita	S6_Abaquita	Species-, sex-, and exposure-route-variation in hoverfly sensitivity to flupyradifurone highlights the need for non-bee pollinator research
Dominika I. Twaróg	S6_Twaróg	Species Sensitivity Distributions in Butterflies towards Flupyradifurone: Implications for Risk Assessment
Linn Vassvik	S6_Vassvik	Alternate floral resources within apple orchards increase apple flower visitation





II List of Posters

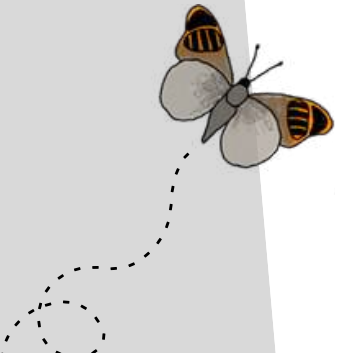
First author	Code	Title
Symposium 6: Conservation of Pollinators and Pollination (cont.)		
Vicari G.	S6_Vicari	Feasibility of Standardized Social Wasp (Vespidae) Monitoring: A Step Towards Inclusive Pollinator Monitoring Schemes
Virág Németh	S6_Németh	Native, diverse, sown wildflower patches enhance pollinators within a capital city of Eastern Europe
Sissi Lozada-Gobilard	S6_LozadaGobilard	Distinct Intra- and Interspecific Foraging Patterns of Stingless Bee Species as a Conservation Tool
Elżbieta Rożej-Pabijan	S6_RożejPabijan	Species diversity of mites inhabiting the nests of wild bumblebees (*Bombus spp.*)
Paolo Biella	S6_Biella	Strategies for pollinator habitat enhancement for biodiversity-friendly cities
Zofia Wrosz	S6_Wrosz	The Good, the Bad and the Flower Meadow: Do Conservation Measures Meet the Ecological Needs of Bumblebees?
D. Clake	S6_Clake	Genetic costs of grassland loss: linking historical and contemporary landscapes to genetic diversity in the small blue butterfly *Cupido minimus*
Christopher Wild	S6_Wild	Landscape genomic patterns reveal contrasting relationships with arable land and edge-rich landscapes across three insect species in an agriculture-dominated grassland mosaic
Hanna Melzén Forss	S6_MelzénForss	Climate-driven shifts in flowering phenology in orchid communities on the island of Öland
Symposium 7: Open Symposium		
Emma Falkeid Andrews	S7_Andrews	Structural polymorphisms, including a putative supergene, correlate with the geographic distribution of the solitary bee Andrena haemorrhoa in Northern Europe
Gavin Ballantyne	S7_Ballantyne	Railway brownfield sites as flower visitor habitat
Leidy Kelly Guimarães Cunha	S7_Guimarães Cunha	Floral soundscapes: vibrating bees alters the acoustic soundscape nearby buzz-pollinated flowers
Joseph Gillson	S7_Gillson	Tag glue attachment and effects on bumblebee longevity and colony development
Sewwandi Rasangika	S7_Rasangika	Beyond pollinators: Exclusion bags also shape the floral microbiome





II List of Posters

First author	Code	Title
Symposium 7: Open Symposium (cont.)		
Nerea Montes-Pérez	S7_Montes-Pérez	Pollinator response diversity and turnover buffer pollination networks from habitat loss in human-modified landscapes.
Carlos Martel	S7_Martel	Pollen and sterol content differentially affect solitary bee development
Nick Rosenberger	S7_Rosenberger	Assessing rapid assessment method effectiveness in capturing pollinator abundance and richness patterns across Europe
Epp Valdaru	S7_Valdaru	Different floral resource use across European agricultural landscapes: richer pollen loads in bumblebees and greater heterogeneity among solitary bees
Symposium 8: 40th Anniversary		
Natalia Davila	S8_Davila	Beyond the honeybee: Flupyradifurone toxicity in the hoverfly *Eristalis tenax* and the butterfly *Pieris napi*
Julia Witter	S8_Witter	The role of visual and olfactory cues in attracting the invasive bee *Megachile sculpturalis* to its main host plant in Europe



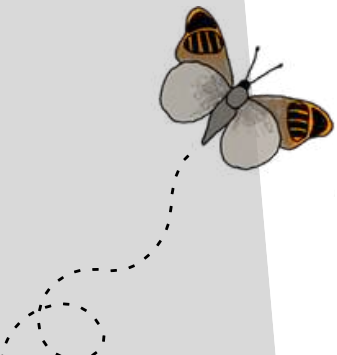


III Oral presentations ABSTRACTS

FULL LENGTH TALKS

FLASH TALKS

KEYNOTES





1 Where did my pollen go? How *Pleroma* 's visitors and anthers change across an elevational gradient

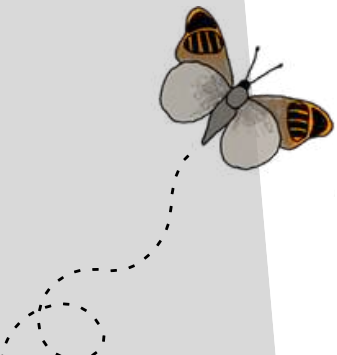
FULL LENGTH TALK

Juliane Nazari-Montazer[1], César Augusto Arvelos[1,2], Marcela Camila de Oliveira Arata[2], Carlos Andres Matallana-Puerto[2], Fabian Polz[1], João Pedro Santos Pereira[2], Vinícius Lourenço Garcia de Brito[2], Agnes Dellinger[1]

[1]University of Vienna, Austria
[2]Federal University of Uberlândia, Brazil

Abstract

Pollen extraction without pollen deposition can cause fitness loss. Especially in flowers where pollen fulfills the dual role of both attractant and reproductive agent, such as the flowers of the genus *Pleroma* (Melastomataceae), such pollen loss poses a threat to reproduction. *Pleroma* possess poricidal anthers, with a small apical opening, through which pollen can be extracted by sonication. Typical pollinators of *Pleroma* include large bees, such as *Xylocopa* or *Bombus*, that are able to perform buzz-pollination on these flowers. Most visitors of Pleroma however, are bees that do not fulfill the mutualistic interaction of pollination. These include robbers, which, in addition to not touching the stigma, will bite anthers to extract pollen, leaving the reproductive structures damaged. As this damage to anthers entails substantial pollen loss in addition to impairing the floral display, we hypothesized that anthers may contain repellent substances, keeping bees from biting. Microtome cuts of anthers revealed oils and calcium oxalate druses. Comparisons over an elevational gradient ranging from sea level to ~2400m in the Atlantic Rainforest (Brazil) revealed that visitor composition and repellents present in anthers of *Pleroma* differ across elevations. Lower numbers of robbers seem to coincide with the presence of both oils and druses.





2 Pollen release during buzz pollination depends on vibration amplitude and floral vibration transmission, but not on spectral composition

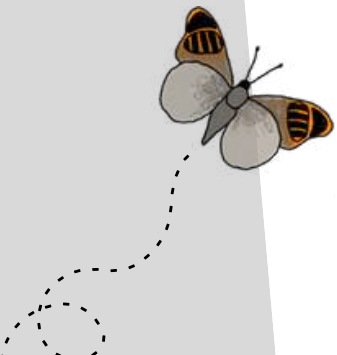
FULL LENGTH TALK

Mario Vallejo-Marin[1], Alexie Magitteri[1], Noah T. Jafferis[2]

[1]Evolutionary Biology Centre, Uppsala University
[2]University of Massachusetts, Lowe

Abstract

Buzz pollination occurs when bees apply vibrations to remove pollen from flowers, incidentally pollinating them. More than half of all bee species can buzz pollinate and 8-10% of flowering plants have morphologies associated with buzz pollination. The vibrations produced by bees on flowers (floral buzzes) can reach very high accelerations and are usually of a higher frequency than flight and communication buzzes. Different types of bees produce different types of vibrations. Previous work has shown that the type of vibration produced by a bee is important in determining its functional consequence: Higher accelerations are associated with more pollen released form the anther. However, how the frequency components (spectral properties) of a bee's buzz modulate pollen release is poorly understood. Bee buzzes are not pure tones with a single frequency or pitch. Instead, they are composed of a fundamental frequency and a rich set of harmonics, i.e., multiples of the fundamental frequency. Our study represents the first attempt to establish whether the presence of harmonic components in floral buzzes translates into differences in pollen release. We applied synthetically produced vibrations with different numbers of harmonics but identical mean accelerations (root mean squared) to buzz pollinated flowers and estimated pollen release. As a model system, we used flowers of *Solanum pyracanthos*, a buzz pollinated herb endemic to Madagascar. Our study provides an insight into how the mechanical properties of bee buzzes, including their spectral characteristics, translate to floral function.





3 Hybridization reshapes adaptive trajectories across different stages of plant hybrid zones

FULL LENGTH TALK

Modesto Berbel[1], Ana García-Muñoz[1,2], Andrés Ferreira-Rodriguez[1], José Carlos del Valle[2], Eduardo Narbona[3], Gonzalo Nieto Feliner[4], A. Jesús Muñoz-Pajares[1], **Mohamed Abdelaziz[1]**

[1]BioChange network, Departamento de Genética, Universidad de Granada. Granada, Spain.
[2]Departamento de Biología Vegetal y Ecología, Universidad de Sevilla. Sevilla, Spain.
[3] Departamento de Biología Molecular e Ingeniería Bioquímica, Universidad Pablo de Olavide. Sevilla, Spain.
[4] Departamento de Biodiversidad y Conservación, Real Jardín Botánico de Madrid-CSIC. Madrid, Spain.

Abstract

Hybrid zones provide natural laboratories for investigating how interactions between divergent genomes generate phenotypic variation and reshape evolutionary trajectories. However, the selective forces acting on hybrids may change as hybrid zones progress from early-generation hybrids to advanced-generation hybrids and backcrosses. Understanding this variation is critical for determining whether hybridization generates novel adaptive trajectories or reinforces those already present in parental populations. We investigated two natural hybrid zones between two Erysimum (Brassicaceae) species in Serra da Estrela, Portugal. We sampled 480 individuals from six populations along two transects, characterized 25 phenotypic traits, and genotyped individuals using more than 4,000 genome-wide SNPs. Plants were monitored throughout an entire reproductive season to quantify different components of fitness. Genomic analyses revealed two hybrid zones differing markedly in their composition, one enriched in F1 hybrids and another dominated by later-generation hybrids and backcrosses. Patterns of natural selection differed between parental and hybrid populations and, importantly, between hybrid zones. In parental populations, selection primarily acted on traits associated with plant size and reproductive investment. In the F1-enriched hybrid zone, hybrids experienced distinct selective pressures, revealing novel adaptive trajectories involving traits not under detectable selection in parental populations. Conversely, in the hybrid zone enriched in later-generation hybrids and backcrosses, patterns of selection resembled those observed in parental populations. Our results show that the evolutionary consequences of hybridization depend on the genomic composition of hybrid zones. Hybrid zones may therefore represent dynamic evolutionary systems in which selective landscapes change as hybridization proceeds.





4 Functional links between floral traits, pollination performance, and fitness in two heterostylous *Linum* species

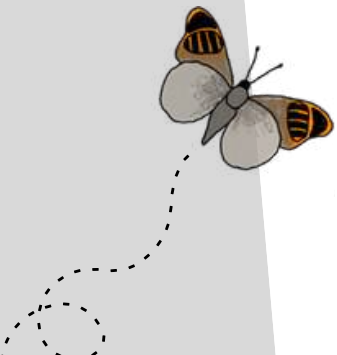
FULL LENGTH TALK

Macarena Marín-Rodulfo[1], W Scott Armbruster[2], Samira Ben-Menni Schuler[1] Øystein H. Opedal[3] & Rocío Pérez-Barrales[1]

[1]University of Granada
[2]University of Portsmouth, UK & University of Alaska Fairbanks
[3]Lund University, Sweden

Abstract

Phenotypic selection on floral traits can vary due to differences in the ecological context experienced by plant populations, as these traits are closely linked to pollination success. Heterostyly is a floral polymorphism characterized by reciprocal positioning of sexual organs (long-styled P and short-styled T morphs), which promotes reciprocal pollination through differential pollen placement on pollinators. This reciprocal arrangement provides an interesting system to study how trait– performance–fitness relationships vary across populations. Here, we investigated the relationship between floral traits, pollen deposition, and female fitness in two heterostylous mediterranean species, *Linum narbonense* and *L. suffruticosum*, across four sympatric populations and one allopatric population for *L. suffruticosum* in the SE of Spain. We measured floral traits (advertisement: petal width, calyx width; fit: gap, style, stamen, stigma, filament, anther and herkogamy), pollen loads (deposited pollen, germinated pollen and developed pollen tubes), and fitness components (fruit set and seed production). Using path analysis, we aim to quantify how much attraction and fit traits differentially affect pollination success and seed production depending on morph, species, and pollinator community (populations). Our results contribute to understanding how spatial variation in pollinator communities shapes floral evolution through phenotypic selection in heterostylous systems.





5 Meta-analyses of nectar differences in response to experimental manipulation of abiotic and biotic environments

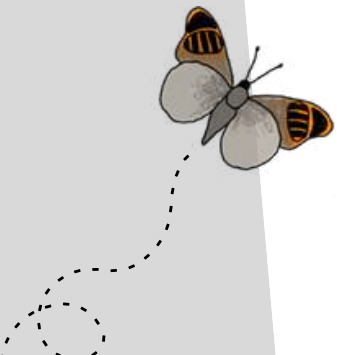
FULL LENGTH TALK

Amy Parachnowitsch[1], Maria Cala Castellanos, Lucy Unwin, Stefan Verch, Valentina Mendoza Perez

[1]University of New Brunswick

Abstract

Nectar is known to be variable due to local conditions such as water availability, temperature, humidity, etc. Nectar production can also be sensitive to plant condition such as damage by herbivory, nutrient availability, etc. However, the effects of these different drivers of nectar variation are scattered throughout many different papers, making comparisons challenging. Here we compile available data on the effects of experimental treatments on nectar to help determine general patterns of how sensitive nectar is to changing conditions and which have the stronger effects. We found that nectar responses to experimental treatments are common but often variable across, and even within studies, meaning it is difficult to generalise expected effects on nectar from any particular environmental variable. Interestingly, our preliminary meta-analyses do not support the hypothesis that nectar volume is more sensitive to changing conditions than nectar sugar concentrations despite pollinators generally being better able to distinguish between nectar sugar differences (and other additives) than nectar amounts. The results add to our understanding of the complexity of nectar variation and be discussed in terms of its implications for both the ecology and evolution of nectar.





6 Flower colour polymorphism in *Anemone coronaria* - molecular drivers and ecological consequences

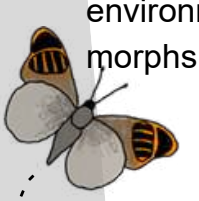
FULL LENGTH TALK

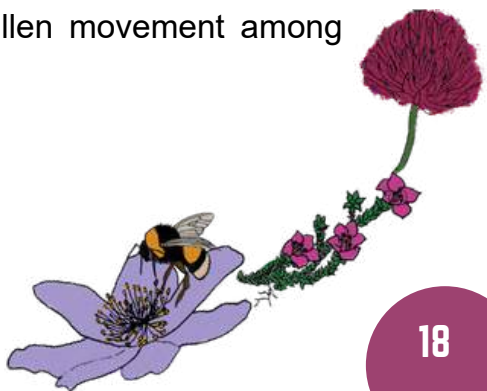
Tzlil Labin[1,2], Nirit Lavi Alon[3], Tamar Keasar[4], **Yuval Sapir[2]**

[1]The Department of Evolutionary and Environmental Biology, Haifa University, Israel.
[2]School of Plant Sciences and Food Security, Faculty of Life Sciences, Tel Aviv University, Israel.
[3]Israel Center for Citizen Science, Steinhardt Museum of Natural History, Tel Aviv University, and the Society for Protection the Nature in Israel.
[4]Department of Biology and Environment, University of Haifa at Oranim, Israel

Abstract

Within-population flower colour polymorphism (FCP) provides an opportunity to study the ecological and evolutionary processes that generate and maintain phenotypic variation in natural populations. In *Anemone coronaria*, southern populations are uniformly red, whereas many Mediterranean populations are polymorphic and contain red, white, and purple flowers. At the molecular level, flower colour variation is driven by differential expression of anthocyanin biosynthesis pathway genes and their R2R3-MYB regulators, resulting in shifts among anthocyanin pigments and distinct flower colours. Using citizen science observations, we mapped the distribution of monomorphic and polymorphic populations across Israel. Non-red flowers were absent from regions receiving less than 450 mm mean annual rainfall, and occurred only in soils with higher water-holding capacity and lower calcium carbonate content, indicating strong environmental constraints on colour variation. We also found that flowering phenology differed among colour morphs, with red flowers generally blooming later than non-red flowers. These phenological differences were closely synchronized with pollinator activity. Early-season bees and hoverflies preferentially visited white and purple flowers, whereas later-emerging glaphyrid beetles showed a strong preference for red flowers. Despite this temporal partitioning, overlap in flowering periods and evidence of pollen flow among colour morphs suggest that pollinator-mediated selection is balanced by continued gene flow. Together, our results indicate that flower colour variation in *A. coronaria* is shaped by the combined effects of genetic regulation, environmental conditions, pollinator preferences, and pollen movement among morphs.





7 Low resilience of floral and nectar traits under acute heat stress

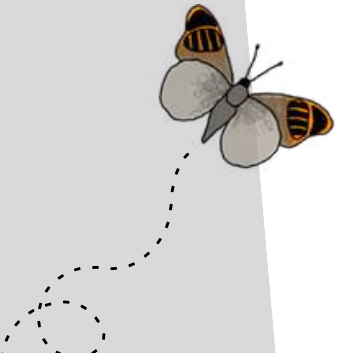
FLASH TALK

Alba Edwards, Lucy A. Unwin, **Maria Clara Castellanos**

Department of Ecology & Evolution, School of Life Sciences, University of Sussex, UK

Abstract

Climate change is driving more intense and prolonged heatwaves, disrupting plant physiological function and reproductive development. Thermal stress can alter floral nectar, influencing pollinator attraction. Heat-associated reproductive losses could have consequences for wild and crop plants, vital for maintaining ecological stability and ensuring food security. We investigated the impacts of experimental heatwaves on floral and nectar traits using Phaseolus vulgaris as a model, moving beyond existing studies by quantifying the time these traits require to rebound to recovery. Exposure to an extreme 2-day heatwave (daytime 33°C) caused dramatic 62% reductions in floral output through abortions, alongside substantial decreases in flower size, nectar volume and sugar concentration. More crucially, nectar volumes in new flowers produced by exposed plants took 8 days to return to baseline volumes, and sugar concentrations remained below baseline 10 days after heatwave exposure. These findings highlight how even short-lived heat events can have negative, prolonged effects on floral rewards. Delayed and incomplete nectar recovery may create temporal resource scarcity for pollinators, with consequences for the whole community. For short-lived species, 10+ days of disrupted pollination may substantially impede critical reproductive windows, and even more so if successive heatwaves deprive plants of time to recover.





8 The reproductive role of floral morphs in a distylous hummingbird- pollinated plant

FLASH TALK

Julia S. Andersson[1], Paulo E. Oliveira[1], Vinícius L. G. Brito[1] and Renata Trevizan[2]

[1]Universidade Federal de Uberlândia
2Universidade Federal de Minas Gerais

Abstract

In distylous plants, floral morphs may differ in their contribution to male and female reproductive functions. This study investigated the reproductive function of the floral morphs of *Psychotria poeppigiana* (Rubiaceae), a hummingbird-pollinated species with brightly red bracts that act as honest signals to pollinators, with larger bracts having greater nectar availability but higher mortality, while smaller bracts produce more fruits. We compared morphological traits between L- and S-styled morphs, including bract size, flower length, flower diameter, and number of flowers per bract. We evaluated morphological trait differences between L- and S-styled morphs, including bract size and floral traits (length, diameter, and number of flowers per bract) and bract mortality. We also evaluated the effect of bract size on male and female pollination performance by analyzing pollen removal and pollen deposition on stigmas and assessing female reproductive success through fruit set and seed viability. S-styled individuals had larger bracts and longer flowers than L-styled individuals. However, pollen removal and pollen deposition were not influenced by bract size or floral morph. Bract size was negatively related to fruit set and fruit volume and positively related to bract mortality, whereas seed traits were not influenced by bract size or morph. Despite morphological differences, no evidence of functional differentiation in male or female reproductive function was found. These results suggest a trade-off regarding the bract size. Larger bracts may demand resource costs that limits their reproductive success without increasing pollination performance, and smaller bracts may allow more efficient resource allocation to fruit production.





9 Tips are appreciated: how clever buzz-pollinated stamen morphologies before the pore modulate pollen placement

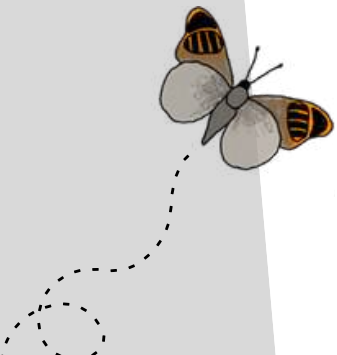
FLASH TALK

Benjamin Lazarus

University of Vienna, Austria

Abstract

Pollen rewarding flowers face an existential dilemma. Their gametes serve as food for their pollinators. However, many buzz-pollinated flowers use this to their advantage and exploit their pollinator's rapacious pursuit of pollen. In particular, many clades have evolved clever morphologies that capitalize on bee behavior to inconspicuously sneak pollen onto hard-to-reach regions of their bodies for transport to a conspecific individual. In this talk, I will present new perspectives on two floral traits, anther wall corrugation and stamen fusion, which were commonly thought to improve fitness via pollen dosing, but may actually be key contributors to how some flowers keep a portion of their pollen out of bee corbicula. Furthermore, I will examine how these floral features work in concert with a suite of other floral traits such as anther curvature, pore shape, rostrum structure, style shape, and enantiostyly to suggest that stamen function in buzz-pollinated flowers likely plays an outsized role in shaping floral structure.





10 Floral trait evolution in generalist daisies

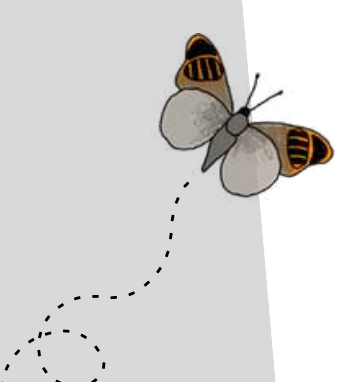
KEYNOTE

Allan Ellis

Stellenbosch University, South Africa

Abstract

Pollinator driven speciation is not considered an important axis of Asteraceae diversification. Instead, the capitulum, the most striking feature of the family, is usually interpreted as an adaptation for generalist pollination. Despite this, daisies exhibit a wide diversity of floral traits that could function to attract or filter specific groups of visitors. In this talk I explore pollination generalism and colour pattern evolution in annual mass flowering daisies in South Africa. I will show that this assemblage of South African daisies features a globally unique set of floral signals associated with exploitation of an unusual set of pollinators. While bees are the most frequent visitors to daisies globally, they are largely absent in this daisy assemblage. Instead the striking diversity of colour pattern in these species arises in response to geographically variable selection imposed by a subset of the visitor community, primarily tabanid and bombyliid flies. The most unusual floral signals are associated with flies that exploit flowers as the primary arena for mating, and function in manipulating mate-searching male flies for pollination. Thus against expectation, floral evolution in this assemblage of daisies is driven by relatively specialised interactions set within the context pollination generalism.





11 Scent or sight? The adaptive significance of scent and visual signals in floral food mimicry

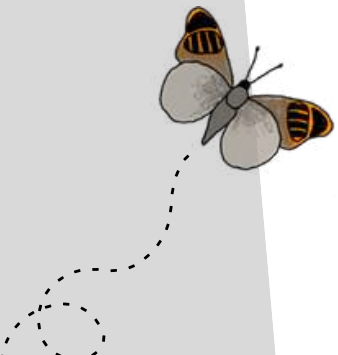
FULL LENGTH TALK

Daniela Scaccabarozzi[1],[2], Gavin Flematti[2], **Nina Sletvold[1]**

[1] Department of Ecology and Genetics, Uppsala University, 75236 Uppsala, Sweden
[2] School of Molecular Sciences, University of Western Australia, Perth, Western Australia

Abstract

Pollinator-mediated selection for trait combinations is expected to be important in floral evolution, and particularly so in deceptive species that gain fitness by resembling a model. Visual signals should have major impact, but how they interact and depend on other traits remain unknown. To test whether trait adaptive value is contextual, we used factorial manipulations of trait combinations in two species of deceptive sun orchids (*Thelymitra*) that mimic buzz-pollinated plants. In the scented *T. macrophylla*, we removed tepal UV reflectance and increased scent. In the non-scented *T. crinita*, we removed two visual signals (tepal UV reflectance and false anther visibility). In *T. macrophylla*, scent addition markedly increased reproductive success, whereas effects of UV reflectance were weak, and not statistically significant. In *T. crinita*, removal of either visual signal strongly reduced reproductive success, and combined effects were nonadditive, indicating that both traits are critical for model resemblance. The difference between the two orchids in importance of tepal reflectance and trait integration demonstrates that precise visual model resemblance is not always necessary in food deceptive species. The results also show that scent can constitute an important component of food mimicry, similar to its key role in sexual mimicry.





12 Unravelling the genetic underpinnings of floral scent variation in Lithophragma hybrids

FULL LENGTH TALK

Aurélien Caries[1], Mia Taylor Waters[2], John N Thompson[2], Magne Friberg[1]

[1]Department of Biology, Lund University
[2]Department of Ecology and Evolutionary Biology, University of California, Santa Cruz.

Abstract

Floral traits play a central role in mediating plant-pollinator interactions and are shaped by selection imposed by these interactions. Both the strength and the outcome of these interactions can vary geographically, and natural selection on floral traits may thus generate a geographic selection mosaic that contributes to floral trait diversification. One such trait, involved in many plant-insect interactions is floral scent, which may vary widely in composition and abundance across populations and species. This multivariate, complex trait may directly affect local adaptation and reproductive isolation, yet only few studies have investigated the quantitative-genetic underpinnings of floral scent. Here, we ask how hybridization among chemically variable plant populations may alter the scent bouquets and to what extent it ultimately disrupts the signals used by pollinators. We use two *Lithophragma* (Saxifragaceae) species (*L. affine* and *L. parviflorum*) grown in a common garden, and assess how the composition of the floral scent bouquet changes across parental-, F1-, F2- and backcross-generations. Thereby, we test whether the overall floral scent variation, as well as the individual compounds that make up these scent bouquets, follow a pattern of dominance, of additive genetic variation or even show evidence of transgressive segregation, with hybrids emitting novel compounds or combination of compounds to the parental taxa. Such an understanding of the genetic architecture behind the ecologically important and structurally complex floral scent trait will guide future studies on how these signals may respond to pollinator mediated selection and diversification.





13 Pollinarium reconfiguration responds to humidity, but it can be controlled in the inflated trap flowers of *Ceropegia* (Apocynaceae)

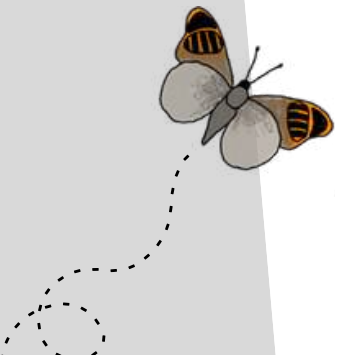
FLASH TALK

James Tucker, Philip C. Stevenson & **Carlos Martel**

Royal Botanic Gardens, Kew, Kew Green, Richmond, Surrey, TW9 3AE, United Kingdom

Abstract

Over 150 years ago, Charles Darwin observed that orchid pollinaria undergo reconfiguration after removal, which facilitates the pollinia to engage with the stigma of the flower. By rinsing pollinaria in water, he asserted that hygrometric movements caused pollinarium reconfiguration in orchids. However, whether environmental humidity affects pollinarium reconfiguration has not been tested to date. The genus *Ceropegia* (Apocynaceae) possesses intricate trap flowers and, similar to orchids, has also evolved pollinaria. Our study aimed to test the effect of environmental relative humidity on the pollinarium reconfiguration process in *Ceropegia* species. We assessed the relative humidity inside the trap flowers and at the corolla opening in eight *Ceropegia* species. We then experimentally tested pollinarium reconfiguration (as changes in angular degrees) over time under different humidity conditions (4-13%, 42-62%, 75-85%, 95-99.9%). The relative humidity inside the trap flowers ranged between 96% and 100% in all *Ceropegia*, significantly higher than that at the corolla opening and in the environment. We demonstrated that pollinarium reconfiguration was affected by relative humidity, but also by time and species identity. All *Ceropegia* species studied exhibited pollinarium reconfiguration except when the relative humidity of the environment was approaching saturation (95-99.9%). Pollinarium reconfiguration in Ceropegia occurs in response to humidity changes, but it is controlled by keeping a high relative humidity within their trap flowers, which might be critical to avoid self-pollination in self-compatible species.





14 From pollen placement to pollen tubes: differences in floral function in two distylous *Linum* species

FLASH TALK

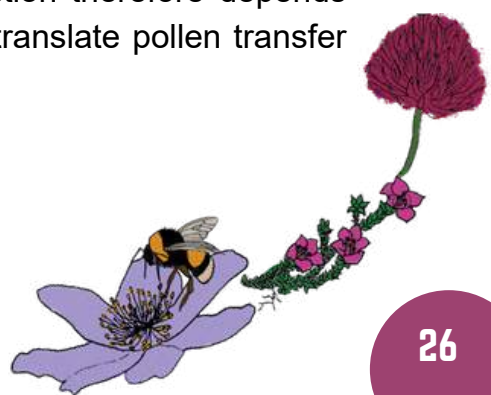
Rocío Pérez-Barrales[1], Joana Retamero-Argemí[1], W. Scott Armbruster[1,2,3]

[1]Botany Department, University of Granada, Spain
[2]School of Biological Sciences, University of Portsmouth, Portsmouth PO1 2DY, UK
[3]Institute of Arctic Biology, University of Alaska, Fairbanks, AK 99775 USA

Abstract

Reciprocal placement of anthers and stigmas in distylous flowers promotes pollen transfer between morphs, but pollen arrival may not predict subsequent pollen performance. Here we tested if disassortative pollination advantages persist through post-pollination stages in two Linum species. We conducted a field experiment under natural pollination conditions with *L. narbonense*, characterised by one-dimensional reciprocity and a comparatively generalised pollination system, and *L. suffruticosum*, with three-dimensional reciprocity and predominantly Usia bee-fly pollination. Virgin recipient flowers were exposed for 24 h in single-morph donor patches, creating either intermorph or intramorph plots (virgin flower of opposite or same morph, respectively). We quantified conspecific and heterospecific pollen deposition, pollen-tube number and formation probability. Heterospecific pollen receipt was greater in *L. narbonense*, consistent with its broader pollinator assemblage. Both species showed approximately twofold intermorph advantages in conspecific pollen deposition. However, post-pollination responses differed. In *L. narbonense*, the intermorph advantage weakened, whereas in *L. suffruticosum*, pollen performance of intermorph plots became substantially stronger. Between-species contrasts showed that the intermorph advantage was nearly threefold stronger in *L. suffruticosum* for both pollen-tube number and formation probability. These results show that similar patterns of disassortative pollination can have different post-pollination consequences. The stronger persistence of the intermorph advantage in *L. suffruticosum* is consistent with more precise pollen placement facilitated by a specialised floral architecture. Floral function therefore depends on how pollinator interactions and post-pollination filters translate pollen transfer into subsequent reproductive performance.





15 Pollination ecosystem services and Cerrado savanna conservation

FULL LENGTH TALK

Paulo E. Oliveira[5,6], Renata Trevizan[1], Pietro K. Maruyama[1,6], Ana P. S. Caetano[2], Rogério V. Gonçalves[3], Yasmine Antonini[4]; João C. F. Cardoso[5]

[1]Pós-Graduação em Ecologia, Conservação e Manejo da Vida Silvestre, UFMG, Belo Horizonte-MG. Brazil.
[2]Instituto de Biociências, Universidade Federal de Mato Grosso, Cuiabá, Mato Grosso. Brazil.
[3]School of Science, Environmental Futures Research Centre, University of Wollongong, New South Wales, Australia.
[4]Departamento de Biodiversidade, Evolução e Meio Ambiente, Universidade Federal de Ouro Preto, Brazil.
[5]Instituto de Biologia, Universidade Federal de Uberlândia, Brazil.
[6]Centro de Biodiversidade e Mudanças do Clima-CBioClima-FAPESP. UNESP-Rio Claro

Abstract

The Brazilian Cerrado is a biodiversity hotspot savanna ecosystem, characterized by a mosaic of interconnected plant formations. Seasonality and natural fires are key and ancient natural drivers, with organisms specifically adapted. The Cerrado is also home to an increasing human population and the main agricultural frontier in Brazil. However, it has undergone intense destruction, historically overshadowed by the neighboring tropical forest biomes. Information on pollination and plant reproduction will be vital for Cerrado conservation and may be useful for other megadiverse ecosystems worldwide. Although apomixis and self-pollination mechanisms do occur, most Cerrado plants are allogamous and animal-pollinated, especially in denser woodlands. Plant–pollinator interaction networks are mostly generalist guilds, mostly bees but also including beetles, moths, hummingbirds, and bats. Flowering phenology peaks at different times across plant formations, leading to habitat complementarity that continuously sustains transiting pollinators. Thus, landscape complexity and complementarity are essential for ecosystem conservation. In this context, periodic natural fires and frosts trigger flowering and maintain open landscape diversity. Plant-pollinator interdependence will depend on complementary habitats at the landscape scale. While forest and palm swamp formations are granted legal protection, these are insufficient to maintain pollinator diversity and ecosystem services and will require policies to protect neglected grasslands and savanna plant formations. Such conservation policies will be crucial for the future of the region.





16 Co-flowering species interactions influence selection on floral traits

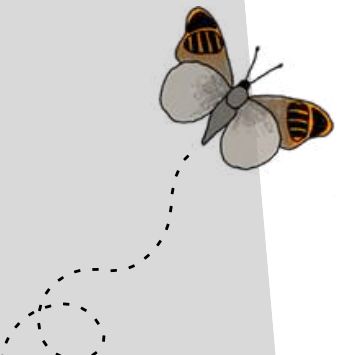
FULL LENGTH TALK

Yedra García[1], Magne Friberg[1], Giovanni Pascucci[2], Sofía Moreno de la Cuesta[1], Øystein H. Opedal[1]

[1]Department of Biology, Lund University, Sweden.
[2]Department of Life, Health and Environmental Sciences, University of L'Aquila, Italy.

Abstract

Understanding the biotic and abiotic forces driving variation in natural selection on floral traits is necessary to further understand floral evolution, yet selection is often studied without considering the surrounding floral ecological context of pollination interactions. Interactions among co-flowering species for shared pollinators are among the most widespread biotic interactions in natural communities and represent an important component of this context. Such interactions may modify the selective pressures experienced by plants, potentially generating context-dependent selection. Here, we used hierarchical models within the Hierarchical Modelling of Species Communities (HMSC) framework to investigate phenotypic selection on three co-flowering orchid species and quantify how biotic and abiotic factors contribute to variation in patterns of selection. We focused on three bumblebee-pollinated orchid species on Öland, Sweden, which commonly co-occur intermixed in floral communities. Across three consecutive years, we recorded pollination-related floral traits, floral abundance, and reproductive success across spatially replicated patches differing in species composition. We additionally characterized the immediate co-flowering community of animal-pollinated species surrounding each orchid individual and quantified abiotic microenvironmental variation. This allowed us to assess whether selection on floral traits varied with environmental conditions and the composition of the surrounding community. We found evidence that co-flowering species can influence selection on one another, with interspecific effects detected for some species and traits, indicating that selective regimes may depend on local co-flowering community context. More broadly, our findings demonstrate the importance of considering multispecies communities and environmental heterogeneity when investigating the processes shaping floral phenotypic evolution.





17 Architecture of stability: fifteen years of pollinator-sharing networks reveal a stable core amidst a highly dynamic network as driver of system resilience

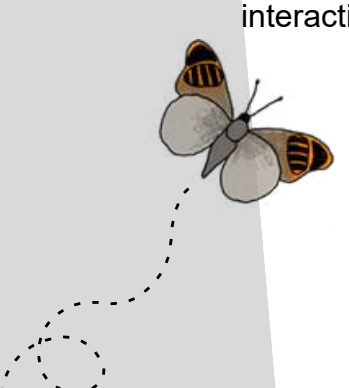
FULL LENGTH TALK

Jakub Štenc[1,2,3], Sailee P. Sakhalkar[4], Jiří Hadrava[2], Michael Mikát[2], Eva Matoušková[1], Helena Pijálková[2], Tadeáš Ryšan[2,5], Petr Švanda[1,2], Eva Horčičková[6], Zdeněk Janovský[7], Jakub Straka[2], Jordi Bosch[3]

[1]Department of Botany, Faculty of Science, Charles University, Benátská 2, 128 41 Prague, Czech Republic.
[2]Department of Zoology, Faculty of Science, Charles University, Viničná 7, 128 41 Prague, Czech Republic.
[3]CREAF – Centre de Recerca Ecològica i Aplicacions Forestals, 08193 Bellaterra, Barcelona, Spain.
[4]Institute of Microbiology of the Czech Academy of Sciences, Videnska 1083, 142 00 Prague, Czech Republic.
[5]Institute of Entomology, Biology Centre of Czech Academy of Sciences, Branišovská 1160/31, 370 05 České Budějovice, Czech Republic.
[6]Department of Environment, Faculty of Environment, Jan Evangelista Purkyně University in Ústí nad Labem, Pasteurova 3632/15, 400 96 Ústí nad Labem, Czech Republic.
[7]Svatý Jan t. Krsovice 1, 285 04 Uhlířské Janovice, Czech Republic.

Abstract

Extreme climatic perturbations increasingly threaten the stability of mutualistic interaction networks, yet many persist through severe environmental fluctuations. Here, we analyze a continuous 15-year plant-pollinator network to uncover the structural basis of ecological resilience. We show that despite high abundance-driven interaction turnover, the underlying stable architecture is supported by a guild of “core” plant species. We reveal that these core species act as an ecological buffer during the extreme drought events. While peripheral species show high interannual fluctuations in their abundance and network roles, core species remain relatively stable over the study period. Iterated extinction simulations demonstrate that while the network easily survives peripheral loss, its survival during extreme droughts becomes exclusively dependent on the core species. Thus, while peripheral species drive annual structural plasticity, the core species maintain overarching systemic stability. Our findings provide empirical evidence that the resilience of highly connected mutualistic networks relies not on general plasticity, but on the persistent structural roles of a few critical species. These results lead to a crucial question: Can the targeted protection of the core species be the key to protection of the whole interaction network against environmental perturbations?





18 Seasonal variation mediates the importance of species attributes in plant- pollinator interactions

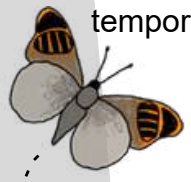
FULL LENGTH TALK

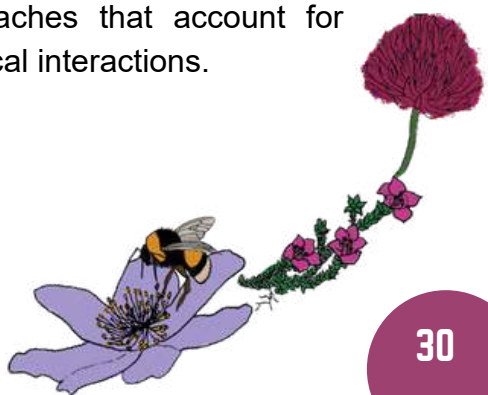
José B. Lanuza[1,2], Alfonso Allen-Perkins[3], Will Glenny[1], Anna Traveset[2], Henriette F. Morgenroth[1], Raymond Umazekabiri[1], Marc Hoffmann[1], Panagiotis Theodorou[1,4], Robert J. Paxton[1,4], Isabell Hensen[1,5], Robert Rauschkolb[1,6,7], Christine Römermann[1,6,7], Oliver Schweiger[1,8], and Tiffany Knight[1]

[1]German Centre for Integrative Biodiversity Research (iDiv) Halle–Jena–Leipzig, Puschstr. 4, 04103 Leipzig, Germany.
[2]Mediterranean Institute for Advanced Studies (IMEDEA, UIB-CSIC), Mallorca, Balearic Islands, Spain.
[3]Departamento de Ingeniería Eléctrica, Electrónica, Automática y Física Aplicada, ETSIDI, Universidad Politécnica de Madrid, Madrid, Spain.
[4]Institute for Biology; General Zoology, Martin Luther University Halle-Wittenberg, Halle (Saale), Germany.
[5]Institute of Biology/Geobotany and Botanical Garden, Martin Luther University Halle-Wittenberg, Halle (Saale), Germany.
[6]Institute of Biodiversity, Ecology and Evolution, Friedrich Schiller University Jena, Germany.
[7]Senckenberg Institute for Plant Form and Function (SIP), Jena, Germany.
[8]UFZ – Helmholtz Centre for Environmental Research, Department of Community Ecology, Halle, Germany.

Abstract

Predicting species interactions remains a major challenge, as multiple species attributes operate simultaneously and their relative importance may vary seasonally and with temporal resolution. Here, we assess how the relative contributions of abundance, trait matching, and phenology to plant-pollinator interactions vary through a flowering season and across temporal resolutions using interaction data from three European botanical gardens. We show that predictive models explain a substantial proportion of variation in visitation patterns, with floral and pollinator abundances consistently explaining most variation across the flowering season. Trait matching between pollinator body size and floral size also contributes to visitation patterns, playing a secondary but persistent role in shaping interactions, while phenology plays a relatively minor role at broader temporal resolutions but becomes more important at finer temporal scales. Additionally, null models accounting for spatio-temporal variation in floral and pollinator abundance reveal consistent patterns of pollinator preference and avoidance, indicating that abundance alone cannot explain the observed interaction patterns. Our results show that seasonal variation and temporal resolution differentially shape the importance of species attributes, highlighting the need for multi-variable approaches that account for temporal dynamics to accurately explain and predict ecological interactions.





19 Exploring bee buzzing behavior across gradients of flower morphology, pollen availability and temperature in the wild

FULL LENGTH TALK

Agnes S. Dellinger, Imran Sadovic, Viktoria C. Wieser, Ash Kerber, Benjamin Lazarus

University of Vienna, Austria; University of Melbourne, Australia; University of Colorado Denver, USA.

Abstract

How bees vibrate (buzz) flowers to extract pollen may be determined by intrinsic (e.g. body size) and extrinsic factors (e.g. high temperatures increasing buzzing frequency, low pollen availability reducing buzzing duration). To date, however, few studies have explored how these intrinsic and extrinsic factors link together under natural conditions to determine buzzing properties and pollination performance of bees in the wild. In my contribution, I will present new data on the buzzing behavior of bees visiting morphologically distinct flowers of co-flowering Melastomataceae, and test whether bees commonly vary their buzzing behavior across flowers of different sizes and stamen configurations, temperature and pollen availability gradients, and how buzz properties and bee size affect pollination performance. I will show that buzzing properties can vary more between flowers of the same species than among species, with cyclical variation in buzz number across repeated flower visits. This cyclical variation suggests that bees may flexibly vary the number of buzzes in response to changeable pollen availability. I will further explore how high ambient temperatures may constrain the foraging activity and buzzing in bees and discuss how pollination performance is not only determined by size-matching between flowers and bees but largely also by stamen configuration. Lastly, I will give an outlook on how buzz-bee-flower interactions may vary across major ecogeographic gradients and shape interaction patterns in co-flowering communities.





20 Is acceleration enough? Mechanical variation in pollen release from buzz- pollinated flowers

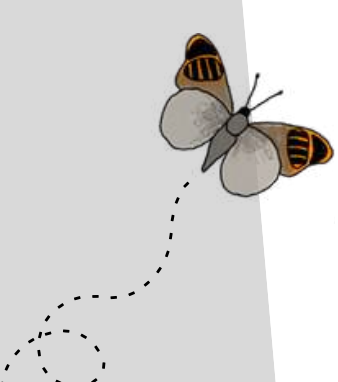
FULL LENGTH TALK

César Augusto Arvelos[1,2], Leidy Kelly Guimarães Cunha[1], Marcela Andressa Sponchiado[1], Fabian Polz[2], Juliane Nazari-Montazer[2], Philipp Weber[2], Emilio José Buenaño-Mancheno[3], Benjamin Lazarus[2], Vinicius Lourenço Garcia de Brito[1], Agnes Dellinger[2]

[1]Universidade Federal de Uberlândia.
[2]Universität Wien.
[3]Universidad Central del Ecuador

Abstract

Buzz pollinated flowers depends on vibrations to release pollen from poricidal anthers. Although different vibration properties have been investigated, acceleration consistently emerges as an important predictor of pollen release. Yet acceleration itself results from the combination of vibration frequency and displacement [A= (2πf)2D], two components whose effects have varied among previous studies. We therefore asked whether pollen release is fully described by acceleration or whether different frequency–displacement combinations producing similar accelerations generate different responses. We applied controlled sinusoidal vibrations spanning 150–350 Hz and a broad range of accelerations (~100-1000 m/s²) to flowers of multiple buzz-pollinated species from Brazil and Ecuador. Pollen release was standardized within morphotype × stamen type. We first quantified its relationship with acceleration and then reconstructed each vibration in frequency–displacement space. Predicted pollen-release contours were compared with the mechanical expectation for iso-acceleration. Pollen release consistently increased with acceleration across species. However, the mechanical basis of this response was not uniform. In some flowers, pollen release closely followed the pattern expected from acceleration alone, whereas in others the response was relatively more associated with either displacement or frequency. These results show that acceleration provides a general predictor of pollen release while masking substantial interspecific variation in how vibration components contribute to this response. Understanding the biological basis of this variation may help explain contrasting effects of vibration parameters reported across buzz-pollination studies.





21 Shift from bee to vertebrate pollination in the genus Medinilla along an elevational gradient in Marojejy National Park, Madagascar: first evidence from african Melatomataceae

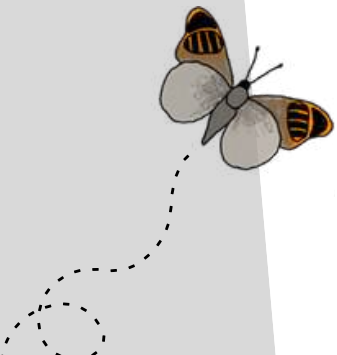
FLASH TALK

Richard D. Randriatsitohaina[1], Lalaina F. Ramiliarisona[1], Andrea Errante[2], Gregor Traum[2], Mijoro Rakotoarinivo[1], Agnes Dellinger[2]

[1]University of Antananarivo, Madagascar
[2]University of Vienna

Abstract

The Melastomataceae are among the tropical plant families most closely associated with bee pollination, with nearly 95% of the species relying on bees as their primary pollinators. Although this specialization is considered a defining characteristic of the family, the genus *Medinilla* exhibits remarkable floral morphological diversity, suggesting diversification in its pollination systems. Natural history information remains scarce, however, with no data available for Malagasy species, where 19% of the genus's diversity is found. With its distribution ranging from lowland to montane forests, we here tested whether pollination systems change as environmental conditions become increasingly harsher at high elevations. We characterized the pollination systems of eleven *Medinilla* species along an elevational gradient in Marojejy National Park, northeastern Madagascar. We conducted daytime and nighttime observations using camera recorder and camera traps and compared the composition and behavior of floral visitors. We found a clear elevational shift in the composition of floral visitors. At lower elevations, bees and wasps were the predominant visitors to *Medinilla* flowers. In contrast, several abundant high-elevation species with campanulate flowers were visited primarily by vertebrates, including nectar-feeding birds, small lemurs, and rodents, whereas insect visits became rare. These findings indicate a transition from bee pollination to vertebrate pollination in campanulate-flowered *Medinilla* species inhabiting montane environments and represents the first evidence from Africa of a shift from bee to vertebrate pollination within the Melastomataceae.





22 Pollinator identity shapes offspring quality and lifetime fitness in *Clarkia*

FULL LENGTH TALK

Kathleen M. Kay[1], Zoe Diaz-Martin[2,3,4], Shelley A. Sianta[1,5], Anita Cisternas Fuentes[2,3,6], Jeremie B. Fant[2,3]

[1]Department of Ecology and Evolutionary Biology, University of California, Santa Cruz, CA 95060, USA
[2]Negaunee Institute for Plant Conservation Science and Action, Chicago Botanic Garden, Glencoe, Illinois
[3]Plant Biology and Conservation, Northwestern University, 2205 Tech Drive, Evanston, Illinois, 60208, USA
[4]Current address: Biology, Spelman College, 350 Spelman Lane S.W., Atlanta, GA 30314-4399, USA
[5]Current address: Department of Integrative Biology, University of Texas at Austin, Austin, TX 78712, USA
[6]Current address: Facultad de Medicina Veterinaria y Agronomía, Universidad de Las Américas, Campus Providencia, Santiago, Chile

Abstract

Traditional assessments of pollinator-driven selection focus on visitation frequency, pollen deposition, or seed set as fitness metrics, often neglecting how different pollinators impact the genetic quality of the resulting seeds. We evaluated how distinct pollinator functional groups shape both the quantity and quality of reproduction in two California annual wildflowers, *Clarkia breweri* and *C. concinna*, tracking success from initial pollen transfer to offspring relatedness and lifetime fitness. Using single-visit field observations, we quantified per-visit pollen deposition and seed set. We then reared resulting progeny in a greenhouse to measure germination, survival, and fecundity to model lifetime fitness, and genotyped offspring within multi-seeded fruits using amplicon sequencing to determine pairwise sibling relatedness. In *C. breweri*, nocturnal hawkmoths (*Hyles lineata*) deposited significantly more pollen than bees or hummingbirds, yielding marginally higher seed set. Progeny from hawkmoth pollination also exhibited lower within-fruit relatedness and significantly higher lifetime fitness. In *C. concinna*, bee flies, bumble bees, and carpenter bees contributed similar levels of pollen deposition and seed set. However, offspring from bee fly pollination showed lower sibling relatedness and significantly higher lifetime fitness compared to those from bee pollination. These findings demonstrate that pollinators drive plant reproductive success not only through pollen quantity, but also by shaping mating dynamics and offspring quality. The superior performance and lower relatedness of progeny from hawkmoth and bee fly pollination help explain the evolutionary maintenance of specialized floral traits for spatiotemporally unreliable pollinators within a generalized visitor assemblage.





23 One flower, many pollinators: how pollinator identity shapes reproductive success and selection

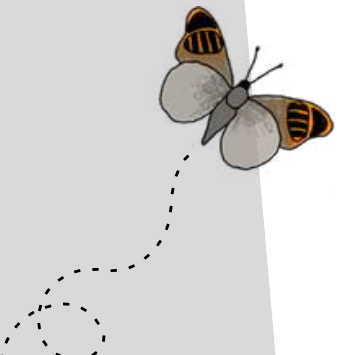
FULL LENGTH TALK

Felipe Torres-Vanegas, Aarushi Susheel, Vanda Temesvári, Zainab Aliwi, Katja Gram, Alba Tobio- Turnes, Mattia Russo, Sophie Hecht, Magne Friberg & Øystein H. Opedal

Department of Biology, Lund University, Lund, Sweden

Abstract

Floral trait evolution mediated by pollinators is a major driver of the diversification of flowering plants, yet we still know relatively little about how individual pollinator taxa contribute to patterns of selection, particularly in species visited by diverse pollinator assemblages. Here, we used replicated flight-cage experiments to quantify pollinator-specific patterns of phenotypic selection on floral traits in *Viscaria vulgaris*, a perennial herb of dry meadows. Across three years, we exposed plants to functionally and taxonomically distinct pollinators, including nectar-robbing and legitimate bumblebees, solitary bees, hoverflies, bee flies, butterflies, and noctuid moths. Pollinator treatments differed substantially in reproductive success, measured as mean seed mass per capsule, and the relative performance of pollinator groups varied among years. Autonomous self-pollination generally resulted in lower mean seed mass per capsule than pollinator-mediated and hand-pollination treatments. Pollinator treatments generated distinct patterns of phenotypic selection on floral traits, with substantial variation in the strength of selection among pollinators and across years. These results demonstrate that pollinator identity can alter both plant reproductive success and the strength of selection on floral traits. Identifying the contributions of individual pollinator taxa is therefore important for understanding how diverse pollinator assemblages shape floral evolution.





24 Fine-scale selection divergence as a component of geographic coevolutionary mosaics

FULL LENGTH TALK

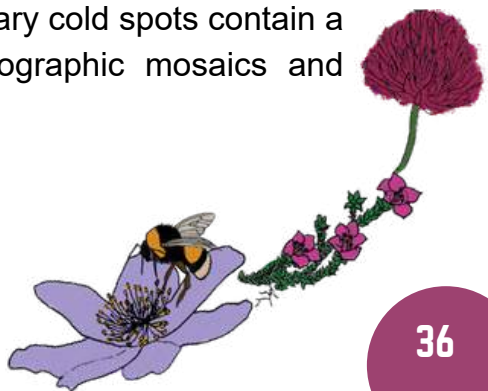
Pamela C. Santana[1], Giacomo Frassanito[2], Frida Sevrell[1], John N Thompson[3], Øystein Opedal[1] and Magne Friberg[1]

[1] Department of Biology, Lund University, Sölvegatan 37, 223 62 Lund, Sweden
[2] School of Mathematical, Physical and Natural Sciences, University of Florence, Florence, Italy
[3] Department of Ecology and Evolutionary Biology, University of California, Santa Cruz, Santa Cruz, CA 95060, USA

Abstract

Geographic mosaics of coevolution emerge when reciprocal selection varies spatially. Thus, pollinator-community divergence can reshape floral fitness landscapes, but the geographic scale of these selection mosaics and to what extent selection varies in mode and intensity also across short distances is rarely studied. We quantified how phenotypic selection diverged across two populations of *Lithophragma bolanderi*, separated by less than 15 km, pollinated by seed-parasitic Greya moths at specialist sites and by bee flies and solitary bees at generalist sites. At these sites, the pollinator assemblages were partly overlapping, but *Greya* larvae were detected in capsules only in one of the two populations, indicating variation in the moth component of the interaction. We measured nine floral traits and used the number of fertilized seeds per capsule as a component of female reproductive success. Multivariate regressions of relative fitness on standardized traits provided directional (β) and nonlinear (γ) selection gradients. The larvae-detected (LD–BRI) and larvae-undetected (LU–SMR) populations showed contrasting fitness landscapes. Petal width and style height had the strongest positive directional associations with fitness. Corolla opening was under stabilizing selection in LD–BRI but disruptive selection in LU–SMR, whereas petal width showed the reverse pattern. Style height was subject to disruptive selection in LD–BRI and strong stabilizing selection in LU–SMR. Selection divergence was concentrated in traits related to floral resource accessibility and pollen transfer. By quantifying differences in selection strength, direction, and curvature, our study shows that coevolutionary cold spots contain a fine-scale microevolutionary variation that structure geographic mosaics and create conditions for floral divergence.





25 Sexual dimorphism in fly visual function and its influence on flower visitation behaviour and floral evolution in Cape daisies

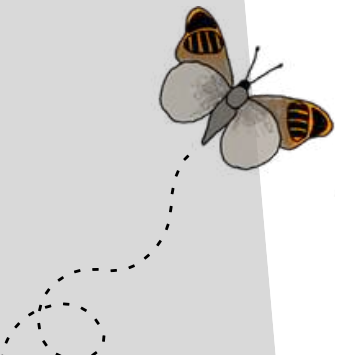
FULL LENGTH TALK

Arjan Engelen

Groningen University, Stellenbosch University

Abstract

Elaborate floral spot traits are a common feature among the annual daisies of the Greater Cape Floristic Region in South Africa. Previous work suggests that the intricate spots of *Gorteria diffusa* enhance pollen export by deceiving male *Megapalpus capensis* beeflies into misclassifying floral spots as potential mates. Here, I show that the evolution of elaborate spots in annual daisies of Dimorphotheca pluvialis-sinuata exhibit many parallels with the *Gorteria diffusa* system. Complex-spotted morphs of *D. pluvialis-sinuata* are strongly associated with several beefly and horsefly pollinator taxa, all with similar mate-searching behaviours to *M. capensis*. Sister taxa to these flower-searching flies show more generalised visitation patterns across *D. pluvialis-sinuata* morphs, with sexual behaviour that appears less conducive to pollen export than their flower-searching counterparts. The differences in flower-visitation and sexual behaviour are associated with repeated and consistent divergence patterns in male fly eye morphologies across multiple sister taxon pairs. Detailed eye measurements, behavioural experiments, and visual modelling are currently underway to assess the effects of male eye morphological shifts on the floral preferences and visual perception of ornamented *D. pluvialis-sinuata* morphs. This ongoing PhD work is expected to advance our understanding of the evolutionary prerequisites and functions of spot-like floral ornamentation in the angiosperms.





26 Buzzing and spinning: insights into the functional and morphological diversity of pollination in Pyxidantheae (Melastomataceae)

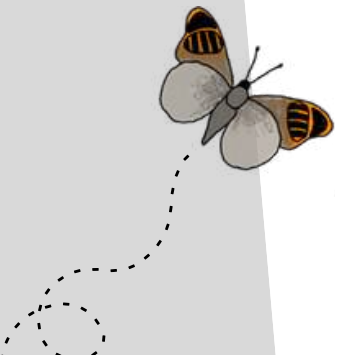
FULL LENGTH TALK

Johan Urrea[1], Darin S. Penneys[2], Benjamin S. Lazarus[1], Néstor García[3], Agnes S. Dellinger[1]

[1]Department of Botany and Biodiversity Research, University of Vienna, Austria,
[2]Department of Biology and Marine Biology, University of North Carolina at Wilmington, USA,
[3]Departmento de Biología, Pontificia Universidad Javeriana, Bogotá, Colombia.

Abstract

Animal pollination is recognized as a major driver of floral evolution and diversification in angiosperms, with many works focusing on morphological adaptations and changes associated with shifts of functional pollinator groups. However, much less is known about the diversification of flowers within the same functional pollinator group. Bees, particularly buzz-pollinating bees using mechanical vibrations to extract pollen, provide an interesting system to study floral diversification within the same functional pollinator group. The Neotropical tribe *Pyxidantheae* (Melastomataceae) with approximately 200 species represents a remarkable opportunity to investigate such interactions. Most species are buzz-pollinated, yet they display striking floral variation in size, shape, color, scent and stamen arrangement. The tribe also has three independent shifts to vertebrate pollination by hummingbirds, bats and rodents in high elevations. Here, we investigate how floral diversity evolves related to the same functional group of pollinators and identify traits associated with the diversity of morphologies. We integrate a floral morphological matrix with pollinator observations to test the macroevolution of flower morphology across the tribe and the potential relations with bee groups. *Pyxidantheae* flowers are structured in three distinct clusters, with two significantly different morphologies within the buzz-pollination syndrome. Stamen morphology and pollen expulsion mechanism seem to be important traits to separate flowers, triggering differential behaviors from bees. Specifically, bees will approach flowers from different sides, and they will move while buzzing in different directions depending on the stamen morphology, allowing closely related plant species to explore different mechanisms and ways to use the same group of pollinators.





27 Water availability, rather than pollinators, drives selection on flower size in irises

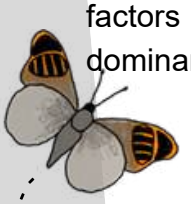
FULL LENGTH TALK

Pritee Subhadarshini[1], Yamit Bar-Lev[1], Asaf Avrahamy[2], Yuval Nokrian[2], Yuval Sapir[1]

[1]School of plant sciences and food security, Tel Aviv University.
[2]School of Mathematical Sciences, Tel Aviv University.

Abstract

Floral traits are traditionally viewed as adaptations shaped by pollinator-mediated selection, and flower size is a key advertisement trait in animal-pollinated plants. Studies show that larger flowers are more attractive to pollinators because they signal a larger reward and are easier to detect from a distance. However, abiotic factors like water availability can also exert strong negative selection pressures on floral size due to the high transpirational costs of maintaining large flowers. These contradicting selection pressures predict balancing selection on flower size. The flowers of the Royal Irises (*Iris* section Oncocyclus) are the largest of the Middle East flora, providing a model system to study the role of selection in shaping such an extreme floral trait. In this study, we investigate the relative contributions of pollinators and water availability in shaping flower size evolution in Irises. We conducted a field experiment in two species, *Iris atropurpurea* and *I. petrana*, combining phenotypic measurements with two-way manipulations: pollinator environment (supplemental hand-pollination versus open pollination) and water availability (supplemental watering versus natural rainfall control). Floral size traits were measured across individuals, and maternal fitness was estimated as total number of seeds. Due to low fruit set, fitness data was zero-inflated; thus, we used a zero-inflated hurdle model to analyze phenotypic selection. This statistical approach allowed us to model separately the probability of producing any seeds (the hurdle) and the total seed output, conditional on successful reproduction.Our selection analysis revealed no evidence of pollinator-mediated selection on Iris flower size. Instead, we found that water availability acted as the primary selection agent. In addition, flower size showed significant plasticity in response to watering in a common garden experiment, suggesting that phenotypic plasticity may balance these selection pressures. While not resolving the evolutionary driver of the large flower size in the Royal Irises, our results suggest that abiotic factors such as water availability, rather than pollinator preferences, may have a dominant role in shaping floral morphological evolution.





28 Floral syndromes and pollinators across mating system shifts in Mediterranean Linum

FLASH TALK

Stamouli S.[1]*, Cuscó-Borràs J.[1], de Castro A.[1], Valverde J.[1], Pareja-Bonilla D.[1], Gkournelos N.[2], Myronidou M.[3], Arroyo J.[1] and Simón-Porcar V.[1]

[1] Departamento de Biología Vegetal y Ecología, Facultad de Biología, Universidad de Sevilla, E-41080 Sevilla, Spain; * sstamouli@us.es
[2] Department of Ecology and Taxonomy, Faculty of Biology, National and Kapodistrian University of Athens, 15784 Athens, Greece
[3] Department of Conservation Biology, Faculty of Biology and Psychology, University of Göttingen, 37073 Göttingen, Germany

Abstract

A significant part of angiosperms extreme diversification is linked to mating systems. To promote outcrossing, many flowering plants exhibit pollinator-attractive traits, including large colourful floral displays and rewards, as well as structural traits such as herkogamy, the spatial separation of reproductive organs within flowers. Conversely, species experiencing unpredictable pollinator environments may reduce investment in floral traits and shift towards predominantly selfing, exhibiting the “selfing syndrome”, characterised by smaller perianths and reduced herkogamy. A useful system to explore the interplay between outcrossing/selfing shifts and floral traits is the genus *Linum* (Linaceae), comprising both herkogamous and non-herkogamous species. Linum also includes several heterostylous species, which further promote outcrossing through the coexistence of floral morphs with different style lengths and reciprocal herkogamy in their populations. Across angiosperms, heterostyly is associated with longer, narrower floral tubes and pollination by long-tongued insects that facilitate efficient pollen transfer between morphs, whereas evidence for a consistent selfing syndrome remains limited. In this study, following theoretical expectations, we hypothesised that herkogamous and heterostylous *Linum* species show larger perianths and receive higher pollinator visitation rates than non-herkogamous species, while heterostylous species present longer, narrower floral tubes and higher visitation rates by long-tongued pollinators than monomorphic species. We tested these hypotheses across 18 Mediterranean *Linum* species by compiling a dataset of over 260 hours of pollinator observations and more than 720 floral morphometric measurements. Understanding the ecology and evolution of mating-system shifts is increasingly important for predicting angiosperms evolutionary trajectories under the ongoing pollinator decline and global change.





29 Are plant mating systems associated with pollination systems across the Brazilian flora?

FLASH TALK

Beatriz Monteiro

UNESP Rio Claro/Universidad de Sevilla

Abstract

Plant mating systems range from complete self-fertilization to outcrossing with non-relative individuals, with mixed mating as an intermediate strategy. Although self-compatibility enables self-fertilization, realized mating patterns emerge from interactions between reproductive traits and ecological and evolutionary conditions. Pollination systems may be particularly relevant because pollinators mediate pollen transfer among individuals. Given the remarkable diversity of the Brazilian flora, we asked: are plant mating systems associated with pollination systems across the Brazilian flora? Using a systematic literature review, we compiled information from 457 studies and characterized the mating systems of 734 species, approximately 2% of the country's plant species diversity. Overall, 66.8% of species were predominantly outcrossers, 32.1% showed mixed mating, and 1.2% were predominantly selfers. Pollination system information was available for 80.2% of species, with bees (43.8%), hummingbirds (15.1%), and diverse animals (12.1%; more than two pollinator functional groups) as the predominant systems. We tested for associations between mating and pollination systems and compared species pollinated by single versus multiple functional groups as a proxy for pollination generalization. The frequencies of mating systems were not significantly associated with pollination systems (χ^2=29.05, p=0.182) nor with pollination by single versus multiple functional groups (χ^2=5.33, p=0.074). Our results suggest that broad pollination categories alone do not explain variation in mating systems. Accounting for phylogenetic relatedness and ecological factors, including life form, vegetation type, may help reveal the drivers of mating system variation across this megadiverse flora.





30 Co-flowering species interactions and pollination-mediated selection in *Gymnadenia conopsea*

FLASH TALK

Sofía Moreno de la Cuesta, Øystein H. Opedal, Magne Friberg, Yedra García

Department of Biology, Lund University, Lund, Sweden

Abstract

Plant-pollinator interactions are central to plant reproductive success and the evolution of floral traits. However, pollination occurs within diverse co-flowering communities, where neighboring plant species may modify pollinator behavior and consequently influence plant fitness and selection on floral traits. Understanding how these community-level interactions shape the pollination environment is therefore important for explaining variation in plant reproductive success. The orchid *Gymnadenia conopsea* provides an opportunity to examine these effects in species-rich semi-natural meadows at Gråborg, on the island of Öland, Sweden. Previous observational work in this system showed that co-flowering community composition influenced pollination-mediated selection in orchids, suggesting that neighboring species can shape selection on focal plants. Building on these findings, observational and experimental approaches will be combined to examine how co-flowering species influence pollination success, reproductive fitness, and pollinator-mediated selection in *G. conopsea*. Data collected during the previous flowering season will be used to assess variation in floral traits, pollination success (pollinia removal and pollen deposition), reproductive success (fruit number, fruit set, and fruit weight), and co-flowering community structure across the flowering season. In addition, a field experiment will experimentally remove two key co-flowering groups: *Potentilla erecta*, a highly abundant generalist species, and *Rhinanthus spp*., which strongly overlap with *G. conopsea* in flowering time and share pollinators. Removing these species is expected to alter the pollination environment of G. conopsea, potentially affecting pollination success, fitness, and the strength and direction of selection on pollination-related floral traits.





31 Red clover seed production: Impact of pollinators across Sweden and floral scents

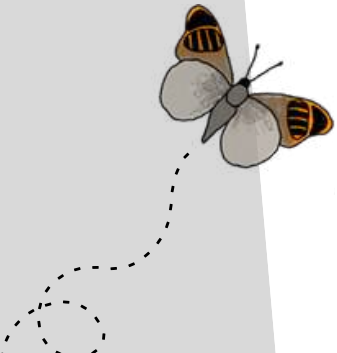
FULL LENGTH TALK

Kajsa Svensson[1], Veronica Hederström[2], Ida Valentin[1], Sara Lindholm[1], Marina Emilianova[1], Linda Öhlund[3], Mattias C. Larsson[1], **Åsa Lankinen[1]**

[1]Swedish University of Agricultural Sciences
[2]Lund University
[3]Lantmännen Lantbruk, Sweden

Abstract

Red clover (*Trifolium pratense* L.), an important insect-pollinated forage crop, has low and variable seed production particularly in tetraploid cultivars. The importance of short- and long-tongued bees for seed yield is not fully known. We are investigating the impact of pollinators on seed production and how pollination affects floral scent. We investigated the impact of short- and long-tongued bees in one diploid and three tetraploid red clover cultivars across a latitudinal distribution, at six sites in southern and northern Sweden. Contrary to our expectation, there was no clear southern vs. northern pattern for the abundance of short- and long-tongued bees. Seed yield was positively related to long-tongued bees, whereas seed set was positively related to both short- and long-tongued bees. In another study we investigated floral scents across cultivars and how pollination influences scent emission, as less is known about this in red clover. Surprisingly, our five investigated cultivars had similar scent profiles. Insect visited flower heads reduced their scent emission, which is in line with the pattern seen in other species. Our results support the significance of both short- and especially long-tongued bees for red clover seed production. However, given that red clover seed production may be limited by available pollinators, it would be important to learn more about whether post-pollination scent reduction occurs at the individual floret level or across the entire flower head, and whether head-level shutdown of scent can happen prematurely when pollinators are scarce.





32 Rainforest conversion reshapes multiple dimensions of stingless bee colony performance

FULL LENGTH TALK

Huan Liang[1,2,3], Catrin Westphal[4,5], Zheng Zhou[4,6], Arne Wenzel[4], Windra Priawandiputra[7], Michael Schlund[8], Stefan Erasmi[9], Carina Carneiro de Melo Moura[10], Oliver Gailing[5,11], Dirk Hölscher[5,12], Pallavi[12], Ingo Grass[6,13]

[1]State Key Laboratory of Plant Diversity and Specialty Crops, Wuhan Botanical Garden, Chinese Academy of Sciences, 430074 Wuhan, China
[2]German Centre for Integrative Biodiversity Research (iDiv), Halle-Jena-Leipzig, 04103 Leipzig, Germany
[3]Department of Community Ecology, Helmholtz Centre for Environmental Research - UFZ, Halle (Saale), Germany
[4]Agroecology & Functional Agrobiodiversity, University of Göttingen, 37077 Göttingen, Germany
[5]Campus Centre of Biodiversity and Sustainable Land Use, University of Göttingen, 37073 Göttingen, Germany
[6]Ecology of Tropical Agricultural Systems, University of Hohenheim, 70599 Stuttgart, Germany
[7]Animal Biosystematics and Ecology Division, Department of Biology, Faculty of Mathematics and Natural Sciences, IPB University, Bogor 16680, Indonesia
[8]Faculty of Geo-information Science and Earth Observation (ITC), University of Twente, 7500 AE Enschede, The Netherlands
[9]Thünen Institute of Farm Economics, Johann Heinrich von Thünen Institute, 38116 Braunschweig, Germany
[10]Forest Genetics, University of Freiburg, 79104 Freiburg im Breisgau, Germany
[11]Forest Genetics and Forest Tree Breeding, University of Göttingen, 37077 Göttingen, Germany
[12]Tropical Silviculture and Forest Ecology, University of Göttingen, 37077 Göttingen, Germany
[13]Center for Biodiversity and Integrative Taxonomy (KomBioTa), University of Hohenheim, 70599 Stuttgart, Germany

Abstract

Tropical rainforest conversion alters landscape structure, local environments and resource distributions, yet its consequences for the colony-level functioning of tropical social bee colonies remain poorly understood. We conducted a landscape-scale field experiment with the native stingless bee *Tetragonula laeviceps* in Sumatra, Indonesia. We established 240 colonies across 80 plots representing rainforest, shrubland, rubber plantation and oil palm plantation, and monitored colony activity, structural development and survival over six monthly survey rounds. We evaluated how these responses varied with land-use type, landscape context, local environmental conditions and initial colony condition. Land use affected several activity metrics, with outgoing bees, total returning bees and returning pollen foragers generally more abundant in rubber plantations than in rainforest. In contrast, pot, brood, resin and total colony volumes did not differ significantly among land-use types but varied strongly over time. Conditional interval survival differed among land-use types and declined over the monitoring period, with lower survival in rainforest than in oil palm. Structural equation models showed that land use was strongly associated with local environmental conditions but had little direct effect on colony performance or final survival. Initial colony condition was the most consistent predictor, positively affecting all colony responses. Contrary to expectations, established colonies of this disturbance-tolerant species maintained—and in some cases showed higher—activity and short-term survival in agricultural land-use systems than in rainforest. However, this resilience should not be taken to imply that other wild bee species or long-term pollination functions respond similarly to land-use changes.





33 Influence of non-native flower strips on pollen transport of native species in an agricultural landscape

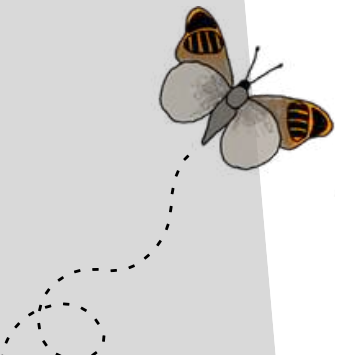
FULL LENGTH TALK

Magda Karlo[1,2], Erik T. Aschehoug[2], Line Johansen[1], Marie V. Henriksen[1]

[1]Norwegian Institute of Bioeconomy Research (NIBIO)
[2]Norwegian University of Life Sciences (NMBU)

Abstract

Changes in land use and habitat fragmentation have contributed to widespread declines in wild pollinator populations. Flower strips have therefore been implemented as an agri-environmental scheme to increase floral resources for pollinators in agricultural landscapes. Commercially available flower strip seed mixtures may contain non-native species because they are highly attractive to pollinators and provide abundant food resources. However, little is known about how non-native species in flower strips affect pollinator visitation and pollination of local native plants and, consequently, their contribution to native plant pollination. We investigated whether the origin of plant species within flower strips is associated with differences in pollen collected by bumblebees. We captured 290 individuals of *Bombus s. str.* and *Bombus soroeensis* visiting three different floral strip types within a single site in central Norway: a commercial mixture containing non-native species, a regional mixture containing native species, and a road verge containing locally occurring species. Bumblebees were collected in July and pollen composition was compared. Pollen composition differed significantly between bumblebees visiting the commercial and those visiting the regional mixture. Of the pollen found on bumblebees collected in the commercial mixture, 77% originated from genus in the mixture, suggesting that these bumblebees primarily foraged within the commercial seed mixture flower strip. In contrast, 56% of the pollen from bumblebees collected in the local seed mixture originated from genus in the mixture, indicating a greater degree of foraging on plants outside the flower strip and potentially greater contribution to pollination of native plants in the surrounding landscape.





34 Transplanting ground-nesting sweat bees (Halictidae) into greenhouses: survival, nest architecture, and pollination potential

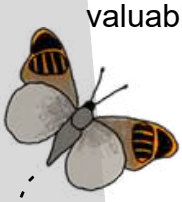
FULL LENGTH TALK

M.C. van den Hil[1,2], T.J. Wood[1], S.G.T Klumpers[1,3], J.C. Biesmeijer[1,2]

[1]Naturalis Biodiversity Center, Leiden, The Netherlands
[2]Institute of Environmental Sciences (CML), Leiden University, Leiden, The Netherlands
[3]HAS green academy, 's-Hertogenbosch, The Netherlands

Abstract

Commercially available bumblebees and honeybees are not always the most efficient pollinator for all crops. Wild pollinators, such as sweat bees (Halictidae), are a promising alternative for crop pollination. However, establishing wild bee populations of ground-nesting bees in an enclosed environment remains a practical challenge. This study evaluated the feasibility of transplanting buckets with Halictidae nests from outside into a greenhouse environment to assess their survival, nesting behaviour, and potential as crop pollinators. In the autumn of 2024, 40 buckets filled with soil were established near Halictidae nest aggregations in a nature area in the south of the Netherlands. In spring 2025, buckets containing nests were transferred to a greenhouse, where they were monitored for five weeks. This methodology was repeated also in 2025/2026. In the greenhouse the buckets with nests were sunk into the ground in multiple cages containing flowers as a food source. After relocation, bees successfully emerged and continued normal foraging behaviour. Pollen and nectar collecting continued throughout the whole observation period. New nests kept being found in the first few weeks and more bees kept emerging during the whole observation period. After the observation period 10 buckets were CT-scanned and 4 were excavated by hand. This resulted in a clear understanding of the nest architecture and 3D models of nests from multiple halictid species. Excavations confirmed that the bees continued normal foraging behaviour, since multiple stages of development (egg, larvae and pupae) were found within their brood cells. This study demonstrates that transplanting Halictidae nests is a viable and effective method for introducing wild ground nesting bees into greenhouses. These findings highlight the potential of managed wild sweat bees to deliver pollination services in a controlled agricultural environment, presenting a valuable tool for sustainable crop production.





35 Where do targeted actions for pollinators rank? The cognitive salience of biodiversity-friendly farming practices in a multi-country European study

FULL LENGTH TALK

Walshe, Niall[1]; Kavanagh, Saorla[1]; Bundschuh, Jana[2]; Kernecker, Maria Lee[2]

[1]Teagasc - Environment , Soils and Land use Department
[2]Zalf – Agriculture and landscape systems

Abstract

Biodiversity-friendly farming (BFF) practices can play a vital role in mitigating pollinator decline across Europe. Our study, within the EU Horizon project FarmBioNet, examined how agricultural professionals prioritise practices that can support pollinators. Data was collected through a multi-national survey incorporating a free-listing exercise. Practices listed by 220 respondents were grouped into 18 categories of practices. Using Smith's salience index, we assessed the cognitive salience of these categories based on both frequency of mention and prioritisation within respondents' lists. One category, "targeted actions for pollinators" included measures explicitly targeting pollinators, such as creating bee hotels and bee scrapes. Despite direct relevance to pollinator conservation, targeted actions for pollinators received the lowest cognitive salience score. In contrast, broader agricultural practices that can also provide substantial benefits for pollinators were considerably more salient. Hedgerow management received the third-highest cognitive salience score, while input reduction, including reductions in synthetic pesticide and fertiliser use, ranked fifth. We further compared the cognitive salience of pollinator-relevant practices across countries, farming systems, farm types and farmer age groups, identifying the contexts in which these practices receive greater or lower priority. The findings suggest that respondents more readily prioritise practices that are integrated into familiar agricultural management than with standalone, pollinator-specific interventions. This presents an opportunity to support pollinator conservation by incentivising widely recognised BFF practices. However, the low salience of explicitly pollinator-focused measures also indicates a need to improve awareness of how these interventions can be incorporated into farming systems, and the co-benefits that they have for the farm.

Keywords: Biodiversity-friendly farming; pollinator conservation; cognitive salience; free-listing; Smith's salience index.





36 Evidence for floral trait divergence and potential past selection divergence among human land-use type

FULL LENGTH TALK

Sophie Hecht[1], Sandra Blasiusson[1], Ciara Dwyer[1,2], Hannah Flink[1], Yedra García[1], Felipe Torres-Vanegas[1], An-Sofie Vastenavondt[1,3], Ola Olsson[1], Magne Friberg[1] & Øystein H. Opedal[1]

[1]Department of Biology, Lund University
[2]Department of Earth and Environmental Sciences (MGeo), Lund University
[3]Department of Biology, KU Leuven

Abstract

Human land-use impacts the natural world in a multitude of different ways, among others through changes in plant- and insect community composition. Changing pollination environments have in turn been linked to changes in selection on plant traits. This suggests potential for a pollinator-mediated evolutionary impact of land-use on plant traits, but this link has rarely been explored. Here, we link human land-use to floral trait divergence in a wild plant species (*Viscaria vulgaris*, Caryophyllaceae). Through the collection of multi-year, multi-site data on pollinator community composition and visitation rates, floral pollinator-attraction and pollinator-fit traits, and finally plant fitness, we explore whether current between-population differences in trait expression may be due to past adaptive responses to varying surrounding landscapes. Results show variation in pollinator community composition as well as in floral traits along similar land-use gradients in Southern Sweden, suggesting varying past selection at different sites. We propose that potential past adaptive changes would have been mediated by varying pollination environments, since land-use predicts both pollination environment and floral traits, but barely explains additional variation in floral trait state when already accounting for pollination environment. These findings underscore the importance of linking the impact of land-use to changes in pollinator composition, pollinator-mediated selection and, ultimately, adaptation of floral traits.





37 Beat the heat: cultivar-specific pollinator responses to overhead cooling in Highbush Blueberry

FLASH TALK

Lisa Wasko DeVetter[1], Micah Evalt[1], Rufus Isaacs[2], Steven Van Timmeren[2], Emma Rogers[1], Scott T. Orr[3], and David R. Bryla[3]

[1]Department of Horticulture, Washington State University, Northwestern Washington Research and Extension Center, Mount Vernon, WA 98273, USA.
[2]Department of Entomology, Michigan State University, East Lansing, MI 48824, USA.
[3]US Department of Agriculture, Agricultural Research Service, Horticultural Crops Production and Genetic Improvement Research Unit, Corvallis, OR 97330, USA.

Abstract

Climate change has increased the risk of heat damage to floral structures during the pollination period, which can disrupt fertilization and subsequent fruit development. Mitigation strategies are needed to protect pollination processes under extreme heat conditions. Overhead cooling with microsprinklers is commonly used in fruit production to reduce heat stress on fruit, but its influence on pollination dynamics during bloom is not well understood. This study evaluated how overhead cooling affects flower temperature, honey bee (*Apis mellifera* L.) activity, and pollination outcomes across four cultivars of northern highbush blueberry (*Vaccinium corymbosum* L.): 'Duke', 'Draper', 'Cargo', and 'Aurora'. A field trial was conducted in spring 2025 in Corvallis, Oregon, USA. Cooling was initiated when ambient air temperature reached 21 °C. Peak bloom temperatures reached 26 °C, and cooling reduced flower temperatures by approximately 4 °C compared with uncooled controls. Honey bee visitation declined by 41% in 'Draper' under cooling, while visitation in the other cultivars did not change. Despite reduced honey bee activity in 'Draper', cooled and uncooled plots did not differ in fruit set, berry mass, seed number, or total yield. These results suggest that the decline in honey bee visitation did not lead to measurable pollination deficits under the conditions of this study. These results indicate that overhead cooling with microsprinklers can lower flower temperature during bloom without reducing yield, but cultivar-specific changes in honey bee activity highlight the need for further research on how cooling practices influence pollination dynamics and fruit production.





38 Preliminary findings suggest variation in floral scent compound content and composition among apple cultivars: a case for more studies on scent in pollinator- dependent crops

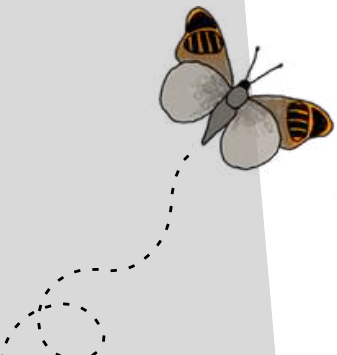
FLASH TALK

Hanna Eriksdotter Thosteman[1]*, **Jørund Johansen[2]***, Linn Vassvik[2], Bjørn Arild Hatteland[3]

[1]Department of Plant Protection Biology, Swedish University of Agricultural Sciences, Alnarp, Sweden.
[2]Department of Landscape and Biodiversity, Norwegian Institute of Bioeconomy Research, Norway.
[3]Department of invertebrate pests and weeds in forestry, agriculture and horticulture, Norwegian Institute of Bioeconomy Research, Norway. *Joint first authors

Abstract

Agricultural systems face mounting challenges in the ongoing pollination crisis. At the same time, crop plant traits important for pollinator attraction have been largely neglected in both plant breeding and agricultural research. There is evidence suggesting that crop cultivars may vary greatly in traits relevant for pollinator attraction, and that pollinators respond differently to this variation. In this talk, we focus on floral scent – an important mediator of plant-pollinator interactions in natural systems – and how this complex trait varies among five Norwegian apple cultivars. We describe large differences in total floral scent content between the cultivars, as well as some variation in compound composition. We discuss how floral scent may be an important aspect of pollinator foraging behaviour in apple orchards and suggest several research avenues to explore how floral scent emission rate and diversity is related to pollinator visitation frequency, diversity and pollination success.





39 Elevational patterns of flower visitation on tropical smallholder farms

FLASH TALK

Tianying Zhang[1], Barnabas Philip Malila[2], Elvillah William Rweyemamu[3], Herieth Nyarobi[4], Rose Kicheleri[5], Thomas Sawe[6], William Joseph Kindeketa[7], Jumanne Moshi Abdallah[4], Laura Vang Rasmussen[8], Bo Dalsgaard[1]

[1] Globe Institute, University of Copenhagen, Denmark
[2] Department of Ecosystem and Conservation, Sokoine University of Agriculture, Tanzania
[3] Department of Crop Science and Horticulture, Sokoine University of Agriculture, Tanzania
[4] Department of Forest and Environmental Economics, Sokoine University of Agriculture, Tanzania
[5] Department of Wildlife Management, Sokoine University of Agriculture, Tanzania
[6] World Wildlife Fund
[7] Tanzania Forestry Research Institute (TAFORI), Tanzania
[8] Department of Geosciences and Natural Resource Management, University of Copenhagen, Denmark

Abstract

There is a concern that global environmental change causes declines in wild pollinators and the ecosystem services they provide. Tropical mountain smallholders grow diverse, often insect-pollinated crops, yet it remains unclear how crop visitation varies with elevation and environmental conditions. We addressed this across 95 smallholder farms spanning 530–1962 m in the Eastern Arc Mountains, Tanzania. Standardized surveys covered nine crops and 7,223 flower-visiting events from 12 flower-visitor groups. We examined elevational variation in crop composition, total visitation and visitor-group composition, and assessed the roles of crop identity, microclimate, farm management and landscape context. Total insect visitation showed no significant trend with elevation, but this masked contrasting responses among visitor groups. Non-syrphid Diptera and Hemiptera increased with elevation, whereas honeybees (*Apis mellifera*), other bees, wasps and thrips declined. Crop identity uniquely explained 18.2% of variation in visitor-group composition. Semi-natural habitat cover and pesticide use explained smaller but significant fractions, whereas elevation explained little unique variation. Within individual crops, further analyses revealed that total visitation declined with elevation for beans, but no significant trend was detected for other crops. Visitor-group responses to elevation also varied among crops, with declines in thrips in bean and honeybees and hoverflies in green pea but increases in Coleoptera and Lepidoptera in pigeon pea. These results show that crop identity can structure elevational patterns in insect visitation, with visitor groups showing distinct crop-specific responses. Therefore, impacts of global environmental change on crop pollinators may manifest through compositional shifts rather than uniform declines in overall visitation.





40 Buzz below ground - how does timing of grazing impact soils and pollinators?

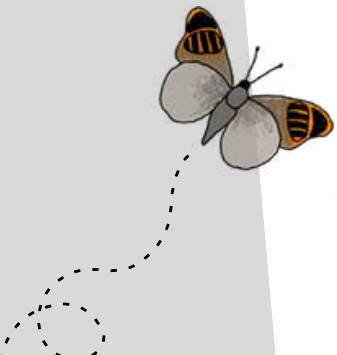
FLASH TALK

Tirza Moerman[1], Dara Stanley[1]

[1]University College Dublin, School of Agriculture and Food Sciences

Abstract

Insect pollinators are known best in their above-ground environment. Yet, many pollinators rely on soil at various stages such as nesting or overwintering. How these soil dependent pollinators are impacted by land use management practices is not well understood. Within this context, and as part of the EU Horizon funded ProPollSoil project, we aim to understand how grazing management impacts soils and soil-dependent pollinators. With a network of stakeholders in a case study area in western Ireland, we designed a study to test how physical and chemical soil characteristics and pollinator abundance and composition are impacted by timing of grazing in species-rich coastal grasslands. To this end, we collect pollinator and soil data in fields that are grazed during winter only and fields that are all year round grazed. We expect that winter grazed fields are less compacted and nutrient enriched and have a different plant composition than all-year grazed fields with cascading impacts on pollinator composition and abundance. A better understanding of pollinators in their below-ground environment and the impacts of management practices on soils and soil-dependent pollinators is important to help improve pollinator conservation measures."





41 Historical comparison reveals taxonomic and functional community turnover of an Arctic bumblebee community with shifting plant visitation patterns

FULL LENGTH TALK

Océane Bartholomée[1], Aoife Cantwell-Jones[2], Femke Verweij[3], Jonas J. Lembrechts[4], Keith Larson[5] & Richard J. Gill[2]

[1]Department of Earth and Environmental Sciences (MGeo), Lund University, Sweden
[2]Georgina Mace Centre for the Living Planet, Department of Life Sciences, Imperial College London, UK
[3]Leiden University, Leiden, the Netherlands
[4]Ecology & Biodiversity, Utrecht University, the Netherlands
[5]Climate Impacts Research Centre (CIRC), Department of Ecology and Environmental Sciences, Umeå University, Sweden

Abstract

High-latitude montane regions are warming faster than the global average, potentially weakening temperature-based environmental filtering along elevation gradients. As minimum thermal thresholds are surpassed, constraints on low-elevation species may relax, promoting upslope shifts. Yet these processes remain poorly quantified due to limited pre-warming baselines, and scarce information on consequences for species interactions. Plant–pollinator interactions are especially sensitive to warming because both partners depend strongly on temperature for their phenology and distribution. Bumblebees are key Arctic pollinators, but community-level responses to climate change remain unclear. We quantify multi-dimensional responses of an Arctic bumblebee community along an elevational gradient by comparing historical surveys (1971–1972) with contemporary data (2018–2024). We assess elevational shifts in relative abundance, community composition, community-weighted functional traits, visitation to *Vaccinium* shrubs, and caste-specific phenological responses. All species showed consistent upslope shifts in relative abundance, while overall composition remained stable except for the cold-adapted specialist *Bombus alpinus*, which increased at high elevation. Functional traits shifted toward warmer-adapted assemblages, with smaller-bodied communities at mid and high elevation and higher heat tolerance and warmer thermal affinities at low elevation. Visitation to *Vaccinium* shrubs changed, with *B. jonellus* and *B. lapponicus* increasing interactions in line with their upslope redistribution. Drones exhibited earlier phenological activity, suggesting accelerated colony development, whereas queens and workers showed no detectable shift. Our results show that the bumblebee community is spatiotemporally tracking climate warming, with functional reorganisation occurring despite stable species composition, underscoring the value of long-term sentinel datasets for predicting plant–pollinator responses.





42 Environmental gradients and season structure bumblebee communities in northern Norway (with focus on bilberry interactions)

FULL LENGTH TALK

Elise Dahl, Jarad Mellard

Department of Arctic and Marine Biology

Abstract

High-latitude plant-pollinator communities experience relatively short flowering seasons and strong environmental gradients. This study addresses limited knowledge about the bumblebee community and their environmental drivers in northern Norway. We surveyed the bumblebee community and flower visits along environmental gradients on Kvaløya throughout the summer season and during peak bilberry flowering on Varanger Peninsula. By walking transects, we recorded bumblebee activity/abundance, species richness, flower visits by bumblebees and potential environmental drivers. We examined how season, elevation, temperature, and wind influence bumblebee activity and how they use Bilberry (*Vaccinium myrtillus* (L.)) as a resource. Bumblebee activity/abundance and species richness on Kvaløya was found to be affected by day of season following a concave curve, peaking mid-season and declined with elevation. Vegetation temperature positively affected the bumblebee abundance during late season and wind speed negatively affected the bumblebee abundance at high elevations. On Varanger, activity/abundance and species richness was negatively affected by wind at higher elevations. The most visited plant species was Bilberry (*Vaccinium myrtillus* (L.)) particularly early in the season and on Varanger. We also conducted simultaneously a pollinator exclosure experiment and found that excluding pollinators greatly reduced bilberry fruit set. This study suggests that northern Norwegian bumblebee communities are structured by interacting temporal and environmental/spatial factors. Furthermore, the focal activities of these bumblebee communities have consequences for bilberry reproduction. To our knowledge, this is among the first studies on the ecology of the bumblebee community and its drivers in northern Norway.





43 Flower visitors along an elevational gradient across nine years

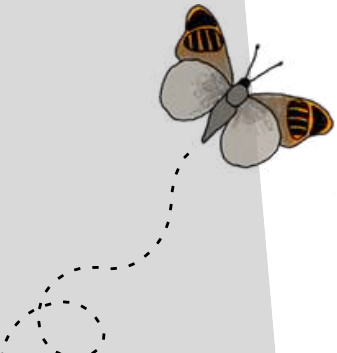
FULL LENGTH TALK

Stein Joar Hegland[1], Mark Gillespie[2]

[1]Department of Civil Engineering and Environmental Sciences, Western Norway University of Applied Sciences
[2]Department of Ecoscience, Biodiversity and Conservation, Aarhus University

Abstract

Elevational gradients may represent environmental variation that can guide our understanding on the climatic influence on ecological functions, processes, and interactions. We used such a gradient along the Sognefjord, Western Norway, and collected data on plant-pollinator interactions at three elevational sites, at ca. 100 (temperate/hemi-boreal), 500 (boreal) and 900 (alpine) masl. The transects were placed in open woodland areas dominating by mass-flowering shrubs like *Vaccinium myrtillus* (bilberry) and *V. vitis-idaea* (lingonberry), which are considered functional important species in northern ecosystems, e.g. because of their importance to pollinators. We recorded individual pollinators and which flowers they visited in 450-m long transects at each of the elevational sites, during 9 years from 2018 to 2026. We observed 4523 interactions, i.e. flower visitors, during 352 walks of 30-min (>10 000 minutes). The flower-visitation interactions were dominated by the two functional important plant species that were visited mostly by various Bombus (bumblebees) and Andrena (mining) bees. We will present some basic metrics of the collected data that indicate how pollinators may vary across elevations and time. We also want to get input on how to use this dataset.





44 Plant–pollinator interactions of Gravesia across an elevational gradient in Marojejy National Park, Madagascar

FLASH TALK

Lalaina F. Ramiliarisona[1], Richard D. Randriatsitohaina[1], Andrea Errante[2], Gregor Traun[2], Harisoa Ravaomanalina[1], Agnes Dellinger[2]

[1]University of Antananarivo, Madagascar
[2]University of Vienna, Austria

Abstract

In addition to influencing environmental conditions such as humidity, temperature and precipitation, elevational gradients have the potential to impact pollinator behavior and interactions with plants. In plant lineages with wide elevational distributions, we may hence observe changes in pollination strategies. The Melastomataceae genus *Gravesia* is primarily distributed in Madagascar, where approximately 95% of all known species occur, and can be found from lowland to montane forests; however, little is known about its pollination ecology. We here examine the pollination ecology of *Gravesia* along an elevational gradient in Marojejy National Park, northeastern Madagascar, focusing on nine species, to test whether environmental variation influenced plant–pollinator interactions through influencing pollinator community structure and behavior. We made floral observations during the flowering period and all flower visitors were registered. In addition, we compared pollinator visitation rate and visitor composition between elevation zones. The preliminary results showed variation in visitation rate along the elevational gradient regarding the pollinator communities, with fewer bees visiting *Gravesia* flowers at higher elevations than in the lowlands, while buzz-pollinating bees at high elevations were generally larger-bodied. Reductions in bee abundance, coupled with size differences, may have implications for the efficiency of pollen release from poricidal anthers and pollen deposition onto stigmas, resulting in lower reproductive success. Our results indicate that elevation might play a crucial role in shaping pollination strategies in *Gravesia* and enhance our understanding of the interactions between plants and their pollinators in the montane rainforests of Madagascar, a region known for its rich biodiversity.





45 Convergence or partitioning? Seasonal flower use by northern bumblebees

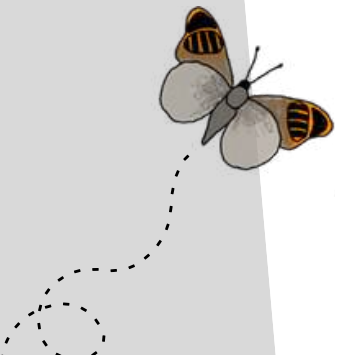
FLASH TALK

Jarad P. Mellard, Elise Dahl

Department of Arctic and Marine Biology, UiT The Arctic University of Norway

Abstract

Bumblebee species are generally considered floral generalists. However, this conclusion is often based on observations pooled across an entire season. At any one time, species might divide the available flowers among themselves, potentially reducing competition. Alternatively, many species might use the same rewarding flowers and switch together as different plants begin and finish flowering. Northern Norway provides a useful system for examining these alternatives in a short, strongly seasonal environment. We developed a simple model in which bees track seasonally changing floral resources while differing in their flower associations. We related the model to repeated transect surveys from northern Norway. Foraging records were grouped into seven-day periods, and flower use was examined for common bumblebee taxa. For each period, we calculated the fraction of visits to the most frequently visited plant and the fraction of observed bee taxa using it. Several common bumblebee taxa shared the same important early-season resource, followed by partly shared use of later-flowering plants. In the model, weak differences among bees caused them to track the same sequence of resources. Strong differences encouraged resource partitioning, but a temporarily abundant floral resource could still draw species together. The observations were consistent with shared resource tracking, and the model showed that seasonal changes in flowers do not necessarily divide bumblebee species into separate floral niches. Instead, different species may follow the same sequence of important resources. Generalism measured across a whole season may therefore arise partly from flexible switching as the floral environment changes.





46 Plant-pollinator interactions in anthropized landscapes

KEYNOTE

Amparo Lázaro

Mediterranean Institute for Advanced Studies (IMEDEA, CSIC–UIB), Spain

Abstract

Pollination is an essential process for maintaining biodiversity and ecosystem functioning. However, this essential ecosystem service is severely threatened by pollinator losses, raising important challenges for biodiversity conservation and crop production. Among the many threats to wild pollinators today, land-use changes have been identified as one of the main causes of declines, and this effect is expected to be accentuated in the following decades as human population increases. I will present the studies conducted in my group to understand how landscape modifications affect plant and pollinator communities, the structure of plant-pollinator interactions, and the provision of pollination services to plants. The results of these studies have important implications for the sustainability of anthropized landscapes and for the conservation of pollinators as a key ecosystem service.





47 Assessing diet overlap and effects of honeybee competition on pollen diet and communities of threatened bumblebees

FULL LENGTH TALK

Johanna Yourstone[1,2], Tegan Gaetano[1], Ola Olsson[3], Fabio Manfredini[1,4]

[1]School of Biological Sciences, University of Aberdeen, UK.
[2]Department of Earth and Environmental Sciences (MGeo), Lund University, Sweden.
[3]Department of Biology, Lund University, Sweden.
[4]Department of Food, Environmental and Nutritional Sciences, University of Milan, Italy

Abstract

Concerns have been raised that competition from managed honeybees (*Apis mellifera*) for flower resources could exacerbate ongoing declines in wild bees, including bumblebees. Most evidence for honeybee competition effects come from resource-poor agricultural landscapes, while effects on rare and threatened bumblebees persisting in high-quality habitats are largely unknown. In the present study, we quantify population metrics, dietary overlap and competition-induced dietary shifts in bumblebees as an effect of honeybee presence in the Hebrides archipelago, Scotland, a hotspot for rare bumblebees in the UK. We surveyed bees and collected pollen from foraging bumblebees as well as honeybees from replicated sites with contrasting presence of managed honeybees. The collected pollen was identified using an automated deep learning method. We found that there is a considerable but variable pollen overlap between local bumblebees and honeybees. The overlap with honeybees was e.g. small in the Great Yellow bumblebee (*Bombus distinguendus*), but almost 50 % in the Moss Carder Bee (*B. muscorum*), indicating a risk for resource competition between honeybees and this rare bumblebee species. Effects of honeybee presence on bumblebee communities and diet in terms of potential shifts and diversity changes will be presented. These data are important for guiding management actions to promote a sustainable coexistence between honeybees and threatened bumblebees. Future research should determine whether competition translates into fitness consequences for rare bumblebees and identify critical time points of competition during the foraging season to inform targeted conservation actions.





48 Integration of non-native plants into pollination networks across urban ecosystems

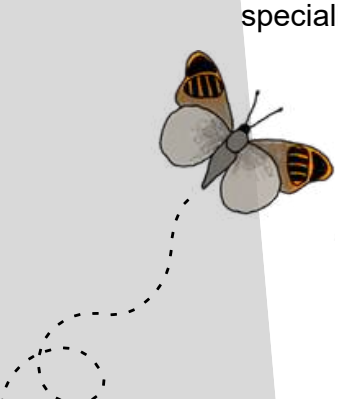
FULL LENGTH TALK

Pietro K. Maruyama[1,2,3], Victor H. D. Silva1,[3], Renata Trevizan[1,3], Caio S. Ballarin[2,4], Francisco E. Fontúrbel[5], Aldenice B. Alves[1], Andressa L. L. Luna[1], Urban Pollination Networks Consortium6, Patrícia C. Morellato[2]

[1]Centro de Síntese Ecológica e Conservação, Departamento de Genética, Ecologia e Evolução - ICB, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil.
[2]Centro de Pesquisa em Biodiversidade e Mudanças do Clima, Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil.
[3]Instituto Nacional de Ciência e Tecnologia em Polinização (INPol), Rio de Janeiro, Brazil.
[4]Laboratório de Ecologia da Polinização e Interações, Instituto de Biociências, Universidade Estadual Paulista, Botucatu, São Paulo, Brazil.
[5]Instituto de Biología, Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile.

Abstract

Non-native plants are a major component of novel urban ecosystems, but how they integrate into local ecosystem processes is poorly understood. We assessed the ecological determinants of non-native plant integration, including climate, urbanization degree, diversity of non-native plants, pollinator groups, and network characteristics, in urban plant-pollinator networks across the globe. Using a dataset of 323 plant-pollinator interaction networks comprising 2029 plant and 1786 pollinator species involved in 29,346 pairwise interactions, we found that network level specialization (H2') was negatively related to the proportion of non-native plant species in the community. At the same time, the effect of annual precipitation on specialization changed with pollinator groups, in which specialization increased with annual precipitation in networks composed exclusively by vertebrates but decreased in those including insects. While network size negatively influenced specialization, degree of urbanization and sampling completeness had no detectable influence. At the species level, we found that non-native plants show lower specialization (d') than native species, and this difference was also associated with plant growth form, but not with floral symmetry or resource type. Considering an alternative compound metric (PC1) combining species degree, strength, and partner diversity to express the importance of a species in the network showed that radial flowers are more important than bilateral ones only among the native plants, but not among the non-natives. Our global study highlights the role of non-native plants in structuring urban plant-pollinator networks, especially by reducing interaction specialization and potentially influencing urban ecosystem functioning.





49 Landscape and floral drivers of wild bee reproduction in a montane ecosystem

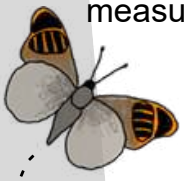
FULL LENGTH TALK

Jennifer Rose[1], Estefanía Tobajas[1], Luis J. Chueca[1], Marta Feliu-Paradeda[1], Agus Fernández-Álvarez[1], Christian Gostout[1], Brais Hermosilla[1], Luka Meléndex-Arteaga[1], Monste Muriana[1], Xabier Salgado-Irazabal[1], Jon Zubieta-Rodríguez[1], & Ainhoa Magrach[1,2]

[1]Basque Centre for Climate Change (BC3), Leioa, Spain
[2]Ikerbasque, Basque Foundation for Science, Bilbao, Spain

Abstract

Wild bees provide essential pollination services across both natural and agricultural systems, yet the local-scale drivers enabling successful reproduction remain poorly understood. Most studies rely on adult-stage metrics such as abundance or richness, which can mask the reproductive processes that ultimately determine population persistence. Linking landscape and floral resource availability directly to reproductive outcomes, such as nest occupation or offspring survival, offers a more mechanistic understanding of what allows wild bee populations to thrive in heterogeneous landscapes. Here, we present a 3-year trap-nest study across 16 sites in Gorbeia Natural Park (Basque Country; 750–1220 m a.s.l.), relating floral diversity and abundance to reproductive metrics including nest occupation, brood cell production, and sex ratio. Across the first two seasons, we recorded ten cavity-nesting species with highly variable output. Mean brood cells per occupied nest nearly doubled from 3.89 ± 3.25 in 2024 to 6.23 ± 4.45 in 2025, while site-level occupation ranged from 0–29.2% to 0–54.2%, respectively. In 2026, occupation reached up to 83.3%. Nest completion peaked from mid-June through July; however, the first two years revealed no significant relationship with floral diversity or abundance, suggesting that other local factors may mediate occupancy. These preliminary findings underscore the importance for continued monitoring as environmental conditions shift. We hypothesize that results from 2026, conducted during Europe's recent heatwaves, may provide critical insight into whether resource limitation exerts a measurable effect on bee reproduction in this montane community.





50 Traffic accidents: when do a few dead bees become a population problem?

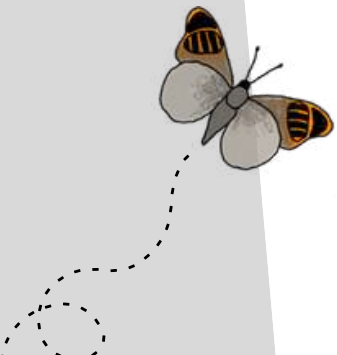
FULL LENGTH TALK

Richard Walters

Lund University

Abstract

Road verges provide valuable forage and nesting habitat for bumblebees but also place bees next to moving vehicles. Field studies show that traffic kills bumblebees and reduces their local abundance, yet detecting consequences at the landscape scale is harder. So when does a small additional risk of death actually matter to a population? We address this question using a spatially explicit, process-based model of bumblebee foraging and population dynamics, parameterised within a real agricultural landscape. Rather than treating road mortality as reduced abundance, we follow how repeated exposure during foraging affects colony growth, queen production, nest success and recolonisation. We explore mortality risks spanning several orders of magnitude and ask whether floral enhancement of road verges offsets or amplifies traffic impacts. Preliminary results reveal a potentially deceptive population response. Even small per-visit mortality risks can accumulate through repeated foraging trips, substantially reducing colony performance beyond the road itself. Crucially, effects can be much stronger for queen production than worker abundance. At the same time, dispersing queens can recolonise empty nest sites, potentially masking local demographic losses in subsequent generations. We test when these processes translate into landscape-scale population loss and whether roadside floral supplementation provides a net benefit. Emerging results suggest the answer depends critically on resource limitation, particularly whether nesting sites constrain populations. Roads may therefore create a demographic trap whose consequences are harder to see than the dead bees beside them.





51 Effectiveness of pollinator-promoting interventions in European urban habitats

FULL LENGTH TALK

Gabriella Süle[1],*, András Báldi[1], David Kleijn[2], Ingolf Steffan-Dewenter[3], Stephen Venn[4], Dave Goulson[5], Simon Dietzel[6], Audrey Muratet[7], Lorna J. Cole[8], Erik Öckinger[9], Olga Tzortzakaki[10], Weronika Banaszak-Cibicka[11], Oliver Betz[12], Lorna M. Blackmore[13], Łukasz Dylewski[11], Benoît Fontaine[14], Bertrand Fournier[15], Costanza Geppert[16], Janine Griffiths-Lee[5], Catriona Hawthorn[8], Andrea Holzschuh[3], Jakub Horák[17,18], Svenja Horstmann[9,19], Helen Hoyle[20], Vassiliki Kati[21], Anikó Kovács-Hostyánszki[1], Lorenzo Marini[16], Alice Michelot-Antalik[22], Marco Moretti[23], Briony A. Norton[24], Benjamin B. Phillips[25], Milan Plećaš26, Patrik Rada[17], Miklós Sárospataki[27], Sonja Schulze[3], Assaf Shwartz[28], Philipp Unterweger[29], Viktor Szigeti[1]

[1]Lendület Ecosystem Services Research Group, Institute of Ecology and Botany, HUN-REN Centre for Ecological Research, Vácrátót, Hungary
[2]Plant Ecology and Nature Conservation Group, Wageningen University, Wageningen, The Netherlands
[3]Department of Animal Ecology and Tropical Ecology, Biocenter, University of Würzburg, Würzburg, Germany
[4]Department of Invertebrate Zoology & Hydrobiology, Faculty of Biology & Environmental Protection, University of Lodz, Lodz, Poland
[5]Department of Ecology & Evolution, School of Life Sciences, University of Sussex, Brighton, United Kingdom
[6]Chair of Restoration Ecology, TUM School of Life Sciences, Technical University of Munich, Freising, Germany
[7]Laboratoire Image Ville Environnement (LIVE), CNRS UMR 7362, University of Strasbourg, Strasbourg, France
[8]Integrated Land Management, Scotland's Rural College, Auchincruive Estate, Ayr, United Kingdom
[9]Department of Ecology, Swedish University of Agricultural Sciences, Uppsala, Sweden
[10]Department of Biology, University of Patras, Patras, Greece
[11]Department of Zoology, Poznań University of Life Sciences, Poznań, Poland
[12]Institute of Evolution and Ecology, Evolutionary Biology of Invertebrates, University of Tübingen, Tübingen, Germany
[13]School of Biological Sciences, University of East Anglia, Norwich, United Kingdom
[14]Patrinat & UMR7204 (CESCO), OFB-MNHN-CNRS-IRD, Paris, France
[15]Institute of Environmental Science and Geography, University of Potsdam, Potsdam, Germany
[16]Department of Agronomy, Food, Natural Resources, Animals and Environment, University of Padova, Legnaro, Italy
[17]Faculty of Science, University of Hradec Králové, Hradec Králové, Czech Republic
[18]Faculty of Forestry and Wood Sciences, Czech University of Life Sciences Prague, Prague, Czech Republic
[19]Agricultural Landscapes and Biodiversity, Agroscope, Zürich, Switzerland
[20]School of Architecture and Landscape, University of Sheffield, Sheffield, United Kingdom
[21]Biodiversity Conservation Laboratory, Department of Biological Applications and Technology, University of Ioannina, Ioannina, Greece
[22]University of Lorraine, INRAE, LAE, Nancy, France
[23]Swiss Federal Research Institute WSL, Biodiversity and Conservation Biology, Birmensdorf, Switzerland
[24]Nature-Based Solutions Research Centre, University of Derby, Derby, United Kingdom
[25]Environment and Sustainability Institute, University of Exeter, Penryn, United Kingdom
[26]Faculty of Biology, University of Belgrade, Belgrade, Serbia
[27]Department of Zoology and Ecology, Institute of Wildlife Management and Nature Conservation, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary
[28]Human and Biodiversity Research group, Faculty of Architecture and Town Planning, Technion- Israel Institute of Technology, Haifa, Israel
[29]Dr. Unterweger Biodiversitätsplanung, Wain, Germany

Abstract

Pollinators are of critical importance due to their fundamental role in ecosystem functioning and the maintenance of human well-being. While interventions supporting pollinators have long been studied in agriculture, research focusing on urban environments has only expanded in recent years. However, a synthesis of existing results is still lacking, hindering evidence-based policymaking. To address this gap, we compared pollinator-promoting interventions (treatment) and conventionally managed (control) urban green spaces regarding vegetation attributes, floral resources, and pollinators, based on 28 European primary datasets, using both pooled and dataset-level analyses. Our study encompassed 1,051 sampling sites representing a range of interventions (abandonment, reduced mowing frequency, flower sowing, and their combinations) and habitat types (parks, grasslands, road verges, and private and public gardens). Pollinator-promoting interventions in urban areas generally had positive effects on plants and pollinators, although the effects varied across taxa, intervention types, habitats, and spatio-temporal contexts. Pooled analyses revealed mostly positive and never negative effects, whereas detailed dataset-level analyses predominantly showed positive or neutral, but rarely negative, effects. Interventions were particularly beneficial for bumblebees and butterflies. Among intervention types, flower sowing; among habitats, road verges; and among regions, sites in northwestern Europe, exhibited the strongest positive effects. Although regulations, guidelines, and monitoring practices are increasingly improving, knowledge gaps remain for certain pollinator groups (e.g., beetles), regions (e.g., the Mediterranean), and novel intervention types (e.g., interventions supporting ground-nesting insects). Further research based on international collaboration can help cities develop resilient and multifunctional urban habitats that promote the coexistence of people, plants, and pollinators.





52 Does habitat restoration restore plant-pollinator interactions?

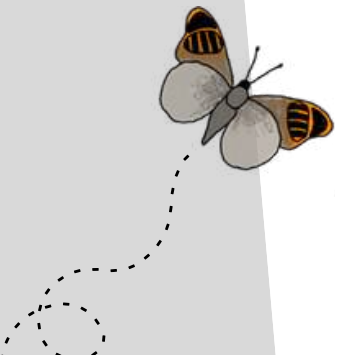
FULL LENGTH TALK

Jacqui A. S. James[1], Lynn V. Dicks[1], Richard F. Comont[2]

[1]Department of Zoology, University of Cambridge, Cambridge, United Kingdom
[2]Bumblebee Conservation Trust, Stirling, United Kingdom

Abstract

When assessing the effectiveness of habitat restoration, it is necessary to look beyond abundance and diversity measures and to consider whether ecological functioning has been restored. This can be assessed by comparing species interactions, such as that between plants and pollinators, which may indicate if pollination services have been restored. I assessed networks of flower visitation of bees, butterflies and hoverflies in restored grasslands in Somerset, United Kingdom. These networks were compared to those in conventionally managed pastures (negative controls) and in remaining fragments of species-rich meadows (positive controls). The restoration sites had notably higher abundance and diversity of pollinators than at the negative control sites. Dissimilarity in interactions seen in restoration site and positive control site networks was mainly due to interaction rewiring rather than differences in species composition, which was the case for all other site type comparisons. This indicates that even if the same species are present at restoration and positive control sites, these species are interacting differently. A core group of pollinator species found across site types showed notably different interaction patterns at the positive control sites than at the other site types. This suggests that while restoration may have been effective in restoring the abundance and diversity of pollinators, interactions do not reflect that at positive control sites. This may affect the pollination services provided, and highlights the importance of assessing if ecological functioning has been restored.





53 Pollinator and wild ungulate conservation on working lands

FULL LENGTH TALK

Will Glenny[1,2,3], Sandra J. DeBano[1,2], Mary M. Rowland[3], Scott R. Mitchell[1,2], Bryan Stevens[3], Lauren DiCarlo[4]

[1]Oregon State University, Department of Fisheries, Wildlife, and Conservation Sciences, Corvallis, OR, 97331
[2]Eastern Oregon Agricultural Research Center, Oregon State University, Union, OR, 97833
[3]U.S. Forest Service, Pacific Northwest Research Station, La Grande, OR, 97850
[4]Westfield State University, Environmental Science Department, Westfield, MA, 01086

Abstract

Ungulates can negatively influence pollinator communities by consuming and trampling flowering plants that provide pollen and nectar resources. However, nearly all studies that investigate the association between ungulates and pollinators examine domestic (e.g., cattle and sheep) instead of wild (e.g., deer and elk) species. Compared to domestic ungulates, wild ungulates are typically more selective feeders, have smaller body sizes, are less controlled by human activities, and provide substantial economic and cultural values through hunting and wildlife viewing opportunities. To understand the individual and additive effects of domestic and wild ungulate grazing on pollinators, we manipulated ungulate assemblages in a 3-year experiment and observed the response of bee and flower communities and bee-flower interaction networks. We found an additive effect of wild and domestic ungulates, with cumulative herbivore activity being negatively associated with bee and flower abundance. Several elk-preferred flowering forbs were also the most attractive to bees and occupied important positions in bee-flower networks. Given these results, we developed a conceptual model to inform management of working lands in ways that support both wild ungulates and pollinators. Active vegetation management that increases the nutritional value of patches in space, but especially during periods of resource bottlenecks, can reduce diet overlap between wild ungulates and pollinators. Understanding the ecological drivers of wild ungulate-pollinator interactions can inform working lands management to sustainably provision ecosystem services for human well-being.





54 What do we know about negative effects of competition between honeybees and wild pollinators?

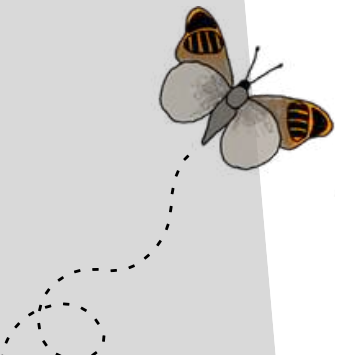
FULL LENGTH TALK

Bjørn Arild Hatteland[1], Jo S. Hermansen[2], Lawrence R. Kirkendall[3], Claus Rasmussen[4], Kristin O. Seljetun[2], Markus A.K. Sydenham[5], Henning Sørum[6], Anders Nielsen[7]

[1]Norwegian Institute of Bioeconomy Research (NIBIO), Div. for Biotechnology and Plant Health
[2]Norwegian Scientific Committee for Food and Environment
[3]University of Bergen, Dept. of Biological Sciences
[4]Aarhus University, Dept. of Agroecology
[5]Norwegian Institute for Nature Research (NINA), NINA Oslo
[6]Norwegian University of Life Sciences (NMBU), Dept. of Paraclinical Sciences
[7]Norwegian Institute of Bioeconomy Research (NIBIO), Div. for Food Production and Society

Abstract

Pollinators are under threat from a variety of environmental drivers, including habitat loss and fragmentation, pesticides, climate change, and invasive species. Despite being domesticated animals, honeybees share many traits with invasive species, and several studies have suggested that beekeeping might pose a threat to wild bees and other pollinators. In Norway, the history of beekeeping dates to at least the 18th century, yet little is known about the consequences of this agricultural practice on biodiversity, especially on wild pollinators. Here we present a recent summary of literature as well as risk assessments of honeybees in Norway and try to pinpoint gaps in knowledge of which negative effects and how severe they might be for wild bees and other pollinators. Risks were grouped into three potential hazards; competition for floral resources, spread of pathogens and parasites, and indirect effects from changes in plant communities and predators. Lastly, risk-reducing measures will be discussed. This will mainly be based on a recent report by the Panel on Biodiversity of the Norwegian Scientific Committee for Food and Environment in Norway (VKM Report 2024: 4).





55 Image-based monitoring using deep learning to assess beekeeping impacts on heathland pollinators

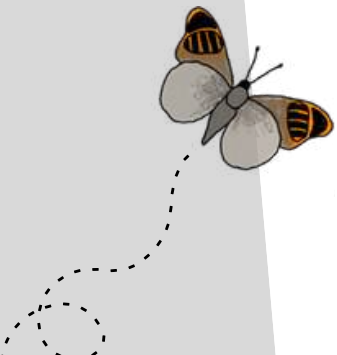
FLASH TALK

Hjalte Calberg Ro-Poulsen[1], David Bille Byriel[1], Henning Bang Madsen[2], Kim Bjerge[3], Lasse Gottlieb[1], Toke Thomas Høye[4], Yoko Luise Dupont[5] & Inger Kappel Schmidt[1]

[1]Department of Geosciences and Natural Resource Management, University of Copenhagen, Rolighedsvej 23, 1958 Frederiksberg C, Denmark
[2]Department of Biology, University of Copenhagen, Universitetsparken 15, 2100 Copenhagen Ø, Denmark
[3]Department of Electrical and Computer Engineering, Aarhus University, Finlandsgade 22, 8200 Aarhus N, Denmark
[4]Department of Agroecology - Agricultural biodiversity, Aarhus, Ole Worms Allé 3, 8000 Aarhus C, Denmark
[5]Department of Ecoscience, Aarhus University, C.F. Møllers Allé 4-8, 8000 Aarhus C, Denmark

Abstract

Beekeeping within and near protected areas has raised concern about honey bees having a negative impact on wild pollinators. Heathlands are semi-natural habitats, which accommodate a rich diversity of pollinators and are attractive locations for migratory beekeeping during the flowering of *Calluna vulgaris*. The potential impact of honey bees (*Apis mellifera*) was investigated, hypothesizing that the high densities of honey bees on heathlands could have a negative effect on the occurrence of wild pollinators. The study included eight heathlands in Denmark with different hive densities. At each site, five time-lapse cameras were placed above C. vulgaris, which captured a total 1,047,435 images during the month of flowering in August. Pollinators in the images were detected using a custom-trained YOLOv8 deep learning model. Detections were manually sorted, totaling nearly 50,000 pollinators, categorized as honey bees, bumble bees, solitary bees, butterflies, hoverflies and non-syrphid flies. *Calluna vulgaris* flowers late in the season after the phenology of most Danish species and the recorded pollinators generally consisted of common and migratory species. Nevertheless, landowners and beekeepers should consider the potential negative effects of high-density beekeeping on heathlands, and we emphasize the importance of introduction timing.





56 Two hundred years of changes in orchid pollination revealed using herbarium specimens

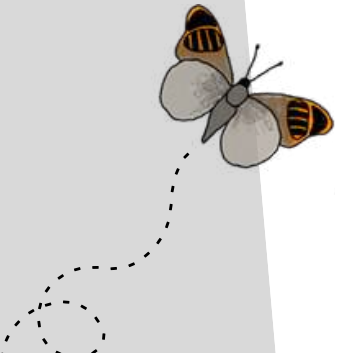
FLASH TALK

Mae Uniacke, Lola Torres-Montagner, Philip C. Stevenson, Carlos Martel

Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AE, United Kingdom

Abstract

Orchids are one of the most diverse plant families in the world. Unfortunately, more than half of orchid species are endangered due to habitat loss, climate change, the decline of pollinator populations, and their extraction for commercial purposes. While low pollination success is known for most orchid taxa with specialised pollination mechanisms, it is unknown whether pollination success was similar in the past or has changed over long periods of time. To get a better understanding of this, we used historical and modern herbarium specimens to assess changes in pollen exportation (i.e., assessing pollinarium removal) over the last 200 to 250 years in two orchid taxa with distinct pollination systems: the sexually deceptive bee orchids of the genus *Ophrys*, and the food-deceptive lady slipper orchids of the subfamily Cypripidinae (genera *Cypripedium, Phragmipedium,* and *Paphiopedilum*). We found that pollinarium removal significantly increased over time in *Ophrys*, whereas it strongly decreased in Cypripidinae. These changes in pollinarium removal over time were also associated with pollinator type and geographical region. Our results are consistent with current conservation status that considers that bee orchids are listed as not threatened, while many lady slipper orchids are. These contrasting findings reflect the role of orchid identity, particular geographical conditions and pollination strategy in shaping reproductive success under anthropogenic change. Overall, our study demonstrates the power of herbarium specimens to reveal long-term ecological changes, providing unique insights into the response of specific plant-pollinator interactions to increasing anthropogenic pressure.





57 DoPI: The Database of Pollinator Interactions

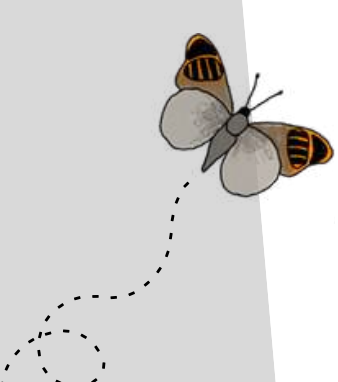
FLASH TALK

Nicholas Balfour, Maria Clara Castellanos

Department of Ecology & Evolution, School of Life Sciences, University of Sussex, Brighton, BN1 9QG, United Kingdom

Abstract

Effective pollinator conservation requires understanding not only where pollinator species occur, but also the plants that sustain them and how these interactions vary across space and time. However, plant-pollinator interaction data remain fragmented across scientific publications, monitoring schemes, and unpublished datasets, limiting the development of evidence-based conservation strategies. The Database of Pollinator Interactions (DoPI) addresses this challenge by providing an open-access platform that collates, standardises, and harmonises plant–pollinator interaction records within a common framework. Originally developed from published and contributed datasets in Britain, DoPI has expanded through the Horizon Europe Butterfly project into a pan-European evidence base containing over 650,000 curated records representing more than 1.3 million documented interactions. These data comprise interactions involving over 6,000 pollinator species and 3,000 plant species, drawn from more than 600 publications and contributed datasets and encompassing over 70,000 unique plant–pollinator pairwise interactions. By linking interactions with standardised taxonomy, geographic and temporal information, habitat context, sampling methodology, and bibliographic metadata, DoPI enables large-scale analyses of pollinator resource use, plant importance for conservation, and changes in plant-pollinator communities. The database supports research into pollinator declines, habitat restoration, biodiversity monitoring, and the identification of key plant resources required to maintain diverse pollinator assemblages. Together, these features transform dispersed ecological observations into a reusable research resource and provide a scalable framework for integrating plant–pollinator interaction data across Europe. DoPI therefore creates new opportunities to examine how these interactions respond to environmental change and to strengthen the evidence base for pollinator conservation.





58 Functional traits modulate solitary bee species turnover along potential dispersal corridors in fragmented grasslands

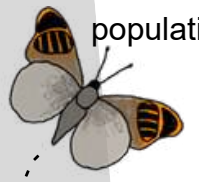
FLASH TALK

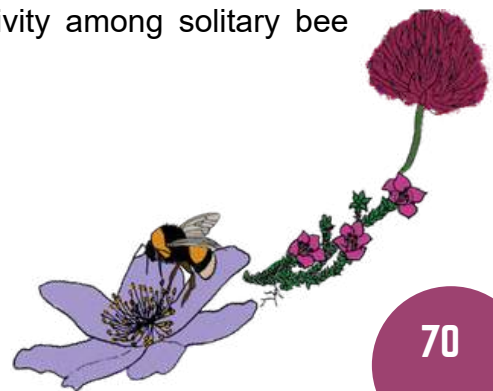
Marianne S. Torvanger[1,2], Océane Bartholomée[3], Bastiaan Star[1], Markus A. K. Sydenham[2]

[1]Centre for Ecological and Evolutionary Synthesis, Department of Biosciences, University of Oslo, NO-0314 Oslo, Norway
[2]Norwegian Institute for Nature Research, NINA, NO-0855 Oslo, Norway
[3]Department of Earth and Environmental Sciences (MGeo), Lund University, Lund, Sweden

Abstract

Understanding connectivity between wild bee populations is essential to mitigating negative impacts of habitat fragmentation. Among wild bees, solitary bees are often more affected by fragmentation than social bees. Solitary bees differ in their sensitivity to fragmentation, yet we still lack a clear picture of how functional traits shape species turnover and connectivity. Habitats likely to facilitate movement of wild bees include semi-natural grasslands and edge habitats, and potential dispersal routes can be identified using least cost paths (LCPs) based on the amount of these habitats in the surrounding landscape. Here, we quantify trait-dependent distance–decay of solitary bees in South-East Norway using species site-pair occurrence modelling (SSPO). We model the change in pairwise occurrence as a function of functional traits and their interactions with LCP length. We find a clear trait-dependent distance–decay: warm-associated, nest-excavating, smaller bees had a higher predicted pairwise occurrences along LCPs than cold-associated, renters and larger bees. We observe distinct species-specific responses: most species (n = 19) have a negative response to increased LCP lengths (i.e., less connected populations throughout the landscape) while two species have positive responses, suggesting that their populations are well connected (*Andrena fucata* and *Hylaeus confusus*). These results demonstrate that functional traits strongly influence community similarity and conservation efforts should prioritise enhancing habitat and stepping-stone patches for trait groups most negatively affected by increased resistance. Given the clear distance–decay in community similarity, maintaining networks of grasslands and linear elements (e.g., field margins, hedgerows and road verges) is recommended to reduce resistance and facilitate connectivity among solitary bee populations.





59 Buzzing insights: using sound to classify bees and understand buzz- pollination dynamics

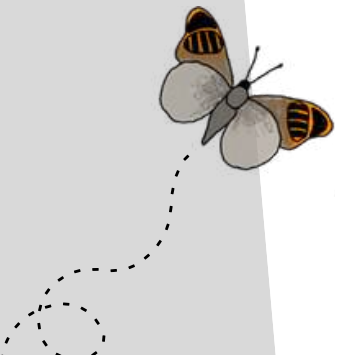
FULL LENGTH TALK

Vinícius L. G. Brito

Federal University of Uberlândia, Uberlândia, Brazil.

Abstract

Buzz pollination is a fascinating phenomenon in which bees use thoracic vibrations to extract pollen from tube-like anthers. Part of the mechanical energy produced by these vibrations propagates through the air as sound, leaving detectable acoustic signatures around flowers. In this talk, I will show how these sounds modify the local acoustic environment and how they can be used to identify bee species and characterize their interactions with flowers. I will also discuss the potential of acoustic monitoring to reveal when, where, and how pollination occurs. These signals offer new opportunities to investigate plant–pollinator interactions remotely, non-invasively, and at low cost.





60 The more the smellier? Effects of polyploidization on floral scent

FULL LENGTH TALK

Karin Gross[1], Elisabeth Schlager[1], Stefan Dötterl[1], Eliška Trávníčková[2], Filip Kolář[2], John N. Thompson[3], Magne Friberg[4]

[1] Department of Environment and Biodiversity, University of Salzburg, Austria
[2] Department of Botany, Charles University, Prague, Czech Republic
[3] Department of Ecology and Evolutionary Biology, University of California, Santa Cruz, USA
[4] Department of Biology, Lund University, Sweden

Abstract

Polyploidization and pollinators are key drivers of the evolution and diversification of flowering plants. Mixed-ploidy species (i.e. specie with populations of different ploidy levels) are ideal to study how polyploidization affects plant phenotypes, such as floral traits that are involved in the plants' interaction with pollinators. Effects of polyploidization have often been shown for plant and floral morphology. Here, we assess how polyploidization affects floral scent, which is key to many interactions of plants with pollinators. Floral scent was quantified in natural, established diploids and polyploids as well as in synthetically generated neo-polyploids in greenhouse common-garden settings to assess both the direct effects of polyploidization on floral scent and its long-term effects in combination with other evolutionary processes, such as selection mediated by pollinators. We present data on how floral scent differs between established diploid and polyploid plants and between synthetically generated polyploids compared to their diploid progenitors in two systems: (i) the plant *Lithophragma bolanderi* (Saxifragaceae) interacting with two highly specialized moth pollinators of the genus *Greya* (Prodoxidae) and (ii) the plant *Arabidopsis arenosa* (Brassicaceae) with a more generalized pollination system. Together, these results provide novel insights into the effects of polyploidization on floral scent, how these could affect the interactions of plants with pollinators, and how consistent they are among species.





61 Why should pollen limitation be rare or adaptive?

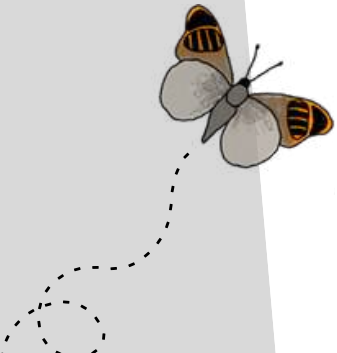
FULL LENGTH TALK

Wilhelm H. A. Osterman, Camila Pacheco-Riaño, Julia Osterman, Anne Bjorkman

Department of Biological and Environmental, Sciences, University of Gothenburg, Gothenburg, Sweden

Abstract

Pollen limitation is one of the most widely used measures of pollination success in plants, yet its underlying causes and ecological significance remain debated. Rather than reflecting persistent constraints on plant reproductive success, pollen limitation has often been interpreted as a short-term consequence of stochastic variation in pollinator activity or resource availability. Other explanations suggest that estimates of pollen limitation may arise from experimental artefacts, or that plant reproduction is ultimately constrained by resources rather than pollen availability. However, empirical support for many of these explanations remains limited. In this talk, I examine the assumptions underlying the suggestion that pollen limitation should be rare. I empirically test whether pollen limitation is a transient or persistent feature of plant populations and whether its estimated magnitude increases when fewer flowers receive supplemental pollination, as has frequently been suggested. I show that pollen limitation is often consistent across years and that more extensive pollination treatments seldom substantially change its estimated magnitude. Finally, I revisit key theoretical frameworks that have been used to argue that pollen limitation should be rare and discuss how their predictions have been misinterpreted. Together, these findings challenge common assumptions about the causes and prevalence of pollen limitation and suggest that it may represent a more persistent constraint on plant reproduction than is often assumed.





62 Pollen tube-pollen grain relationship as a tool for characterising pollinator effectiveness

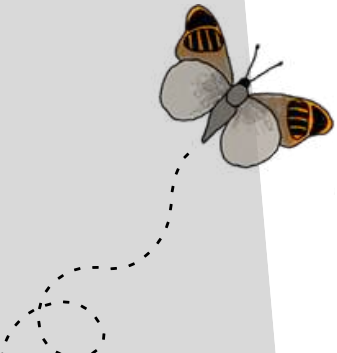
FULL LENGTH TALK

Javier Valverde[1], Tia-Lynn Ashman[2], Conchita Alonso[3]

[1]Dep. Biología Vegetal y Ecología, Universidad de Sevilla
[2]Dep. Biological Sciences, University of Pittsburgh
[3]Estación Biológica de Doñana (EBD-CSIC), Sevilla

Abstract

Pollinator effectiveness (PE) reflects the contribution of a flower visitor to a plant's reproductive success. Single-visit experiments usually measure the female component of PE either using estimates related to the pollination process (e.g. pollen deposition) or through estimates derived from the fertilisation process (e.g. seed production). We propose the dose-response relationship followed by the number of growing pollen tubes to that of conspecific pollen grains deposited on a stigma as a measure of PE that integrates both processes. In plant species with sporophytic incompatibility this estimate reflects the quality of the pollen deposited on a stigma, allowing to explore additional aspects that may affect PE such as self pollen transfer. *Lithodora fruticosa* is a self-incompatible Boraginaceae which has tubular flowers visited by long-tongued insects. Among these, *Andrena solenopalpa* is a highly specialised Andrenidae bee with unusually long mouthparts. We used the previously described methodology in single-visit experiments at the Sierra de Cazorla (Spain) in 2025 and 2026 to investigate whether this highly specialised species is the most effective pollinator. We demonstrate that *A. solenopalpa* transfers the greatest quantity and highest quality of pollen to stigmas of *L. fruticosa,* but that its importance depends on the spatio-temporal variation in the pollinator assemblage and their visitation rates. Our results highlight the value of this method for gaining a deeper understanding of the evolution of plant–pollinator relationships.





63 Global patterns of thermogenesis and pollination in plants

FULL LENGTH TALK

Lucía D. Moreyra[1], José María Postigo-Mijarra[2], Javier Mugueta Sanz[3], David Peris[1]

[1] Institut Botànic de Barcelona (CSIC-CMCNB), Barcelona, Spain
[2] Department of Biodiversity, Ecology and Evolution, Faculty of Biological Sciences, Complutense University of Madrid, Madrid, Spain
[3] Asociación Iberozoa, Madrid, Spain

Abstract

Floral thermogenesis, the ability of plants to generate heat in reproductive tissues through metabolic activity, is a remarkable trait that has evolved repeatedly across seed plants. Despite extensive research into its physiological mechanisms and ecological functions, important questions remain about plant thermogenesis. We compiled a comprehensive and up-to-date list of currently known thermogenic species based on an extensive literature review in order to examine their geographical distribution and identify potential ecological drivers of thermogenesis. Our dataset encompasses almost 400 species across multiple gymnosperm and angiosperm lineages, which is four times the number of species that have been identified as thermogenic up to now, and reveals a striking distribution of thermogenesis across tropical and subtropical humid biogeographical spaces. We further examine the interactions between thermogenic plants and their floral visitors to assess whether thermogenesis is associated with particular pollination syndromes. By compiling records of visitors and pollinators associated with thermogenic species, we identified a clear pattern in the composition and structure of these interactions. Coleoptera resulted the most abundant and diverse order of insects interacting with thermogenic plants. Together, our results provide a global framework for understanding the distribution and ecological significance of thermogenesis in plants.





64 Do pollinators trust floral repellent more than attractants?

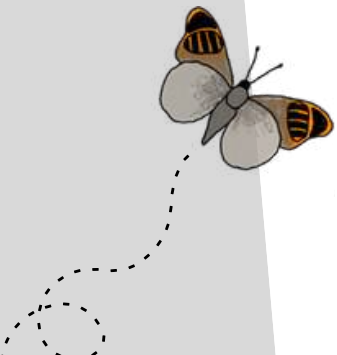
FULL LENGTH TALK

Molly J. Moseley[1], Upuli Wickramaarachchi[1,2], Michael T. Smith[1], Stuart A. Campbell[1]

[1]University of Sheffield, United Kingdom
[2]University of Ruhuna, Sri Lanka

Abstract

Volatile organic compounds (VOCs) emitted by flowers are an important mediator of visitation by pollinators. Floral VOCs have been shown to be vital for attracting insect visitors, particularly in specialised plant-pollinator relationships. However, the relative importance of attractant and deterrent VOCs remains unclear, and we have a poor understanding of the specific VOCs that allow generalist pollinator species to discriminate between low- and high-quality plants. Utilising *Solanum habrochaites*, a wild tomato species that exhibits high-within species divergence in floral VOCs, we experimentally induced herbivore stress responses, which include changes in its floral scent blend that are linked with pollen quality. Using this broad phenotypic variation, we identified candidate compounds hypothesised as either repellents or attractants based on whole-plant visitation trials and presented these as synthetic blends to naïve *Bombus terrestris* in a series of behavioural experiments using arrays of artificial tomato-flower mimics. Candidate attractants recruited significantly more visits than controls. However, compared to the magnitude of attraction, bees demonstrated stronger aversion to candidate repellent compounds. Attractants had the greatest effect on visitation at mid-range prior to visiting the flower, whereas repellents appeared to be functional at medium distance but also at close range, eliciting a reduction in feeding behaviour. Our results suggest that generalist bumblebees may rely more on repellent VOCs, rather than attractant compounds. Consequently, we relate our behavioural results to predictions from optimal foraging theory and propose that olfactory cues signalling poor rewards may convey more relevant information than attractant cues for foraging.





65 Same heat, different flowers: urban heat and flower richness are associated with species-specific changes in floral morphology and rewards

FLASH TALK

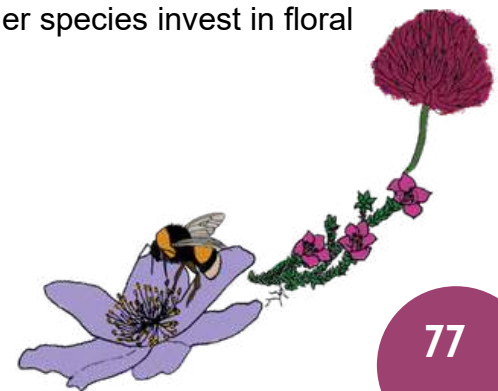
G. M. ten Kate[1], F. Bobinger[1], I. D. Castillo[1], M. Egerer[2], S. D. Leonhardt[1]

[1]Professorship for Plant-Insect Interactions, School of Life Science Systems, Technical University of Munich, Freising, Bavaria, Germany
[2]Professorship for Urban Productive Ecosystems, School of Life Science Systems, Technical University of Munich, Freising, Bavaria, Germany

Abstract

Floral traits play an important role in the attractiveness of flowers to pollinators, but different traits are known to change in response to biotic and abiotic stressors. For example, land-use change can affect floral display size and colour, but little is known about how the quantity and quality of floral rewards of different flower species respond to environmental changes. Urbanization is one of the largest drivers of land-use change in the world and is associated with increased temperatures and habitat fragmentation. Here, we aim to understand how urban heat and local flower richness affect flower morphological traits as well as the nutritional quality of nectar and pollen in urban community gardens in Munich and Berlin, Germany. We measured flower size and colour, nectar sugar concentration and pollen fatty acids and amino acids from six common insect-pollinated wildflower species in Germany. We found species-specific responses to temperature and floral richness. Flower size decreased with increasing temperatures for *Lamium purpureum* and *Trifolium pratense* only, while *Lotus corniculatus* and *Centaurea jacea* showed interactive effects between temperature and floral richness, and Taraxacum officinale and *Centaurea cyanus* were unaffected by either predictor. Flower colour did not change with temperature or floral richness across species. Nectar sugar concentration decreased with floral richness for *C. cyanus* and showed interactive effects for *T. pratense* and *C. jacea*, whereas *L. purpureum, T. officinale* and *L. corniculatus* were not affected. Similarly, the sum of fatty acids and the ratio of unsaturated to saturated fatty acids showed different responses to temperature and floral richness for different flower species. Our findings show that different flower species respond differently to urban heat and floral richness, where some species appear to invest more in morphological changes to attract pollinators and other species invest in floral resources to attract flower-visitors.





66 Floral scents and temperature affect the behaviour and mortality of bumblebees under silver lime (*Tilia tomentosa*) trees

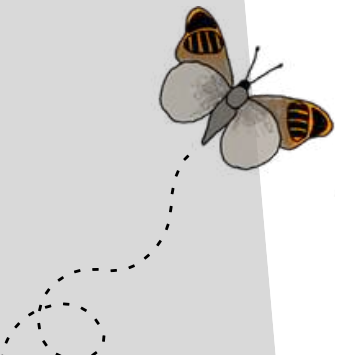
FLASH TALK

Anna Wright, Melina Dominguez-Olivares, Josef Kreidt, Hauke Koch, Philip C. Stevenson, **Carlos Martel**

Royal Botanic Gardens, Kew

Abstract

Silver lime trees (*Tilia tomentosa*) have long been associated with the mass mortality of bumblebees, particularly *Bombus terrestris*. Bumblebees are found paralysed on the flowers, especially on warm days, which suggests bees were psychotropically affected by the lime trees. To identify the causes of these effects, we tested: (a) the effect of lime tree floral volatiles and temperature on bumblebee behaviour and mortality; and (b) how lime trees affect neurotransmitter concentrations in bees. For (a), commercial B. terrestris workers were exposed to three *T. tomentosa* floral volatiles (limonene, terpinolene, β-ocimene) under two distinct temperatures (20 and 30°C), and behavioural responses were recorded and quantified. A significant chemical effect was observed, with bees exposed to terpinolene showing the least active and most static behaviour; temperature had a significant effect on mortality, with bees exposed to 30°C showing the highest mortality. For (b), the levels of γ-aminobutyric acid (GABA) in wild *B. terrestris* affected (paralysed) and unaffected (flying) by T. tomentosa were analysed and compared with those of bees foraging on non-Tilia plants. Paralysed bees on *T. tomentosa* flowers had a significantly lower relative abundance of GABA compared to both unaffected bees and those foraging on non-Tilia plants, while the unaffected bees also had significantly lower abundance compared to bees foraging on non-Tilia plants. Our results indicate that *T. tomentosa* floral scents, notably terpinolene, can induce paralysis-like behaviour in bumblebees and that bees incapacitated by volatiles may be more vulnerable to the effects of heat stress at warm temperatures.





67 Taking a step back from plant-pollinator-networks: the role of community structure, trait diversity and spatial heterogeneity

FLASH TALK

Arne Devriese, Virve Sõber, Tiit Teder, Tsipe Aavik

University of Tartu (Tartu Ülikool), Estonia

Abstract

Interaction networks have become a widely used approach for studying plant-pollinator interactions. However, their increasing popularity has raised questions about their appropriate use, interpretation and other potential concerns. These concerns can be both methodological, i.e. how to construct a representative network and analyse its properties, as well as conceptual, i.e. how ecologically meaningful these properties are. Early on, it has been argued that network metrics like specialisation, nestedness and modularity may reflect underlying patterns of functional diversity, species abundance distribution and spatial heterogeneity, rather than network-level organisation itself. Yet, good mechanistic explanations for how the ecological processes create these network properties are rare. Using basic principles of pollinator behaviour, we propose mechanistic explanations on how the most often used network metrics are affected by trait diversity, species abundance distribution and spatial heterogeneity. We acknowledge that certain concepts form interaction networks, like modularity, provide useful insights for better understanding and managing plant-pollinator interactions. However, we argue that changes in plant-pollinator networks often mainly reflect changes in community structure, functional diversity and spatial configurations. Hence it would be more appropriate to focus research questions on the latter. This will not only lead to more ecologically relevant research questions, but may also potentially be more time- and cost-effective than analysing interaction networks.





68 Heat impairs bumblebee pollination effectiveness and plant reproduction

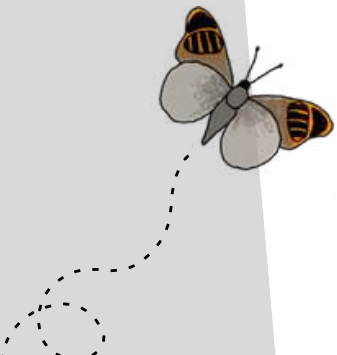
FLASH TALK

Guadalupe Sepúlveda-Rodríguez[1], Priscila Araújo[1], Luce Gay[1], Maxence Gérard[1,2], Anna T. Renner[1], Charlie Woodrow[3], Mario Vallejo-Marín[3], **Emily Baird[1]**

[1]Department of Zoology, Stockholm University, Stockholm, Sweden
[2]Laboratory of Zoology, Research Institute for Biosciences, University of Mons, Mons, Belgium
[3]Department of Ecology and Genetics, Uppsala University, Uppsala, Sweden

Abstract

Effective plant-pollinator interactions are critical for global food supply and biodiversity but increasing environmental temperature is predicted to disrupt them. Of particular concern are the rapid increases in temperature that occur during heatwaves, which are increasing in intensity and prevalence worldwide. While previous studies have indicated that heat affects insect foraging behavior, its direct impact on plant-pollinator interactions remains unexplored. To address this, we investigated the effect of temperature on the interaction between a buzz-pollinator, the bumblebee *Bombus terrestris*, and a buzz-pollinated plant, *Solanum rostratum*. When exposed to simulated heatwaves, bumblebees visited more flowers and spent less time on each flower and this change in behavior led to a reduction in fruit and seed set. We also found that increasing temperature led to a decrease in the amplitude, frequency, and duration of buzzes and that this variation may have some impact on pollen release. These findings suggest that temperature affects how insect pollinators interact with plants and that this, in turn, can impact the reproductive success of the plants they pollinate.





69 Focusing on pollinators: AI-automated vs. transect surveys in Transylvanian semi- natural grasslands

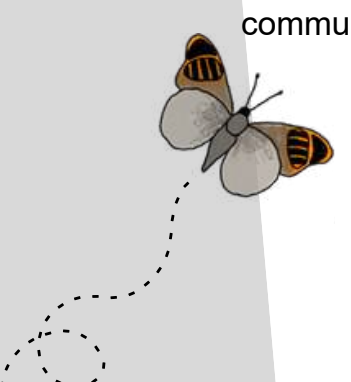
FLASH TALK

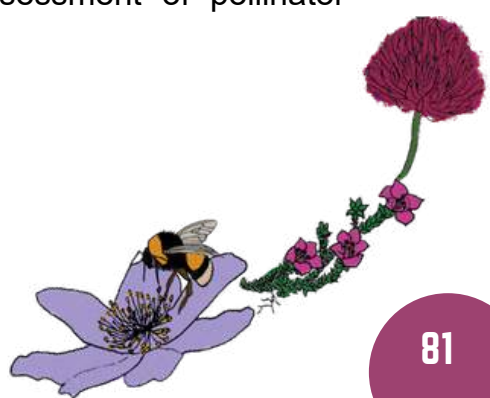
Natalia Timuş[1], Iulia Muntean[1], Zoltán László[1], Cristina Craioveanu[1], Maximilian Sittinger[2,3], Jonna Heuschele[2,3]

[1] Department of Taxonomy and Ecology, Babeș-Bolyai University, Romania
[2] Helmholtz Centre for Environmental Research (UFZ), Germany
[3] German Centre for Integrative Biodiversity Research (iDiv), Germany

Abstract

As global pollinator populations decline, scalable monitoring frameworks are urgently needed. AI-driven automation in monitoring plant–pollinator interactions offer a promising approach. As part of the Standardized European Monitoring of Plant–Pollinator Interactions (SEPPI) project, we evaluated AI-assisted camera trap monitoring (Insect Detect) compared to traditional transects over two field seasons (2024–2025) across hay meadows, abandoned grasslands, and grazed pastures in the Eastern Hills of Cluj, Romania (Natura 2000 Network). Preliminary findings indicate that automated monitoring captures overall pollinator abundance patterns similar to those recorded through transect surveys, particularly concerning land management effects. Both methods detected higher abundance in hay meadows and lower abundance in the grazed pastures. However, taxon-specific performance varied: transects detected Lepidoptera more effectively, whereas camera systems performed better for Diptera. Both methods were equally effective in identifying Hymenoptera. Bipartite interaction networks revealed distinct structural differences. While transect sampling provided broader spatial coverage, data were dominated by a single plant species (*Centaurea jacea*). In contrast, Insect Detect offered high temporal resolution, capturing a more complex and balanced interaction network across a wider diversity of flora. We conclude that automated camera systems such as Insect Detect are effective complementary tools for pollinator monitoring. When integrated with traditional field methods, they can balance spatial coverage with temporal depth, supporting a more comprehensive assessment of pollinator communities.





70 News and updates from the Journal of Pollination Ecology

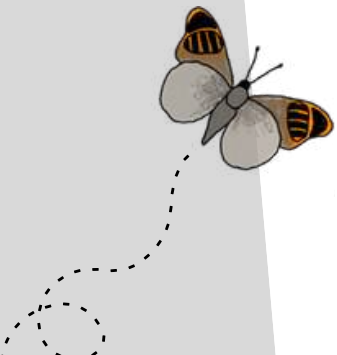
FULL LENGTH TALK

Maria Clara Castellanos, Carolin Mayer

Journal of Pollination Ecology

Abstract

News and updates from the Journal of Pollination Ecology





71 Origin and history of the Scandinavian Association for Pollination Ecology (SCAPE): a personal perspective

FULL LENGTH TALK

Jon Ågren

Department of Ecology and Genetics, EBC, Uppsala University

Abstract

In this presentation, I will give a personal perspective on the origin and history of SCAPE, which in 2026 celebrates its 40th annual meeting. I will sketch the prehistory of SCAPE, the contents and organization of the early SCAPE meetings and the history that followed. The first SCAPE meeting in 1987 was preceded by two other informal meetings attended by persons united in a loosely organized network of pollination biologists in Sweden. The size and geographic reach of the SCAPE meeting have increased markedly since the early years. The contents of the meetings have shifted reflecting changes in the research focus of pollination biologists in the Nordic countries but also because of the attraction of participants of an ever wider geographic origin. I suggest that our ability to maintain an informal atmosphere at the meeting has been crucial for its successful development and attraction. The meeting developed out of a wish to gather people with rather different interests and approaches to pollination biology. I think this will continue to be key for the further success of the meeting in the years to come.





72 Combined sexual and food plant mimicry in Ophrys

FULL LENGTH TALK

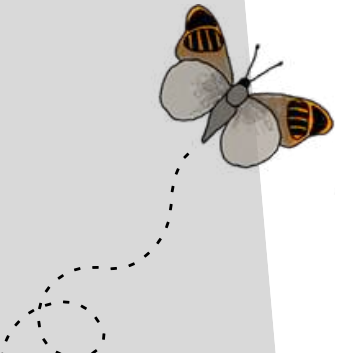
Thomas A. Veldhuis[1], Martin Streinzer[2], Marjan Kraaij[1], Barbara Gravendeel[3], Ola Olsson[4], Johannes Spaethe[5], **Casper J. van der Kooi[1]**

[1]Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, The Netherlands
[2]University of Vienna, Vienna, Austria
[3]Hortus Botanicus Leiden, Leiden, The Netherlands
[4]Lund University, Lund, Sweden
[5]Department of Behavioral Physiology & Sociobiology, University of Wurzburg, Wurzburg, Germany

Abstract

Sexually deceptive orchids have evolved exquisite tactile and chemical resemblance to their female insect models, yet how visual signals contribute to pollinator deception remains poorly understood. Here we reveal that *Ophrys* orchids deceive male pollinators through exaggerated floral visual cues, rather than precise mimicry, that mimic a female insect on a co-flowering food plant. Spectrophotometric analysis of flowers across the entire *Ophrys* genus shows that the dark labellum and glossy speculum function as visual superstimuli: their visual contrasts exceed those of the female insects they mimic. These exaggerated visual effects are caused by floral pigments, glossy surface reflections and diffuse scattering from interior structures. Field experiments with male pollinators validate the importance of colour signals in the sexual mimicry of *Ophrys* speculum. In addition to sexual deception, we show that additional (yellow) floral structures mimic the inflorescence colours of co-flowering Asteraceae that are food plants for the female model. *Ophrys* flowers thus exhibit structural and pigmentary effects to outperform the attractiveness of their model organisms, and represent a case of combined sexual and food plant mimicry.

Keywords: pollination, mimicry, sexual deception, evolution, visual signalling, Orchidaceae





73 The importance of pollination ecology 35 years ago and now, and in the future

FULL LENGTH TALK

Ørjan Totland

University of Bergen

Abstract

During the early years of SCAPE, about 35 years ago, pollination ecology was a small part of ecology, and the focus was quite different from now. Today, pollination ecology is everywhere, studied extensively and has broad and significant impacts on policy and everyday life of many people. With this development, the life of pollination ecologists has also changed. Before we were special, now we are mainstream. In this talk, I use the literature to describe how pollination biology has changed during the past 35 years, and I show that the field currently holds a strong position within ecology. I also highlight fields within pollination ecology where we perhaps should intensify research activity in the future.





IV Posters ABSTRACTS

Ordered by symposia

Floral Function and Evolution S1
Symposium 1

Ecology and Evolution of Co-Flowering Species Interactions S2
Symposium 2

Floral Evolution Along the Specialization-Generalization Continuum S3
Symposium 3

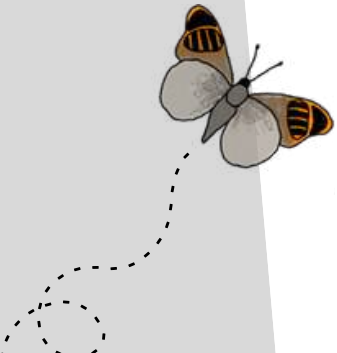
Pollination in Agricultural Landscapes S4
Symposium 4

Pollination in Arctic-Alpine Environments S5
Symposium 5

Conservation of Pollinators and Pollination S6
Symposium 6

Open Symposioum S7
Symposium 7

40th Anniversary S8
Symposium 8





S1

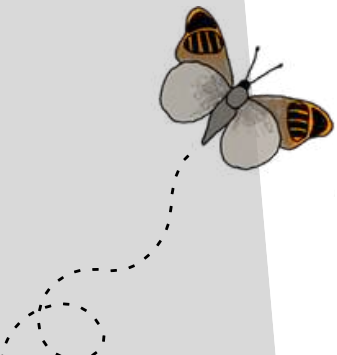
Flower colour polymorphism along an elevational gradient is shaped by temperature and pollinator dynamics

Jonathan Heinze[1], Gerd Vogg[2], Casper J. van der Kooi[3] & Johannes Spaethe[1]

[1]Julius-Maximilians-Universität Würzburg, Biocentre, Chair of Behavioural Physiology and Sociobiology, Am Hubland, 97074 Würzburg, Germany
[2]Julius-Maximilians-Universität Würzburg, Botanischer Garten, Julius-von-Sachs-Platz 4, 97082 Würzburg, Germany
[3]University of Groningen, Faculty of Science and Engineering, Groningen Institute for Evolutionary Life Sciences, Nijenborgh 7, 9747 AG Groningen, The Netherlands

Abstract

Flower colour polymorphisms can be shaped by interactions between biotic and abiotic factors, yet the mechanisms maintaining floral colour variation across environmental gradients remain poorly understood. We investigated the factors underlying flower colour variation in *Anemone pavonina* (Ranunculaceae), a perennial geophyte exhibiting an elevation-dependent colour polymorphism on Mount Olympus, Greece. Red-flowered morphs predominate at lower elevations (~300–1000 m a.s.l.), whereas purple-flowered morphs occur mainly above 1200 m, with both morphs co-occurring in a transition zone (1000–1200 m a.s.l.). The morphs are associated with different pollinators: red morphs are primarily visited by glaphyrid beetles, whereas purple morphs are predominantly pollinated by bees. We conducted field experiments to examine pollinator dependence in *A. pavonina*, as well as pollinator distribution, colour preferences, pollinator effectiveness, and pollinator importance. *Anemone pavonina* was strongly dependent on pollinators for seed production. Both colour morphs experienced pollen limitation, but limitation increased with elevation only in red morphs and resulted in near-complete reproductive failure at high elevations. This pattern correlated with a decline in the abundance of red-preferring glaphyrid beetles with increasing elevation. In contrast, bees remained present along the elevational gradient and preferentially visited non-red colours. Combined field and greenhouse experiments showed that red morphs consistently flowered later than purple morphs under the same conditions. Additionally, low temperatures, such as those found at elevations above 1000m, further delayed flowering and restricted corm growth in red morphs, whereas purple morphs maintained growth. Our results demonstrate that pollinator-mediated selection, together with temperature, maintains flower colour variation in *A. pavonina*. Strong pollinator dependence, spatial variation in pollinator abundance, and differential responses to temperature jointly contribute to the elevation-dependent distribution of colour morphs.





S1

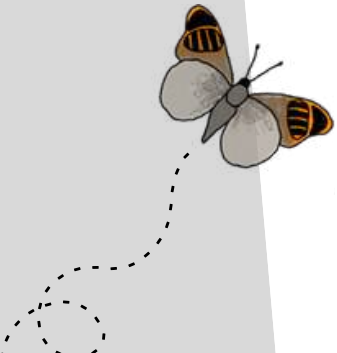
Floral longevity at the community level: a review of patterns

Daniel Cogolludo, Marcos Méndez

Area of Biodiversity and Conservation and Instituto de Investigación en Cambio Global, Universidad Rey Juan Carlos, Móstoles (Madrid), Spain

Abstract

Floral longevity, alongside flower number and size, is a key component of the floral display and, consequently, of the sexual reproductive success of angiosperms. Considerable effort has been devoted to understanding the intrinsic and environmental determinants of floral longevity. However, few studies have examined floral longevity at the community level. Through a literature review of 14 articles, this study analyzed longevity patterns at the community scale in 17 communities from tropical to temperate habitats and from lowlands to alpine sites. Focusing on mean values, variance, skewness, and kurtosis across altitudinal and elevational gradients, we found that floral longevity at the community level was consistently related to habitat openness and temperature. Communities in open/alpine habitats showed higher mean, variance and range of floral longevity, while communities in closed/tropical habitats showed the opposite pattern. Bias, CV and kurtosis were not clearly related to habitat. The consistency of community-level floral longevity patterns regarding four intrinsic factors: flower size, pollination syndrome, the presence or absence of floral nectar, and the sexual system (self-compatibility vs. self-incompatibility) were also studied. Levels of consistency were variable across variables and studies, suggesting very idiosyncratic influence of floral traits on floral longevity.





S1

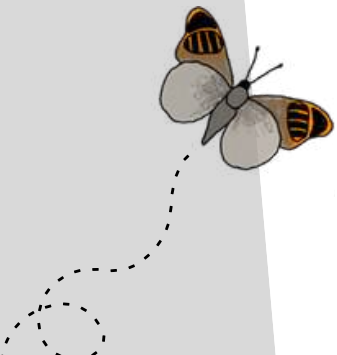
How flower morphology influences pollen explosive release in two Mucuna species with different pollination systems?

Kayna Agostini [1]; Marlies Sazima [2]

[1] Federal University of São Carlos, Center of Agriculture Science, Araras, São Paulo, Brasil.
[2] State University of Campinas, Department of Plant Biology, Campinas, São Paulo, Brasil

Abstract

The genus *Mucuna* exhibits explosive flower opening and remarkable diversification of pollination systems. Mucuna urens is pollinated by bats, whereas M. japira is pollinated by perching birds. This study investigated how the morphology and anatomy of the keel petals influence explosive pollen release and pollinator behavior in these species. The reproductive organs are enclosed within the keel and are released during explosive flower opening, projecting pollen onto the pollinator. The apical region of the keel, where the petals are stiff and united, functions as the trigger for flower explosion. We therefore analyzed the anatomy of this region in both species. In both, lignified cell walls occur in the inner mesophyll, and the non-lignified inner epidermis bears intertwined secretory papillae that keep the petals firmly united. However, secondary wall thickenings in the inner mesophyll were found only in *M. japira*, whose flowers require greater force to open than those of *M. urens*. These anatomical differences are consistent with their contrasting pollination systems. Mucuna japira is pollinated by the large passerine *Cacicus haemorrhous* (Icteridae), whereas *M. urens* is pollinated by the smaller bat *Glossophaga soricina* (Glossophaginae), whose distinct body sizes and foraging behaviors likely exert different mechanical forces to trigger explosive flower opening. Our results show that subtle differences in keel petal morphology and anatomy help explain how flowers with otherwise similar morphology are adapted to pollinators with contrasting functional traits.





S1

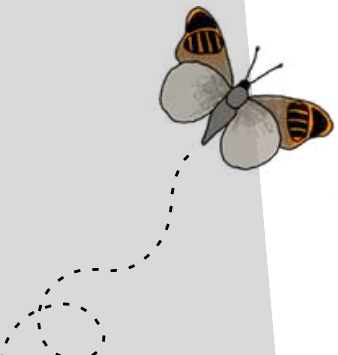
Timing and ecological roles of rhythms in floral traits: Is the circadian clock involved?

Akash Gupta, Roelof A. Hut, Casper J. van der Kooi

Groningen Institute for Evolutionary Life Sciences, University of Groningen, the Netherlands

Abstract

Flowers do not just produce rewards but also time their reward production in sync with their target pollinators. Studies on floral traits mainly explore the phenological context but not the temporal context. This review synthesizes the temporal context of flower traits and rewards. Flowers display pronounced diel or circadian rhythms. Diel rhythms depend on light or temperature cues with some level of entrainment by clock. Circadian rhythms depend on the circadian clock and persist even in constant light/dark conditions. For example, flower opening and closing in *Tulipa spp*. exhibits diel rhythm but in *Arabidopsis thaliana*, it exhibits circadian rhythm. Floral scent emission in *Rosa spp*. follows diel rhythm while in *Nicotiana attenuata* follows circadian rhythm. Floral nectar secretion in Cucurbita pepo follows diel rhythm whereas in Hoya carnosa, it follows circadian rhythm. Floral heating in *Symplocarpus renifolius* follows diel rhythm while in *Petunia spp.* it follows circadian rhythm. Young *Helianthus annuus* floral heads movement shows both, diel movement during the day and circadian movement at night to optimize heat acquisition on the floral head but mature floral heads show no movement. Thus, floral trait/reward rhythms persist significantly in flowers shaping their liking towards specific pollinators. But regardless of type, floral rhythms serve common motives: enhancing flower presentation when preferred pollinators are active, conserve energy by producing rewards only during relevant windows and protect flowers components when pollination is not likely. Therefore, flowers are highly dynamic temporal entities exhibiting diel or circadian rhythms across their traits/rewards for enhanced flower-pollinator interactions.





S2

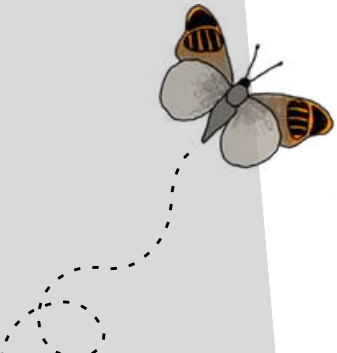
Colour and chemistry: how flowers signal reward-quality to pollinators

Larissa De Paola, Casper J. van der Kooi, Kira J. Tiedge

Groningen Institute for Evolutionary Life Sciences, University of Groningen, the Netherlands

Abstract

The majority of flowering plants depends on animal pollinators for reproduction and many animal pollinators rely on floral rewards (pollen and nectar) for their nourishment. Angiosperms attract pollinators through flowers that display different colours (visual signals) and complex floral fragrances (olfactory cues). In my PhD project we aim to characterize how floral signals and rewards evolve in a pollinator shift and how signals provide pollinators with reliable information about the quantity and quality of the reward offered. To answer this question we investigate at a broad taxonomic scale how floral signals and rewards evolve to match different pollinator sensory systems and nutritional requirements in plant sister-species that underwent independent pollination transitions. We analyse the optical properties of floral displays and through different visual models we evaluate how colours are perceived by pollinators. Floral scents and nutritional profile of nectar and pollen will be characterized and matched with the existing literature on pollinator physiology and ecology. Finally, we will assemble our results to understand which aspects of visual and olfactory signals are more informative about the rewards, if signals are correlated and if a common pattern of floral trait evolution is shared in unrelated angiosperm lineages. I will present our data on optical properties, volatile profiles, nectar and pollen chemistry of different flowering plants and the hypotheses framework.





S2

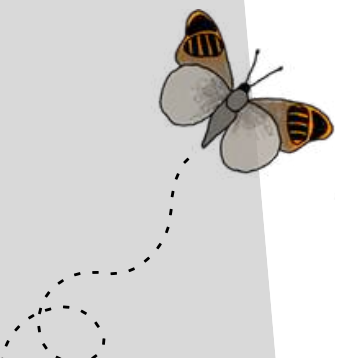
Species-specific responses of pollen germination to temperature

Marjan Kraaij[1], Casper J. van der Kooi[1]

[1] Groningen Institute for Evolutionary Life Sciences, University of Groningen, the Netherlands

Abstract

Temperature varies across elevations and latitudes, which may lead to plant adaptation. We investigated whether populations of the same species adapt to different temperatures along elevational and latitudinal gradients and different seasons. Using pollen germination as a measure of temperature tolerance, we compared *Anemone pavonina* populations from different elevations on Mount Olympus; *Papaver rhoeas* populations from the Mediterranean to central Europe and seasonal differences of flowering times (spring and summer) in *Ranunculus*. Our results suggest that adaptation to local temperature occurs in Papaver rhoeas and seasons (*Ranunculus*), though not in *Anemone pavonina* populations. Understanding temperature effects on pollen germination helps us predicting how plants respond to environmental conditions in a rapidly changing world.





S2

Towards Automated Plant–Pollinator Monitoring: Optimizing Plant Selection and Rapid Hoverfly Classification

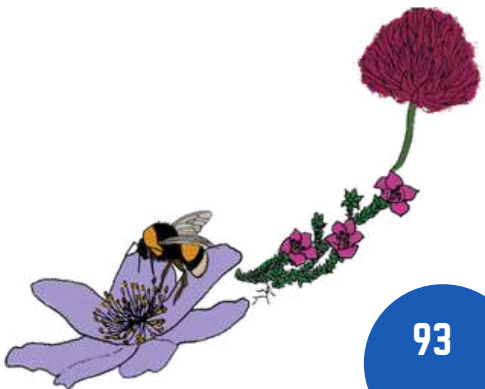
Yuping Zhong[1,2,3], Maximilian Sittinger[1,2,3], Valentin Stephen[1,2], Jose B. Lanuza[2,3,4], Jonna M. Heuschele[1,2], Will Glenny[1,2], Demetra Rakosy[5], Tiffany M. Knight[1,2,3,6]

[1] UFZ – Helmholtz Centre for Environmental Research, Department of Species Interaction Ecology, Permoserstr. 15, 04318 Leipzig, Germany
[2] iDiv–German Centre for Integrative Biodiversity Research Halle-Jena-Leipzig, Puschstraße 4, 04103 Leipzig, Germany
[3] Institute of Biology, Martin Luther University Halle-Wittenberg, Halle (Saale), Germany
[4] Mediterranean Institute for Advanced Studies (IMEDEA, UIB-CSIC), Mallorca, Balearic Islands, Spain
[5] Thünen Institute of Biodiversity, Braunschweig, Germany
[6] National Tropical Botanical Garden, Kalaheo, Hawaii, USA

Abstract

Traditional approaches to collecting plant–pollinator interaction data, such as transect walks followed by laboratory identification, are labour-intensive, costly, and dependent on specialist taxonomic expertise. Automated camera systems provide an efficient, relatively low-cost, and non-lethal alternative. Their successful implementation involves two key steps: first, detecting and capturing images of interacting insects; and second, identifying pollinator taxa from these images. However, both steps present important challenges. First, financial and logistical constraints limit the number of flowering plant species that can be monitored within each community. Using a database of plant–pollinator networks across Europe, we evaluated how plant subsampling affects estimates of pollinator richness and network structure. Across varying sampling efforts, we compared three plant-selection strategies with random selection: choosing the most abundant flowering species, abundant species representing different flower shapes, and phylogenetically distant species. Abundance-based strategies consistently outperformed random selection, with little additional benefit from incorporating flower shape, whereas phylogenetically informed sampling performed similarly to random selection. Second, automated taxonomic identification relies on cutting-edge, AI-based computer-vision methods that can rapidly classify insects from images. However, training, testing, and validating such classifiers are data-intensive and technically challenging. We therefore trained a classifier for hoverflies (Syrphidae), an ecologically important family of pollinators in which many species mimic wasps or bumblebees. The classifier achieved up to 93.1% accuracy when classifying previously unseen hoverfly images. It will next be validated using field images to assess its robustness under real-world monitoring conditions.





S3

Single-Visit Pollination by Functionally-Diverse Pollinators of Viscaria vulgaris

Aarushi Susheel, Felipe Torres-Vanegas, Vanda Témesvari, Zainab Awad Aliwi, Sophie Hecht, Ola Olsson, Magne Friberg & Øystein H. Opedal

aarushi.susheel@biol.lu.se , Department of Biology, Lund University, Sweden

Abstract

The large variation in floral traits is often attributed to pollinator-mediated selection. In specialised systems, a single plant species interacts with one pollinator group, whose preferences influence the floral trait optima. In generalised systems, one plant species can interact with several pollinator groups. Here, the preferences of multiple pollinator groups act together, and changes in the size and composition of the pollinator assemblage can alter the patterns of selection acting on the plant. Through my PhD, I am investigating how populations of the pollination-generalised flowering plant Viscaria vulgaris adapt to functionally diverse pollinator assemblages that vary across space and time. Preliminary analysis shows that each plant population supports different local pollinator assemblages with evidence for diverging phenotypic selection on floral traits. By integrating single- visit efficiency and pollinator visitation rates, I am now quantifying the 'importance' of pollinators in the local pollinator assemblage of each population. This ranking helps me assess the role of individual pollinators in an assemblage and understand how the combined preferences of the pollinator groups together shape floral evolution. Ultimately, these models could clarify the consequences of the global pollinator decline for floral evolution at a local scale.





S4

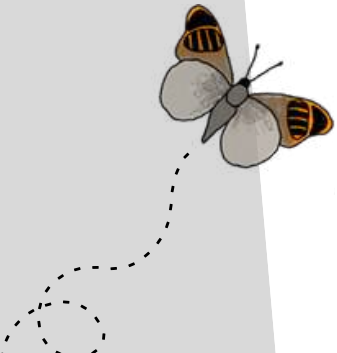
Prolonged heatwaves overpower behavioural compensation in greenhouse bumblebees

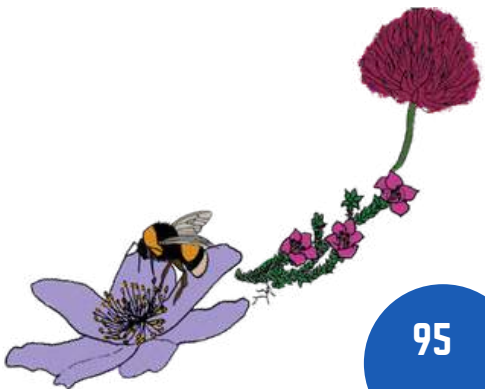
Stella Felsinger[1,2], Stuart Warwick[2], Geraldine Wright[1]

[1]Department of Biology, University of Oxford, South Parks Road, OX1 3EL, Oxford, UK
[2]Oxford Bee Ops, Longworth, OX13 5DZ, Oxford, UK

Abstract

Buff-tailed bumblebees (*Bombus terrestris*) are the principal commercial pollinator of greenhouse- grown crops, such as tomatoes, across Europe. During heatwaves, greenhouse environments routinely exceed bumblebees' preferred temperature range. Although individual behaviour and colony development under heat stress are well-studied under laboratory conditions, studies from commercial greenhouses are rare. Here we show that heatwaves have short- and long-term effects on bumblebee foraging activity in tomato greenhouses. Using a video-based entrance-monitoring system, we tracked flight and pollen-foraging activity of over 70 bumblebee colonies (*B.t. audax* and *B.t. terrestris*) over three 2026 heatwaves in three commercial tomato greenhouses in the UK and mainland Europe. Colonies compensated for high temperatures by fanning and shifting foraging outside of the hottest times of day. However, prolonged heat strongly reduced pollen foraging for over two weeks, consistent with potentially lower larval demand for pollen. Colonies placed below the crop did not show the same long-term reduction in foraging but foraged less overall. Our results identify temperature as a major driver of bumblebee pollen-foraging dynamics in tomato greenhouses and reveal a trade-off between protecting colonies from heat stress and maintaining pollen-foraging activity. With extreme-heat events becoming more frequent, greenhouse climate and pollinators must be managed in tandem to maintain reliable pollination services.





S4

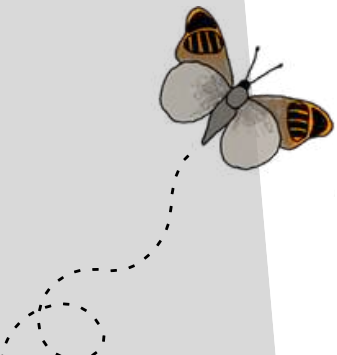
Tree-top heaven - flowering oaks as important food sources for bees

Anke Dietzsch, André Krahner

Julius Kühn Institute (JKI), Federal Research Centre for Cultivated Plants, Institute for Bee Protection, Braunschweig, Germany

Abstract

Tree canopies in bloom can serve as a valuable mass-flowering crop for bees. Particularly in urban environments, street trees may contribute to a network of flower-rich corridors connecting habitats favourable for bees. However, urban green space management may choose alien over native plant species for ornamental or site-specific reasons without considering that nectar and pollen of alien species may not be as suitable for bees as their native counterparts. One tree species that may be adopted by pollinators is the alien Red Oak (*Quercus robur* L.), native to North America. It is often planted conjoinedly with or instead of the native Common Oak (*Quercus robur* L.), an important pollen source for European bees. We sampled bees in the canopies of both species with flight interception traps (FITs) in spring 2025 and 2026. In addition, we counted bee visitors of male flowers in oak canopies at ±5 m height during focal observations in 2026. Bee communities sampled with FITs were dominated by non-eusocial bee species (93.4%), whereas honeybees (4,1%) and bumblebees (2.5%) were trapped relatively rarely. These ratios did not significantly differ between the native and alien oak species. Only a small subset of bee species actively foraged on the flowers of both, the native and alien oak species. Bees may not only have used canopies for foraging but also as rendezvous spots: before flowering commenced, FITs captured many male bee individuals in some of the canopies. Our results have methodological implication for sampling bees and may help inform urban management.





S4

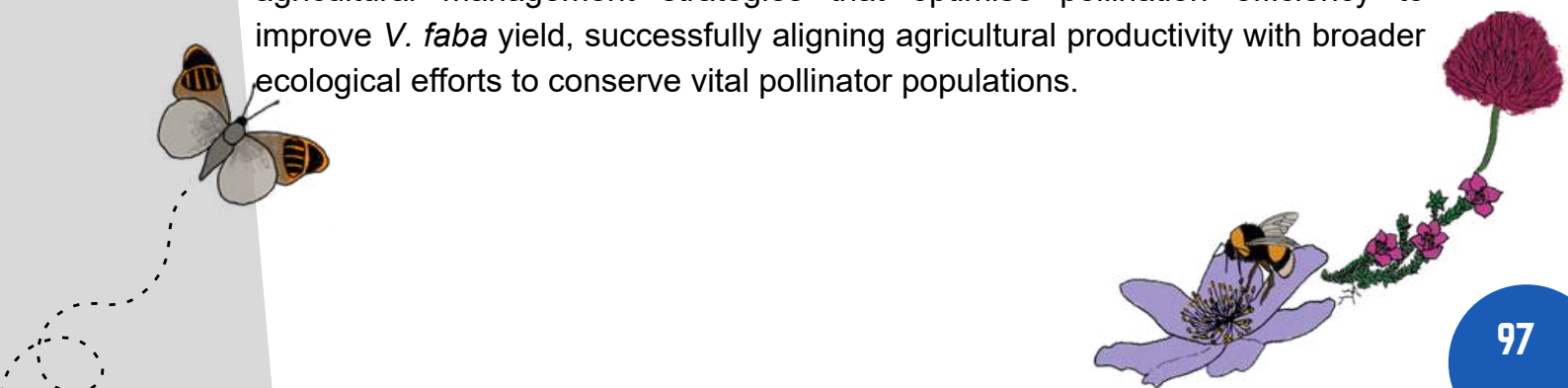
Optimising the pollination of *Vicia faba*

Charlotte Apsey[1], Alex Murphy[1], Tom Wood[2], Roger Vickers[3], Becky Howard[3]3, John Carr[3]3, and Beverley J. Glover[1]

[1]Department of Plant Sciences, University of Cambridge
[2]Plant Pathology Department, NIAB, Cambridge
[3]Processors & Growers Research Organisation (PGRO), Peterborough

Abstract

Vicia faba, a globally cultivated legume, is crucial for food security due to its high protein content, serving both human and animal needs. Therefore, optimising its yield is of particular interest in agricultural research. While traditional breeding programs focus on agronomic traits, enhancing floral characteristics to attract pollinators offers a promising avenue to boost yield while supporting pollinator biodiversity. Insect pollinators, vital to agriculture, are facing severe global declines, threatening food security and human health. Strategies to reverse this trend include promoting pollinator-friendly farming practices, such as planting wildflower margins. Mass-flowering crops like *V. faba* are also particularly important, providing significant nectar resources for foraging insects in agricultural landscapes. Within this project, pollinator-crop interactions are investigated tow two main ways; through looking at the floral traits that attract bees to the bean flowers, and through investigating the impact of flower-rich field margins on bean yield. By exploring how floral traits in different *V. faba* lines influence pollinator attraction and crop yield, we can identify traits that may encourage pollinator visitation. Specifically, this project investigates the scent and colour patterning of four commercially important *V. faba* lines, employing analytical, molecular genetic, and behavioural ecology techniques. This includes observing bumblebees, the primary pollinators of *V. faba*, under both lab and field conditions to assess how these traits affect their behaviour and visitation rates. Additionally, this project investigates the impact of flower-rich margins on crop yield, evaluating whether these margins enhance local pollinator populations and increase crop visitation or inadvertently divert pollinators away from the main crop. Ultimately, this research aims to identify both crop traits and agricultural management strategies that optimise pollination efficiency to improve *V. faba* yield, successfully aligning agricultural productivity with broader ecological efforts to conserve vital pollinator populations.



S4

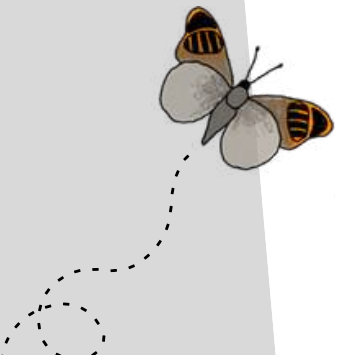
Seasonal dynamics of pollinator communities and pollination services in strawberries

Liam Kendall[1], Charlie C. Nicholson[2,3], Johan A. Stenberg4[4] and Henrik G. Smith[1,3]

[1]Department of Earth and Environmental Sciences, Lund University, Lund, Sweden
[2]Department of Biology, Marine Biology, and Environmental Science, Roger Williams University, Bristol, RI, USA
[3]Department of Biology, Lund University, Lund, Sweden
[4]Department of Plant Protection Biology, Swedish University of Agricultural Sciences, Lomma, Sweden

Abstract

Improving the sustainability of pollination-dependent crops requires understanding both the structure and function of pollinator communities. We combined pollinator-exclusion experiments with flower-visitor surveys across strawberry farms in southern Sweden. We assessed patterns across the flowering period, linking experimentally measured fruit responses with changes in visitor abundance, diversity and composition. Pollinator abundance, richness and community composition varied across the season, with strongly taxon-specific phenologies: *Andrena* peaked in mid-May, Lasioglossum and Syrphidae later in May, while *Apis mellifera* increased through June. These shifts coincided with cultivar-specific flowering windows, suggesting that cultivars encounter distinct pollinator communities during bloom. Open pollination increased fruit weight by 40-90% across three cultivars and consistently reduced fruit deformity. Interestingly, a small-scale trial showed that ant access produced fruit weights comparable to open pollination, highlighting a potentially underappreciated contribution of ants to strawberry pollination. Together, our results show that strawberry pollination dependency varies among cultivars, and that seasonal turnover in pollinator communities may influence the effectiveness of pollination services. Supporting diverse pollinator communities throughout the flowering season could therefore improve strawberry quality and production.





S4

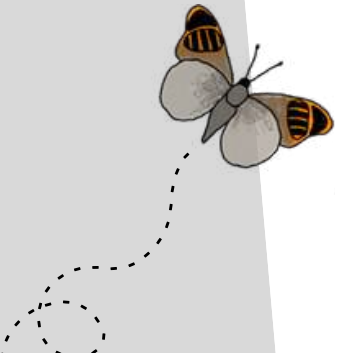
Biodiversity, screening and risk assesment of field-dose pesticides in hoverflies (Syrphidae) of Hardanger, Norway

Sara Rodrigues de Miranda[1], Bjørn Arild Hatteland[2], Roger Holten[2], Sven Roar Odenmarck[2], Ørjan Totland[1]

[1]University of Bergen, Department of Biological Sciences
[2]Norwegian institute for Bioeconomy research – Division for Biotechnology and Plant health

Abstract

Hoverflies (Syrphidae), are beneficial organisms, providing a range of important and diverse ecosystem services -and functions. Many hoverflies are natural enemies of aphids during their larval stage, and the majority are important pollinators as adults. Other species of this family have a wide array of larval habitats, ranging from various wood types, herbaceous plants, sap-runs and honeydew from aphids, to aquatic saprophagous. Due to this range of larval habitats, this family is suited as a model organism for detection of water-soluble pesticides in insects. Of interest are hoverflies with aquatic larvae, where exposure should be higher than other functional groups. An ongoing project is currently testing soil, air and water, we will be presenting results on pesticide concentrations in hoverflies for the purpose of this poster. This project aims to investigate what pesticides are present in agricultural landscapes and what concentrations can be found in adult specimens of hoverfly species in fruit growing districts of Hardanger, West-Norway. We used pan traps and found 54 species (900 individuals) across the field seasons 2024-2025. Most common are xylophagous species (*Xylota ssp*) and semi-aquatious Ferdinandea cuprea. Other common species were *Platycheirus ssp. Cheilosia ssp.* and *Sericomyia ssp.* Dominating pesticides found were fungicides, both in concentration and compounds.





S4

Historical trends of bumblebees in Germany: a literature-based overview

Antonio J. Perez-Sanchez[1], Niels Hellwig[1,2], Anne-Christine Mupepele[3], Demetra Rakosy[1,2]

[1]Thünen Institute of Biodiversity, Bundesallee 65, 38116 Braunschweig, Germany
[2]Department of Agriculture, Ecotrophology, and Landscape Development, Anhalt University of Applied Sciences, Strenzfelder Allee 28, 06406 Bernburg (Saale), Germany
[3]Animal Ecology, Department of Biology, University of Marburg, Karl-von-Frisch-Straße 8, 35043, Marburg, Germany

Abstract

Wild bees, including bumblebees, are essential to human well-being and economic production through their role in wild plant and crop pollination. Yet, growing evidence suggests that bumblebee populations are declining across Europe. Understanding these changes requires long-term data, but few monitoring programmes extend beyond a decade. Historical data can complement contemporary monitoring by providing a longer-term perspective, helping to place current trends in context and assess the magnitude of recent changes. Here, we present a literature-based historical overview of trend reports on bumblebees in Germany. We aimed to characterize reported trends and identify temporal episodes of relevant declines building on a systematic literature map by Mupepele *et al.* (2025) (https://doi.org/10.1186/s13750-025-00364-7). We screened 385 studies investigating changes in wild bee diversity over the last century and identified 230 mentioning bumblebees (*Bombus*, *Psithyrus*) for further full-text screening. For each publication, trend characterization involved classifying community changes (species occurrence and abundance) over time as positive (increase), neutral (no change), or negative (decrease), based on verbatim statements, reported species lists, and numerical values within the assessed publications. Preliminary assessment of studies published up to 1985 show a higher number of reports with neutral and negative trends than positive ones. Positive trends spanned from late-1800s to early-1900s, whereas neutral trends were scattered from early-1900s to mid-1980s. In contrast, negative trends occurred predominantly between 1918-1985, being consistently reported from 1965 onward. Although preliminary, these findings highlight a temporal shift from predominantly positive and neutral bumblebee trends in the early 20th century to consistently more negative reports after 1955. This synthesis provides a historical reference frame for interpreting current monitoring data and contemporary declines, and therefore may represent a historical baseline for designing time-aware bumblebee conservation strategies in Germany.





S4

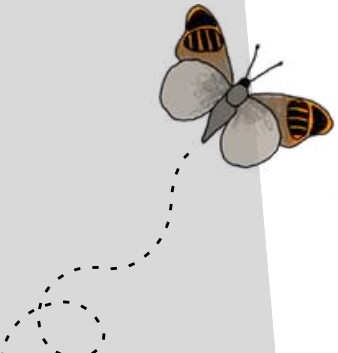
Pollinator community composition and pollen resource use in calcareous grasslands under different landscape contexts across Europe

Olivia Bernhardsson[1*], Epp Valdaru[2], Tsipe Aavik[2], Lucie M. Baltz[3], Tomáš Dostálek[4,5], L. Marie Ende[6,7], Kahlil Jegham[1], Marianne Kivastik[2], Zuzana Münzbergová[4,5], Hana Pánková4, Jan Plue[8], Patrycja Pluta[3], Iris Reinula[2], Virve Sõber[2], Panagiotis Theodorou[3,7], Sabrina Träger[6,7], Mari-Liis Viljur[1], Hans Jacquemyn[1]

[1]Plant Conservation and Population Biology Group, Department of Biology, Katholieke Universiteit Leuven, Kasteelpark Arenberg 31, 3001 Heverlee, Belgium
[2]Institute of Ecology and Earth Sciences, University of Tartu, J. Liivi 2, Tartu 50409, Estonia
[3]General Zoology, Institute for Biology, Martin Luther University Halle-Wittenberg, Hoher Weg 8, 06120 Halle (Saale), Germany
[4]Department of Botany, Faculty of Science, Charles University, Prague, Czech Republic
[5]Czech Academy of Sciences, Institute of Botany, Průhonice, Czech Republic
[6]Department of Biology / Geobotany and Botanical Garden, Martin Luther University Halle-Wittenberg, Am Kirchtor 1, 06108 Halle (Saale), Germany
[7]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Puschstrasse 4, 04103 Leipzig, Germany
[8]SLU Swedish Biodiversity Centre, Department for Urban and Rural Development, Swedish University of Agricultural Scieces, Almas allé 8, 750 07, Uppsala, Sweden

Abstract

Plant–pollinator interactions are essential for plant reproduction and insect fitness, ranging from specialized to generalized relationships. These interactions are dynamic and can shift under changing environmental conditions. Land-use change, in particular, may alter interaction patterns by modifying habitat area, connectivity, and resource availability, thereby influencing both biodiversity and pollinator foraging behavior. In this study, we compared pollinator community composition, resource use, and plant–pollinator network structure in calcareous grasslands across fragmented and connected landscapes in five European countries. Pollinator surveys were conducted to assess community variation, while pollen metabarcoding was used to characterize plant–pollinator interactions. Network analyses evaluated differences in interaction structure between landscape types. We found substantial differences in pollinator communities and pollen composition between fragmented and connected landscapes, resulting in high interaction turnover. Despite this, dominant taxa such as Asteraceae and Syrphidae remained consistently common across sites, indicating functional redundancy. Pollinators also consistently utilized plant resources from the surrounding landscape, regardless of landscape context. Consequently, overall network structure showed limited variation, with similar levels of connectance, nestedness, and modularity across landscapes. Overall, these findings indicate that pronounced differences in pollinator communities and opportunistic foraging strategies resulted in large interaction turnover, but these shifts did not translate into major changes in overall network structure, likely due to functional redundancy.





S4

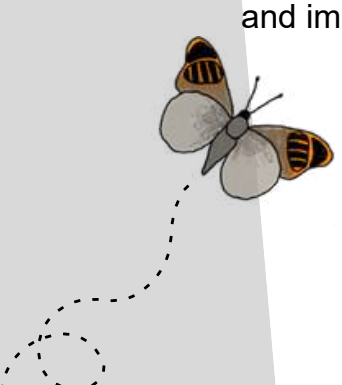
Pesticides on bumble bees across agricultural landscapes and placement of wildflower plantings in farms to reduce exposure

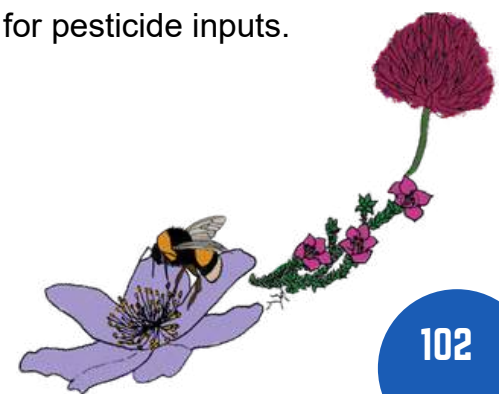
Rufus Isaacs[1], Blake Dawson[1], Sharron Miller[1], Logan Rowe[2], Scott McArt[3], and Kelsey Graham[4]

[1]Department of Entomology, Michigan State University, East Lansing, MI 48824, USA
[2]Michigan Natural Features Inventory, Michigan State University, East Lansing, MI 48824, USA
[3]Department of Entomology, Cornell University, Ithaca, NY 14850, USA
[4]United States Department of Agriculture, Agricultural Research Service, Pollinating Insects Research Unit, Logan, UT 84322, USA

Abstract

The Great Lakes region of North America has a community of bumble bees including abundant species and some that are threatened or endangered. As part of a project to identify locations with minimal pesticide risk for reintroductions of rare species, we sampled bumble bees across 48 sites in three landscape types – natural, urban, and agricultural – during two summers in Michigan, Ohio, and Indiana, USA. Twenty four sites were sampled, with *Bombus impatiens, B. griseocollis,* and *B. bimaculatus* being most common. The most common species were collected and analyzed for pesticide residues. Overall, 34 pesticide active ingredients were detected, with fungicides being most common, comprising 67% of detections from 18 fungicides. The pesticides with highest frequency of detection were fungicides azoxystrobin (41%), pyraclostrobin (24%), and trifloxystrobin (19%), with the herbicide metolachlor was in 23% of samples. High concentrations in individual samples included the fungicides boscalid (105.8 ppb) and mycobutanil (77.3), and the insecticides acephate (632.4), acetamiprid (200.0), chlorantraniliprole (106.1), and methoxyfenozide (86.8). Agricultural sites showed significantly higher fungicide and herbicide risk to bees, while insecticide risk was highest in urban sites but not significantly different from natural or agricultural types of sites. We also explored the change in pesticide exposure with distance from crop fields, to guide placement of wildflower plantings in ways that reduce risk. Sampling at least 24 m from the crop fields was required to significantly reduce fungicide exposure, highlighting the need for development and implementation of IPPM programs that limit the need for pesticide inputs.





S5

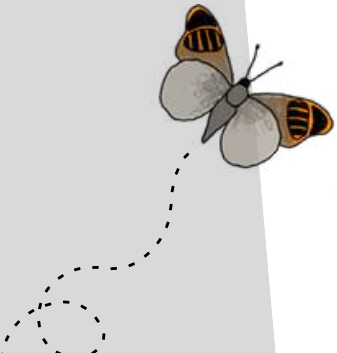
Pollination in the Arctic: Effects of land-use change on bumblebee community composition and the reproductive success of ericaceous shrubs

Olivia Boros-Fenyvesi

Lund University, Department of Biology

Abstract

In high-altitude and -latitude ecosystems where the effects of climate change are amplified, plant- pollinator interactions are under increased vulnerability. Land-use changes further disrupt these interactions, impacting how pollinators navigate their environment, affecting the reproductive success of the plants they pollinate. We investigate the effects of anthropogenic habitat opening on bilberry and lingonberry pollination by comparing a natural closed sub-alpine birch forest with a managed open ski-slope in northern Sweden. Further, we assess the effects of climate warming on lingonberry pollination, comparing bumblebee communities across high- and low-altitude environments. The two focus species of this study, bilberry (*Vaccinium myrtillus*) and lingonberry (*V. vitis-idea*) are keystone species providing important ecosystem services requiring buzz pollination performed primarily by bumblebees to maximize their reproduction. Therefore, we assess the effects that land use change and climate warming have on lingonberry production through a pollination experiment comparing berry dry weight, seed- and fruit-set across studied habitat types (open– closed, high–low altitude). Fieldwork was performed on Mount Nuolja, Abisko National Park during spring and summer 2026. Ongoing analyses aim to investigate the influence of human-driven habitat change on plant-insect interactions, comparing community composition of bumblebees visiting bilberry and lingonberry flowers between the birch forest and ski slope. We also aim to investigate how differences in bumblebee relative abundance affect lingonberry reproduction across all studied habitats. Results of our analyses will be interpreted in the context of the direct consequences of habitat management and indirect consequences of climate warming on plant-pollinator interactions in an Arctic ecosystem.





S6

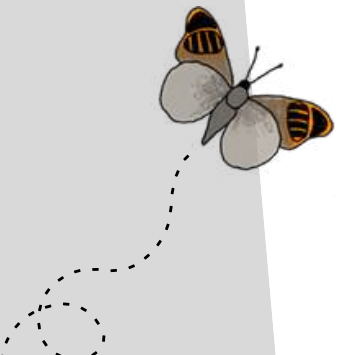
Satellite monitoring of pasture restoration

Linnea Sartorius[1,2] Isak Randahl[1,2], Delia Fano Yela[2,3], Georg Andersson[2], Sadegh Jamali[1], Aleksis Pirinen[2,3,4]

[1]Lund University
[2]RISE - Research Institutes of Sweden
[3]Climate AI Nordics
[4]Swedish Centre for Impacts of Climate Extremes (climes)

Abstract

EU's Nature Restoration Law and Sweden's biodiversity targets emphasise restoration of semi- natural grasslands and open habitats. These systems store carbon and host pollinators and other species groups important for ecosystem functions. However, to maintain a high biodiversity these habitats depend on well-timed grazing, which is lacking in many areas. Therefore, there is a need for restoration, and many areas can potentially be included in new restoration projects. Yet verifying where and when nature restoration occurs is difficult as field inspections are expensive and sparse, and self-reports are noisy. Earth observation (EO) can potentially streamline this significantly – satellites like Sentinel-2 provide free, multi-spectral imagery every few days over all of Sweden. In semi-natural grasslands restoration outcomes develop gradually, but satellite observations are influenced by weather, acquisition conditions, and processing artefacts, making it difficult to distinguish genuine restoration signals from unrelated temporal variation. In this work, we examine whether restoration status can be detected directly from satellite image time series by formulating pasture restoration as a binary deep learning classification problem. We are developing these techniques to scale up monitoring of nature restoration in agricultural areas across Sweden. Here, we evaluate two common deep learning architectures for satellite image time series on different Sentinel-2 image combinations, across 1,397 restored Swedish pastures and reach 0.88 accuracy for the best model.





S6

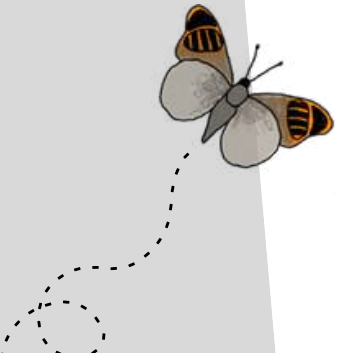
Developmental requirements for saprophagous hoverfly larvae (*Eristalis tenax*) in cow dung: application for future risk assessment

Lena Deck, Eabha Fitzpatrick, Simon Hodge, Dara Stanley

School of Agriculture and Food Science, University College Dublin, Ireland

Abstract

Insect pollinators are declining worldwide due to anthropogenic pressures, such as agricultural intensification and continued use of agrichemicals. Many studies have focused on how above- ground routes of exposure to pesticide may impact pollinators, for example when consuming contaminated pollen or nectar. However, relatively little is known about the implications of pesticide residues in soil, even though many pollinators depend on soil during various stages of their lifecycle. Some hoverflies, considered as one of the major insect pollinator groups, can be in close contact with soil during their larval stage, and are therefore potentially at risk from exposure to soil-borne toxins. As part of the EU Horizon project ProPollSoil, the aim of this study is to understand the lethal and sublethal effects of pesticide residues on the saprophagous hoverfly (*Eristalis tenax)* larvae developing in contaminated habitats. To achieve this objective, we are first developing a laboratory assay that produces consistent results and optimises the survival, development and growth of *E. tenax* larvae in uncontaminated cow dung. This study used artificial mesocosms to better understand *E. tenax* larval requirements, examining the effects of substrate composition, moisture, and temperature. It was found that substrate moisture was the main factor influencing survival and development duration, with larvae benefitting from an addition of water to cow dung. However, more tests are needed to understand if dung composition plays a role in larval survival. We recommend adopting these optimal assay parameters for future chemical tests, to provide better knowledge on larval response to pesticide residues in soil.





S6

How pollinator-friendly are central London and Edinburgh?

K. Tsiolis[1,2], N. Balfour,[5] S.G. Potts[2], K.C.R. Baldock3[3], A. Salisbury[4] and H. Barrett-Mold[1]

[1]Pollinating London Together, City of London, United Kingdom
[2]School of Agriculture, Policy and Development, University of Reading, Reading, United Kingdom
[3]Department of Geography and Environment Sciences, Northumbria University, Newcastle upon Tyne, United Kingdom
[4]Plant Health, Royal Horticultural Society, Wisley, United Kingdom
[5]Royal Botanic Garden Edinburgh, Edinburgh, Scotland, United Kingdom

Abstract

Urbanisation significantly shapes the presence, abundance, and distribution of flower-visiting insects worldwide. Although urban green spaces can provide beneficial habitats for pollinators, the drivers of pollinator abundance and diversity, and the limitations of urban areas, remain underexplored. Four annual rounds of transect surveys were conducted from 2023 to 2026 across each of 45 sites in central London and, in 2025 and 2026, 31 green spaces in central Edinburgh, including roof gardens, allotments, cemeteries, residential gardens, street planting, private gardens, public gardens, botanic gardens, and semi-natural green spaces, to assess pollinator diversity and abundance and the food resources available to pollinators. In London in 2025, the most abundant pollinator groups were honeybees (25%), bumblebees (23%), solitary bees (21%), and hoverflies (14%). The survey identified 57 bee species, 23 hoverfly species, 7 butterfly species, and 4 moth species. Most wild bees recorded were cavity nesters (82%), reflecting the availability of natural cavities in surveyed London areas. Our findings in Edinburgh reveal a generalist pollinator community dominated by bumblebees (45%) and honeybees (26%). By contrast, butterflies, moths, and beetles were notably scarce. However, semi-natural areas, allotments, and cemeteries sustained significant pollinator diversity. As cities continue to densify and expand, these findings emphasise that diverse plant communities are essential building blocks for the green infrastructure needed to sustain urban pollinator biodiversity.





S6

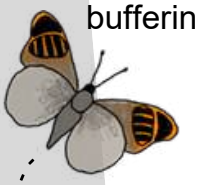
Climate variability shapes the stability of butterfly communities and their pollination interactions

Olivia Gardella[1*], Pau Colom[2], Constantí Stefanescu3[3], Jordi Corbera[4], Laura Blas[1] & Amparo Lázaro[1]

[1]Mediterranean Institute for Advanced Studies (CSIC-UIB)
[2]Centre for Research on Ecology and Forestry Applications (CREAF)
[3]Natural Sciences Museum of Granollers, BiBio Research Group;
[4]ICHN Delegació de la Serralada Litoral Central

Abstract

Understanding how climate variability affects pollinators is crucial for predicting ecosystem responses to global change. However, the mechanisms underlying the stability of ecological communities and interaction networks under climate change remain poorly understood. Using a dataset spanning 30 years across seven butterfly communities in northeast Spain, we examined how temperature and precipitation variability relate to stability, synchrony and spatial portfolio effects in 42 butterfly species and 126 butterfly–plant interactions. We also assessed the role of species and interaction diversity as drivers of stability. Butterfly and interaction communities were more stable and less synchronous when diversity was higher, while low precipitation variability enhanced butterfly community stability. At the population level, butterfly stability was higher under low diversity variability and high precipitation variability. Responses to climatic variability were trait-dependent: under increasing temperature variability, univoltine species showed reduced stability, whereas habitat generalists were more resilient than specialists. Host-plant generalists contributed more strongly to portfolio effects under higher temperature variability, while greater diversity variability increased synchrony under high precipitation variability, weakening portfolio effects. At the interaction level, specialist interactions were more stable under high precipitation variability, whereas the positive effects of diversity variability on stability weakened as temperature variability increased. Moreover, portfolio effects were driven by synchrony, which increased with precipitation variability but decreased with interaction diversity variability. Interactions involving generalist butterflies exhibited lower synchrony and stronger portfolio effects. Together, these findings highlight the key role of biodiversity and species traits in buffering ecological dynamics against environmental variability.





S6

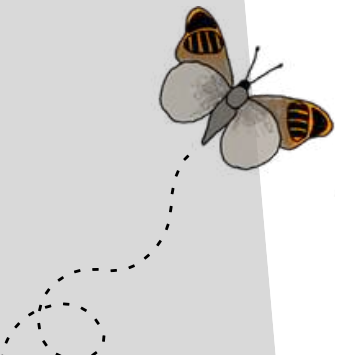
Multi-year manipulative field experiment reveals the impact of road-related urban stressors on plant-pollinator interactions

Stephanie Glendinning[1], Jill Edmondson[1], Jessica E. Stokes[2], Luke Tilley[2], and Stuart A. Campbell[1]

[1]School of Biosciences, University of Sheffield
[2]Royal Entomological Society

Abstract

Urban areas, characterised by highly fragmented greenspaces, present a challenge for pollinator conservation. Small green interventions, such as roadside verges or 'pocket parks', provide opportunities to establish floral resources in city centres. However, these greenspaces are frequently exposed to high levels of road traffic and associated environmental stressors, including heat, drought and pollution, which can impact urban pollinators by affecting the availability and quality of floral resources. We established a multi-year manipulative field experiment to investigate how urban stressors affect floral resource quality and pollinator diversity and abundance, using patches of wildflower turf established in pairs of high-stress (main road) and low-stress (minor road) grass verge sites across Sheffield, UK, while controlling for variation in local landscape quality and initial composition of floral resources. Observational and pan trap data revealed that the diversity and abundance of pollinators, namely bees, hoverflies and non-syrphid flies, were significantly lower on main roads compared to minor roads. Assessments of floral resilience, plant stress, soil moisture and NO2 and particulate matter pollution concentrations, supports the hypothesis that urban stressors associated with road type, particularly pollution, disrupt pollinator visitation as a result of changes to floral resources. Our findings suggest that conservation efforts to support pollinating insects in urban environments should consider how local urban stressors influence the quantity and quality of floral resources provided and the subsequent effect on local pollinators.





S6

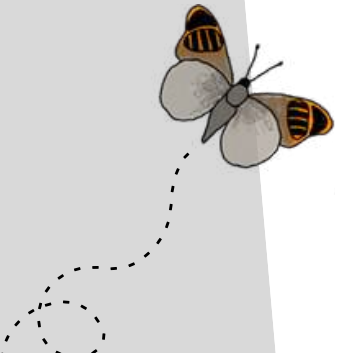
Monitoring bees diversity in agricultural landscapes: insights from four years of piloting

André Krahner[1], Wiebke Kämper[2], Oleg Lewkowski[1], Severin Polreich[1], Jens Pistorius[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Bee Protection, Messeweg 11/12, 38104 Braunschweig, Germany
[2]University of Göttingen, Agroecology & Functional Agrobiodiversity, Grisebachstrasse 6, 37077 Göttingen, Germany

Abstract

Although the pivotal role of pollinators in agroecosystems is well established, we currently lack substantial information about long-term trends in pollinator diversity within common agricultural landscapes throughout Germany. We are therefore piloting a monitoring scheme that combines pan- trap sampling with DNA-metabarcoding, targeting bees and other important pollinators. In spring 2023, we demonstrated the feasibility of yielding standardised samples while covering an area as large as one quarter of Germany. Since 2024, we have been piloting our monitoring scheme on a smaller spatial scale, but covering the entire flight season with multiple sampling rounds per year. Our sampling design is informed by region-specific data on phenology, so as to yield samples that are comparable between sites and years. We detected more than 40% of the bee species inventory of the study area. Accordingly, a significant proportion of bee species occurs in agricultural landscapes, corroborating the value of monitoring and conservation in agroecosystems. Honeybees were found at all sites and thus should not be excluded from bee monitoring. Data from digital hive scales can be used to derive seasonal honeybee colony development and activity at the regional scale. Supplementary projects that accompany our monitoring pilot are designed to close knowledge gaps regarding optimal methodology. From this research, for example, we have learned that biotope mapping within the German Ecosystem Monitoring framework creates synergies with our monitoring scheme.





S6

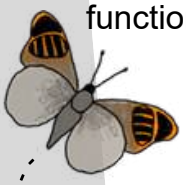
Long-term climatic and landscape changes shape beta and functional diversity of butterfly communities

Laura Blas Lussu[1], Pau Colom[2], Constantí Stefanescu[3], Olivia Gardella[1], and Amparo Lázaro[1]

[1]Global Change Research Group. Mediterranean Institute for Advanced Studies (CSIC-UIB)
[2]Pau Colom: Universitat de Barcelona, Departament de Biologia Evolutiva, Ecologia i Ciències Ambientals
[3]Natural Sciences Museum of Granollers, BiBio Research Group.

Abstract

Beta and functional diversity are fundamental components of functioning, stability, and adaptability in pollinator communities. However, how these dimensions respond to climate and land-use changes, major drivers of insect declines worldwide, remains insufficiently resolved. Here, we used butterfly records spanning 10-33 years across 88 communities of the Catalan Butterfly Monitoring Scheme (CBMS), to test how long-term changes in habitat (heterogeneity and openness) and climatic conditions (mean and interannual variability of temperatures and precipitation) influenced functional diversity (richness and evenness) and communities' local contribution to beta diversity (LCBD). Functional richness and LCBD decreased over time, whereas functional evenness increased. Regarding the effect of climatic variables, functional richness increased linearly with mean precipitation, whereas it showed a hump-shaped relationship with mean temperature, so that communities with intermediate temperatures where those with the highest functional richness. Functional richness was highest in years with a high deviation from the average temperature. Functional evenness and LCBD decreased as communities' mean temperature increased until a threshold of 12 °C from which both variables remained stable and low. Encroachment had the strongest habitat effects: functional richness increased, and functional evenness decreased with habitat openness until intermediate openness levels, with a small decrease in functional richness and increase in evenness when openness was highest. Overall, this study demonstrates that there is a gradual functional homogenization of butterfly communities, and that habitat encroachment and climatic changes modulate the functional diversity of butterfly communities, potentially affecting their stability and functioning.





S6

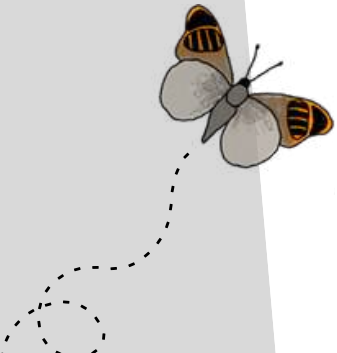
Buzzing Around SUDS: Pollinators and Sustainable Urban Drainage Systems

Andrada Opris[1], Gavin Ballantyne[1], Rob Briers[1], Bernd Hänfling[2]

[1]Edinburgh Napier University
[2]University of the Highlands and Islands

Abstract

Hoverflies provide key ecosystem services, yet their populations are declining due to land-use change and climate-driven phenological shifts. As Sustainable Urban Drainage Systems (SUDS) become mandatory in Scotland, understanding their biodiversity value is increasingly important. This project presents results from three seasonal sampling periods across two years, combining traditional surveys and eDNA methods across 60 SUDS sites in the Central Belt of Scotland to identify drivers of pollinator variation at different scales. Pollinators responded positively to floral richness and heather, but negatively to shade, intensive management, improved grassland, and urban cover. Findings will inform SUDS design to enhance water management while supporting pollinator and freshwater biodiversity, thus contributing to long-term urban ecological resilience.





S6

Grounding the Buzz: Experts' Insights into Soil-Dependent Pollinators

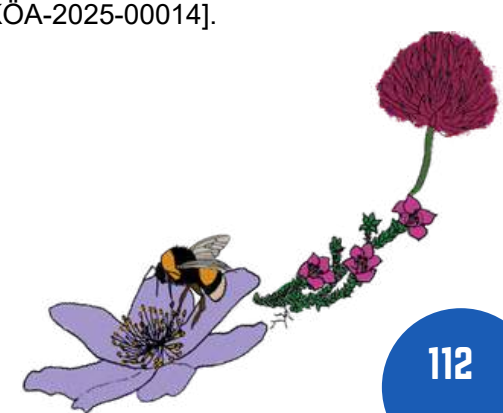
Maria Clara Castellanos[1], Jacek Jachuła[2], Claus Rasmussen[3], Zuzanna M. Filipiak[4], Michał Filipiak[4], Sara Diana Leonhardt[5], Astrid E. Neumann[5], Carmen A. Nebauer[5], Jovana Bila Dubaić[6], Nigel Raine[7], Alexander Keller[8], Martin Hvarregaard Thorsøe[3], Edward A. D. Mitchell[9], Dara A. Stanley[10], Markus A. K. Sydenham[11], Simon Hodge[10], Jorrit Poelen[12], Fabrice Requier[13], Jeff Ollerton[14,15], Vicente Martínez-López[16], Pilar De la Rúa[16], Aleksandra Splitt[2]

[1]University of Sussex; School of Life Sciences
[2]The National Institute of Horticultural Research
[3]Aarhus University, Department of Agroecology
[4]Jagiellonian University, Faculty of Biology, Institute of Environmental Sciences
[5]Technical University of Munich, TUM School of Life Sciences, Plant-Insect Interactions
[6]University of Belgrade, Faculty of Biology
[7]University of Guelph, School of Environmental Sciences
[8]Ludwig Maximilians University of Munich, Cellular and Organismic Networks;
[9]University of Neuchâtel, Laboratory of Soil Biodiversity;
[10]University College Dublin, School of Agriculture and Food Science
[11]Norwegian Institute for Nature Research
[12]University of California, Santa Barbara, Cheadle Center for Biodiversity and Ecological Restoration
[13]Université Paris-Saclay, CNRS, IRD, UMR Évolution, Génomes, Comportement et Écologie
[14]University of Northampton, School of Life and Environmental Sciences
[15]Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, China
[16]University of Murcia, Department of Zoology and Physical Anthropology, Veterinary Faculty

Abstract

A wide range of pollinators depend on suitable soil environments to complete essential life-cycle processes, including nesting and reproduction. Consequently, maintaining healthy soils is fundamental to support pollinator communities and the ecosystem functions they sustain. The pan- European ProPollSoil project, funded under Horizon Europe's Mission Soil, seeks to deepen knowledge of the relationships between soil quality and soil-dependent pollinators. The project's first steps aim to consolidate fragmented knowledge on soil-dependent pollinator biology, threats, and conservation strategies, much of which remains undocumented and preserved primarily as field-based experience. To gather and integrate experts' opinions, we implemented a two-stage Delphi survey. The initial survey phase involved 88 invited specialists, of whom 61 provided complete responses, representing 29 European countries. Experts were asked to list the threats affecting soil-dependent pollinators and potential conservation strategies, which will be ranked according to severity and priority, respectively, in the second round of the survey. Experts' recommendations for field observations highlighted the importance of background knowledge, appropriate design, and favourable observation conditions, including weather, timing, and nest detection methods. Preliminary findings revealed that fieldwork is often constrained by logistical difficulties, limited site access, and resource availability. The second phase of the survey engages 155 experts, with the data collection process planned to finish by late August 2026. This project receives funding from the European Union's Horizon Europe Framework Programme under Grant No.: 101219108 - ProPollSoil - HORIZON-MISS-2024-SOIL-01, the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract No. 25.00306, and the Hungarian NRDI Fund [2025-3.1.2-KÖA-2025-00014].





S6

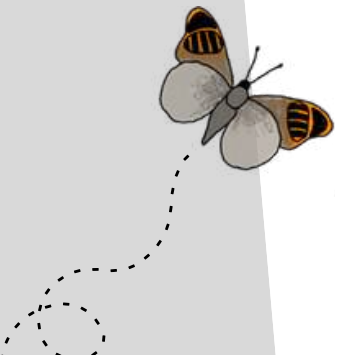
Mother knows best: sex-biased pollen provisioning in *Osmia bicornis*

Carlos Martel, Kavya Prabhakar

Royal Botanical Garden, Kew

Abstract

Solitary bees, the most important animal pollinators, support the reproduction of approximately 75% of flowering plants, yet their nutritional requirements are poorly studied. Unlike progressive feeding in social bees, solitary bee larvae complete their development on a single provision provided by the mother, sealed within its brood cell, making maternal foraging an important nutritional decision for her offsprings. In the red mason bee, *Osmia bicornis*, it is well known that females are larger than males, yet sex-biased maternal investments have been understood primarily only in terms of food quantity. Whether it also extends to sterol nutrients is still unknown. My study compares adult body mass, pollen-grain composition and sterol profiles between male and female diets and bees, using microscopy and liquid chromatography– mass spectrometry to understand their sterol chemistry. The results revealed that females were substantially heavier than males, but pollen-grain composition did not differ between sex-associated diets. The sterol composition, however, differed, with females having more variability in their sterol mixtures. Cycloartenol and cholesterol occurred at higher relative proportions in female-associated provisions, but only cycloartenol was also more strongly represented in female tissues. The sterolome in pollen and bees were substantially different, indicating that the sterolome of the bee does not simply reproduce its pollen diet. These findings suggest sex-associated sterol chemistry as an additional axis to understanding bee nutrition in *O. bicornis*, which is otherwise understudied. More broadly, my study shows that assessing floral resources by abundance alone overlooks chemical variation that may be important for solitary-bee development and reproduction.





S6

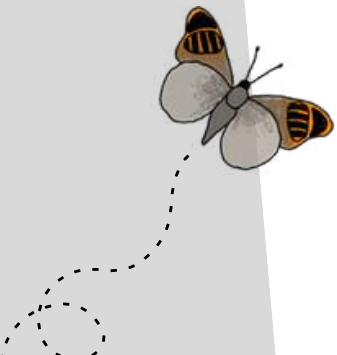
A non-toxic fungicide potentiates a commonly used insecticide in adult hoverflies

Silvia Rönnau, David C. O'Carroll, Maj Rundlöf, Lina Herbertsson, Elisa Rigosi

Department of Biology, Lund University, Sweden
Lina Herbertsson and Elisa Rigosi are co-senior authors.

Abstract

Pollinators in agricultural landscapes are frequently exposed to pesticide mixtures. Yet pesticide risk assessments are largely based on single-compound toxicity tests and a few model species, with pollinators only covered by bees, but not important non-bee pollinators such as hoverflies. Yet dipteran standard test species and their sensitivity to mixtures remains poorly understood. Here we investigated the effects of two neonicotinoid insecticides, imidacloprid and acetamiprid, and the fungicide tebuconazole, applied individually and in binary mixtures to *Eristalis tenax*. Hoverflies were exposed orally, and effect assessed over 48 h. Compared to honeybees, *E. tenax* was 110 times less sensitive to imidacloprid (LD50: 0.41 µg/fly vs 0.0037 µg/bee), while sensitivity to acetamiprid was similar (6.07 vs 14.53 µg/individual). Although tebuconazole alone caused no detectable mortality, synergistic interactions occurred both between the fungicide and the neonicotinoids and between the two neonicotinoids. Across treatments, 39% of individuals were moribund after 2 h, whereas only 22% were dead after 48 h. These transient effects varied independently of mortality, suggesting that standard lethal endpoints may overlook relevant consequences of pesticide exposure. Our results highlight the importance of understanding interspecific variation in pesticide sensitivity, particularly in relation to standard test species, effects of mixtures, and sublethal responses in assessments of pesticide risk. This is important for agricultural landscapes where diverse pollinator communities encounter complex chemical environments.





S6

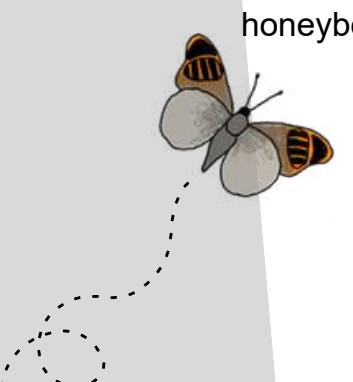
Species-, sex-, and exposure-route-variation in hoverfly sensitivity to flupyradifurone highlights the need for non-bee pollinator research

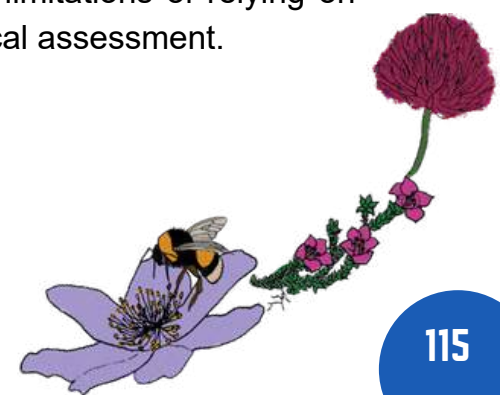
Terence Al L. Abaquita[1], Ligia Kuriańska-Piątek[1], Dominika Twaróg[2], Renata Śliwińska-Grochot[1], and Ryszard Laskowski[1]

[1]Institute of Environmental Sciences, Faculty of Biology, Jagiellonian University, Gronostajowa 7, 30-387 Kraków, Poland
[2]Institute of Nature Conservation, Polish Academy of Sciences, Adama Mickiewicza 33, 31-120 Kraków, Poland

Abstract

Aphidophagous hoverflies (Diptera: Syrphidae) provide crucial ecosystem services in agroecosystems: adults pollinate crops, whereas larvae suppress aphid pest populations. Yet pesticide hazard data remain scarce for hoverflies compared with bees, particularly for newer insecticides such as flupyradifurone (FPF). We tested whether acute FPF sensitivity varies by species, sex, and exposure route in 3- to 5-day-old adults of *Eupeodes corollae* and *Episyrphus balteatus.* FPF was applied topically (620–50,000ng/individual) or offered orally in 33% sucrose (10– 6,250ng for 2h) after starvation, with individual consumption quantified. Dimethoate served as a reference toxicant. Time-specific LD_{50}s and dose-specific LT_{50}s were estimated. FPF toxicity increased with time in both species, as reflected by declining LD_{50}s, while relative responses differed between exposure routes. Following oral exposure, *Ep. balteatus* showed lower LD_{50}s (48–96h) than *Eu. corollae.* This pattern reversed following topical exposure, with lower LD_{50}s (48-96h) in *Eu. corollae* than *Ep. balteatus.* LT_{50} also revealed markedly stronger effects after ingestion: at ~625ng/individual, LT_{50} was only 0.19d in *Ep. balteatus* and 0.14d *Eu. corollae*, compared with 7.40d and 4.16d after topical exposure at 620ng, respectively. Sex effects were likewise context-dependent: male *Ep. balteatus* showed greater sensitivity at 48–72h after oral exposure, whereas sex differences in *Eu. corollae* were evident in topical exposure, with males showing lower LD_{50}s 4-6h post-exposure. Hoverfly LD_{50}s (48h) ranged from 23.5–186.3ng/mg orally and 6,550–86,930ng/mg topically, versus ~59 and ~6,061ng/mg (respectively) in *Apis mellifera*. This variability across species, sex, and exposure route, highlights the limitations of relying on honeybee toxicity values alone in pesticide ecotoxicological assessment.





S6

Species Sensitivity Distributions in Butterflies towards Flupyradifurone: Implications for Risk Assessment

Dominika I. Twaróg, Katarzyna Kłak, Agnieszka J. Bednarska

Institute of Nature Conservation, Polish Academy of Sciences, Adama Mickiewicza 33, 31-120 Kraków, Poland

Abstract

Although pesticide risk assessment for pollinators is gradually expanding beyond *Apis mellifera* to include a wider range of species, some important pollinator groups, such as butterflies are still overlooked. This study aimed to determine the LD_{50} values for active substance flupyradifurone following oral exposure in adults of six butterfly species. Interspecific differences in sensitivity were observed among species, with 24h LD_{50} values of 16.7, 27.8, 41.6, 52.8, 68.5, and 126.4 µg/individual for *Aglais io, Aglais urticae, Gonepteryx rhamni, Papilio machaon, Polygonia c-album,* and *Pieris brassicae,* respectively, while the corresponding 168h LD_{50} values were 6.3, 8.2, 19.1, 10.0, 27.2, 2.6, respectively. Using a broader mortality criterion, including dead and moribund individuals, resulted in generally lower LD_{50} estimates, with 24h LD_{50} values being 16.0, 27.6, 25.6, 8.7, 42.2, and 3.88 µg/individual, respectively. This ranking may change once *A. urticae* dry body mass is available. Lipid content was measured in control individuals to assess whether it might explain differences in the sensitivity among tested species. *A. mellifera* appears to be more sensitive to flupyradifurone than tested butterfly species based on the 24 h LD_{50}. However, later time-point LD_{50} values indicate that the recommended application concentration may still pose a risk to some butterfly species, assuming their daily consumption. This research was part of the EU project PollinERA (HORIZON-RIA No. 101135005).





S6

Alternate floral resources within apple orchards increase apple flower visitation

Linn Vassvik[1,2], Anders Nielsen[1], Michael P. D. Garratt[3], Bjørn Arild Hatteland[1,4], Joseph D. Chipperfield[5], Erik T. Aschehoug[2]

[1] Department of Landscape and Biodiversity, Norwegian Institute for Bioeconomy Research (NIBIO), P.O. Box 115, 1431 Ås, Norway
[2] Faculty of Environmental Sciences and Natural Resource Management, Norwegian University of Life Sciences (NMBU), Høgskoleveien 12, 1430 Ås, Norway
[3] Centre for Agri-Environmental Research, School of Agriculture, Policy and Development, University of Reading, Earley Gate, Reading RG6 6AR, UK
[4] Department of Invertebrate Pests and Weeds in Forestry, Agriculture and Horticulture, Norwegian Institute for Bioeconomy Research (NIBIO), P.O. Box 115, 1431 Ås, Norway
[5] Norwegian Institute for Nature Research (NINA), Thormøhlens Gate 55, 5008 Bergen, Norway

Abstract

Apples are dependent upon pollinators for the transfer of pollen between cultivars to ensure high quality fruit production. Agricultural intensification has reduced the availability of stable floral resources for wild bees, leading to widespread declines of important pollinators of apples. Managed honeybees are commonly used to supplement pollination services in apple orchards, but honeybees are less efficient pollinators compared to wild bees. We investigated whether increased flower abundance in the understory vegetation of apple orchards can increase pollinator activity to apple flowers. We compared bee visitation in five orchards in Eastern Norway: three unmowed orchards, and two mowed orchards. In unmowed orchards, dandelions (*Taraxacum spp.*) dominated the understory vegetation. Bee observations were conducted on the understory vegetation and apple trees, via manual observations and time-lapse cameras. Wild bees preferentially visited apple flowers over dandelions, while honeybees did not differ in their visits to apple flowers and dandelion flowers. We also found that the abundance of dandelion flowers in the understory increased visits by wild bees to apple flowers. Taken together, this suggests that within orchard floral resources do not compete for pollinators but instead increase apple visitation and improve pollination success. Our results highlight the importance of managing apple orchards for wild bee populations and the potential short-term benefits of understory floral resources on apple production. Implications for insect conservation: Our results show that understory vegetation should be left unmowed to increase pollination of apple flowers and provide pollinators with alternate floral resources before, during, and after apple flowering.





S6

Feasibility of Standardized Social Wasp (Vespidae) Monitoring: A Step Towards Inclusive Pollinator Monitoring Schemes

Vicari G.[1], Ferrari A.[2], Polidori C.[3], Cini A.[1]

[1]University of Pisa, Pisa, Italy
[2]Free University of Bozen-Bolzano, Bolzano, Italy
[3]University of Milan, Milan, Italy

Abstract

Social wasps are undervalued pollinators and key ecosystem service providers, yet they remain largely excluded from standardized monitoring schemes. This taxonomic gap limits our ability to detect population trends and integrate social wasps into conservation planning, perpetuating a bias that hinders ecological research as well as insect conservation. Here, we assess the efficacy of a monitoring protocol already employed to detect other pollinators (mostly butterflies, bees, rarely hoverflies) in national and international monitoring networks. We compare this method, a modified Pollard transect, with two commonly used methods for social wasp monitoring: active search and passive sampling using baited traps. Fieldwork was conducted along two routes per site, at four sites in Italy, once every two weeks over six months. For each method, we quantified genus richness, diversity, and relative abundance. Transect walks and active search showed a marked agreement, overlap, and no significant difference in number and type of genera detected, supporting the effectiveness of transect walks for capturing social wasp diversity. Furthermore, both active monitoring methods outperformed baited traps in terms of taxonomic coverage and consistency. Our results demonstrate that standardized transect walks represent a low-cost, scalable, and transferable approach for monitoring social wasps. Integrating this protocol into existing insect monitoring frameworks would facilitate cross-regional comparisons and support evidence-based conservation of social vespids. Furthermore, this could promote the inclusion of wasps in broader pollinator monitoring initiatives, with profound implications for their conservation and public perception. Finally, this work raises concerns regarding the efficacy, sustainability, and ethics of lethal sampling.





S6

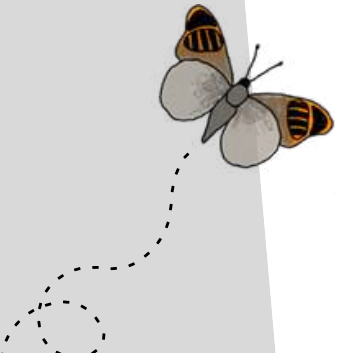
Native, diverse, sown wildflower patches enhance pollinators within a capital city of Eastern Europe

Virág Németh[1,2], Gabriella Süle[1], Miklós Sárospataki[2], Viktor Szigeti[1]

[1]Lendület Ecosystem Services Research Group, HUN-REN Centre for Ecological Research, Vácrátót, Hungary
[2]Department of Zoology and Ecology, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary

Abstract

Urbanisation, along with agricultural intensification, is one of the drivers of pollinator decline. Since pollinators are an essential part of the ecosystem, different interventions have been developed to support their populations in urban landscapes. One method is the sowing of diverse, native wildflower seed mixtures. We aimed to investigate how this treatment affects the pollinator communities within an East-Central European capital city. We studied 10 site pairs in Budapest, Hungary, in 2023 and 2024. Half of the pairs were sown with native wildflower seed mixtures as a pollinator-promoting intervention (treatment), while the other half of the sites were conventionally managed green spaces (control). We assessed how vegetation parameters, floral resources, pollinator abundance and species richness were affected by the treatment compared to the control sites. We also studied how these variables and treatment effects changed along ten sampling periods of two seasons after the beginning of the intervention. The treatment had a positive and mostly increasing impact on the vegetation parameters, floral resources, and pollinator communities. Our results can provide information that can help improve the effectiveness of urban pollinator-promoting interventions in Eastern Europe.





S6

Distinct Intra- and Interspecific Foraging Patterns of Stingless Bee Species as a Conservation Tool

Sissi Lozada-Gobilard[1,2], Pamela Cristina Santana[1], Yamil Maidana-Tuco[3], Elvis Otmar Gutierrez[4], Teresa Ortuño[3,4,5]

[1] Department of Biology, Biodiversity Unit, Lund University, Lund, Sweden
[2] Instituto de Ecología, Universidad Mayor de San Andrés, La Paz, Bolivia
[3] Carrera de Biología, Universidad San Francisco Xavier Chuquisaca (USFX), Sucre, Bolivia
[4] Universidad Católica de Carmen Pampa San Pablo, Yungas La Paz, Bolivia
[5]Instituto Experimental de Biología "Luis Adam Birançon", Facultad de Ciencias Químico Farmacéuticas y Bioquímica, Universidad Mayor, Real y Pontificia de San Francisco Xavier de Chuquisaca (USFX), Sucre, Bolivia

Abstract

Stingless bees (Meliponini) are important pollinators in tropical ecosystems and very abundant in the Bolivian Yungas region; yet little is known about their foraging behavior and floral preferences. In this study, we combined melissopalynology, pollen analysis from honey, with plant-pollinator interactions network to investigate foraging behavior and niche overlap of three rescued stingless bee species (*Tetragonisca angustula, Nannotrigona testaceicornis,* and *Paratrigona opaca*) in Bolivia's tropical Andes. Our results suggest different floral foraging patterns between bee species and hives. *Tetragonisca angustula* consistently preferred Melastomataceae across its hives, while *N. testaceicornis* and *P. opaca* showed more varied foraging patterns, with *P. opaca* favoring Oxalidaceae. Our results also indicate that these foraging differences are influenced by the types of flowers available, indicating that species interact with non-native species if they are in the area. Therefore, our results emphasize the need to preserve a high diversity of floral resources for bees, as well as maintaining diversity within and among stingless bee species to support plant–pollinator interactions in tropical ecosystems. The low level of niche overlap might be a way to avoid competition, with distinct foraging patterns both inter- (between species) and intra-specific (between hives). We encourage the use of native stingless bee species for honey production as a tool to promote conservation and reproduction of non-native and native plant species of the region.





S6

Species diversity of mites inhabiting the nests of wild bumblebees (Bombus spp.)

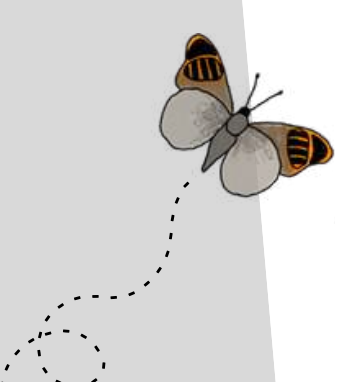
Elżbieta Rożej-Pabijan[1], Wojciech Witaliński[2], Waldemar Celary[3], Mikołaj Borański[4]

[1]Institute of Biology and Earth Sciences, Department of Zoology, University of the National Education Commission, Kraków, ul. Podchorążych 2, 30-084 Kraków
[2]Institute of Zoology and Biomedical Research, Department of Comparative Anatomy, Jagiellonian University, ul. Gronostajowa 9, 30-387 Kraków
[3]Institute of Biology, Department of Environmental Biology, Jan Kochanowski University, Kielce, ul. Uniwersytecka 7, 25-406 Kielce
[4]The Research Institute of Horticulture, Apiculture Division in Puławy, ul. Kazimierska 2A, 24-100 Puławy

Abstract

Mite species associated with wild bumblebees have so far been described on the basis of phoretic forms collected from bumblebees that visited flowers. Therefore knowledge about mite fauna inhabiting wild bumblebee nests remains limited. Bumblebee nests are annual microhabitats, characterized by a stable microclimate and the availability of diverse food sources and provide an opportunity to disperse along with adult bumblebees.The present study was conducted in Poland on eight nests of four bumblebee species: *Bombus terrestris* (Linnaeus 1758), *B. hortorum* (Linnaeus, 1761), *B. ruderarius* (Müller, 1776), and *B. pascuorum* (Scopoli, 1763). The species composition and abundance of mites were determined. The examined material comprises 596 specimens. Representatives of twelve mite species from five families were identified. The most abundant species were: *Leiodinychus orbicularis* (C.L. Koch, 1839) (Trematuridae, Uropodina) and *Tyrophagus putrescentiae* (Acaridae, Astigmatina). Among the representatives of Laelapidae (Gamasina), *Hypoaspis* (Pneumolaelaps) hyatti Evans & Till and *H. marginepilosa* (Sellnick) were the most common. The least numerous in the studied material were representatives of Gamasina from the Parasitidae family (genus *Parasitellus*). Our findings reveal that bumblebee nests have diverse and abundant mite communities, containing species that have a neutral or beneficial impact on bumblebees.

Keywords: nest fauna, social insects, bumblebees, microhabitats





S6

Strategies for pollinator habitat enhancement for biodiversity-friendly cities

Paolo Biella

University of Milano-Bicocca, Department of Biotechnology and Bioscience

Abstract

Reversing the decline of pollinators is a global goal, but cities, however, present a paradox: while urbanization fragments and reduces suitable green spaces, it can also offer unexpected opportunities by providing floral resources and nesting sites under certain conditions. With this contribution, I will introduce the challenges of improving habitats for pollinators in urban areas, by also highlighting their strengths and the promising aspects: I will present two case studies from recent research efforts dealing with the management of urban meadows by differential mowing to increase insect biodiversity and the potential role of ornamental plants and their traits for pollinators. The results clearly highlight that both the differential mowing and some, rather than others, ornamental plants can clearly increase pollinator diversity and abundance in urban green spaces. These research outputs are useful to foster thriving pollinator communities in the places we live in.





S6

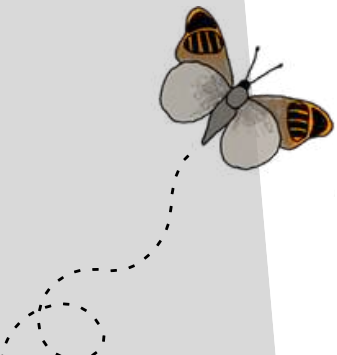
The Good, the Bad and the Flower Meadow: Do Conservation Measures Meet the Ecological Needs of Bumblebees?

Zofia Wrosz[1,2], Jarosław Wrosz[2], Maria Wrosz[2], Mateusz Wrosz[2], Monika Lipińska[1]

[1] University of Gdańsk, Faculty of Biology, Gdańsk, Poland
[2] Wolf Track Jarosław Wrosz, Poland

Abstract

Bumblebee conservation in development projects combines legal regulation with conservation practice. Although bumblebee species are protected in Poland, guidance is lacking on assessing impacts and selecting measures matched to ecological requirements. Projects may destroy nests, nesting and overwintering sites, and disrupt forage continuity. Effective conservation requires identifying the impact and ecological resource at risk, not merely providing flowering plants. This study examines how bumblebees are addressed in development-related proceedings, using derogation decisions issued by the Regional Director for Environmental Protection in Gdask as a case study. The analysis covered taxonomic identification, anticipated impacts, conditions imposed on developers, and whether mitigation, compensation, or pollinator-support measures corresponded to the threatened resource. Particular attention was given to nesting and overwintering sites, forage provision, mowing regimes, habitat retention, artificial nesting structures, and monitoring. A key challenge is the absence of national guidance linking species, nesting strategy, affected habitat features, and appropriate conservation measures. A flower meadow may increase forage availability but is not necessarily an ecological equivalent of a destroyed nest or nesting site. Likewise, nest-box effectiveness depends on design, location, target species, and monitoring. The analysis also considered cuckoo bumblebees of the subgenus *Psithyrus*, obligate social parasites dependent on host colonies. They may be overlooked when specimens are recorded only as *Bombus spp.*, while their species are not explicitly listed in the Polish regulation on protected species. This case study indicates the need for consistent terminology and guidance for evaluating the ecological suitability of conservation measures applied to bumblebees.





S6

Genetic costs of grassland loss: linking historical and contemporary landscapes to genetic diversity in the small blue butterfly Cupido minimus

D. Clake[1], I. van Riemsdijk[1,2]. Z. Nolen[1], R. Steward[1], M. Friberg[1], M. Rundlöf[1], A. Runemark[1]

[1]Lund University
[2]University of Copenhagen, Globe Institute, Section for Hologenomics

Abstract

Habitat loss and fragmentation are major drivers of declines in pollinator abundance and diversity, yet we know comparatively little about how landscape change affects genetic diversity. In particular, it remains unclear how the spatial configuration of remaining habitat influences gene flow and genetic diversity beyond the effects of habitat amount alone, or the extent by which genomic responses lag landscape changes over time. We investigate these questions in the grassland-specialist small blue butterfly, *Cupido minimus*, across the intensively farmed landscape of Skåne in southern Sweden. Substantial grassland loss during agricultural intensification in the mid-20th century provides an opportunity to examine genomic responses to landscape change using historical data on land use, while the time elapsed since these changes allows us to investigate potential delays in genomic responses. Using whole-genome sequencing of over 140 butterflies sampled from 28 unique sites, we quantify genetic diversity and relate genomic patterns to contemporary and historical habitat distributions, assessing how the spatial and temporal scales of habitat change influence genetic diversity. Future analyses will extend this work to examine genetic differentiation, inbreeding, and genomic burden, and the effects of habitat fragmentation per se. By identifying populations and landscape contexts vulnerable to genetic erosion, this research can help inform conservation strategies to mitigate the short- and long-term effects of habitat loss and fragmentation on pollinators.





S6

Landscape genomic patterns reveal contrasting relationships with arable land and edge-rich landscapes across three insect species in an agriculture-dominated grassland mosaic

Christopher Wild[1,2], Belinda Kahnt[1,3], Sebastian Hopfenmüller[4], Bilyana Stoykova Wild[1,3] Cinja Schwarz[5], Florian Fumy[5], Robert J. Paxton[1,3],3, Thomas Fartmann[5], Panagiotis Theodorou[1,3]

[1] Martin Luther University Halle-Wittenberg
[2]Naturkundemuseum Erfurt
[3]German Centre for Integrative Biodiversity Research Halle-Jena-Leipzig (iDiv)
[4]Foundation KulturLandschaft Günztal
[5]Osnabrück University

Abstract

Agricultural intensification and the loss of suitable habitats contribute substantially to ongoing insect declines, but their effects on intraspecific genetic diversity are still insufficiently understood. We applied a landscape genomic approach to investigate genome-wide genetic diversity, population differentiation and spatial variation in gene flow in two butterflies (*Polyommatus icarus* and *Melanargia galathea*) and the bush-cricket *Conocephalus fuscus* across an agriculture-dominated landscape in southern Germany. The study area comprises a heterogeneous network of extensively managed open grasslands maintained through conservation activities, surrounded by intensively managed grasslands, arable land and forests. Combining high-resolution genomic data with extensive spatial sampling revealed clear differences among the three species. Genetic diversity was highest and population structure weakest in the widespread, generalist and highly mobile *P. icarus*. In comparison, *M. galathea* exhibited intermediate patterns, while the less mobile *C. fuscus* had the lowest genetic diversity and greatest population subdivision. Genetic diversity across species increased with edge density and tended to decrease as arable land increased, suggesting an important role of landscape configuration beyond the amount of suitable habitat alone. Effective migration surfaces indicated comparable spatial patterns among species, with reduced effective migration across intensively farmed areas and elevated migration in areas characterised by a greater proportion of grassland. Overall, our findings demonstrate that landscape heterogeneity and species-specific ecological traits contribute to shaping genetic resilience in insects. Maintaining connected networks of structurally heterogeneous grasslands while limiting homogeneous arable areas may therefore help preserve genetic diversity and evolutionary potential within insect communities.





S6

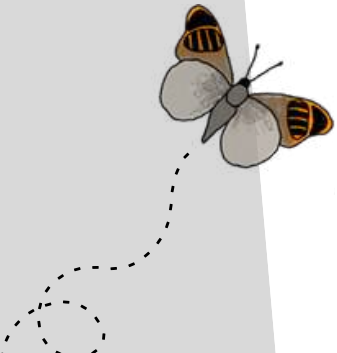
Climate-driven shifts in flowering phenology in orchid communities on the island of Öland

Hanna Melzén Forss, Magne Friberg, Øystein H. Opedal, Yedra García

Biology Department, Lund University, Lund, Sweden.

Abstract

Environmental change and global warming are expected to affect species in multiple ways. One consequence of warmer springs is earlier flowering, which can alter temporal overlap between plants and their pollinators and thereby affect plant reproduction and species interactions. Understanding how flowering phenology is changing is therefore important for assessing how plants may respond to ongoing climate change. The orchids of the island of Öland (Sweden) provide an excellent opportunity to investigate changes in flowering phenology because extensive historical records are available from herbarium collections and, more recently, citizen-science observations. By combining these complementary data sources, I investigated whether orchid flowering phenology has changed over time and whether temporal changes are associated with variation in spring climate. I focused on flowering records from 14 orchid species and use species-specific pre-flowering temperature windows to examine climatic associations. Results from contemporary citizen-science observations (2008–2025) indicate an advance in orchid flowering over time, coinciding with increasing temperatures during the pre-flowering period. Warmer pre-flowering conditions were associated with earlier flowering, although temperature does not fully account for the temporal trend. In contrast to contemporary data, historical herbarium records (1857-1960) did not show clear temporal nor temperature trends.





S7

Structural polymorphisms, including a putative supergene, correlate with the geographic distribution of the solitary bee Andrena haemorrhoa in Northern Europe

Emma Falkeid Andrews[1], Markus Sydenham[2], Bastiaan Star[1]

[1]Section for Ecology, Biodiversity and Evolution (EBE), Department of Biosciences, University of Oslo, Oslo, Norway
[2]Norwegian Institute for Nature Research, Oslo, Norway

Abstract

Andrena is one of the most species-rich bee genera, comprising around 1700 described species distributed across most of the Northern Hemisphere. What drives this remarkable diversity remains poorly understood, despite the genus having experienced notably rapid rates of diversification. Chromosomal rearrangements, particularly inversions, have been repeatedly linked to local adaptation, ecological diversification and speciation across a wide range of taxa, and recent work has uncovered inversions varying in frequency between geographic populations in several eusocial bee lineages, including bumblebees, stingless bees and honeybees. Although the vast majority of described bee species are solitary, few whole genome studies have been done, and no chromosomal rearrangements have yet been described. As structural polymorphisms can cause biased estimations of population features that are commonly used in conservation measures, more information about the genomic architecture of solitary bees is urgently needed. Here, we investigate the ground-nesting solitary bee *Andrena haemorrhoa*, a widespread species across Europe and temperate western Eurasia, to ask whether chromosomal inversions contribute to its diversification. Using high-coverage, whole-genome Illumina sequence data from 171 *A. haemorrhoa* females sampled across Germany, Denmark, Sweden and Norway, we characterize population genetic structure and identify divergent chromosomal regions, including three putative inversions and one double inversion, that correlate with patterns of spatial genetic divergence across landscape barriers. Notably, these populations have only recently become established following the last glacial maximum, making the high degree of divergence we observe, particularly at inversion sites, striking. These findings highlight the putative role of chromosomal inversions in generating and maintaining diversity within this exceptionally species-rich genus, even over comparatively short evolutionary timescales.





S7

Railway brownfield sites as flower visitor habitat

Gavin Ballantyne

Edinburgh Napier University, United Kingdom

Abstract

Brownfield sites are now well known amongst ecologists for their potential suitability as habitats for many pollinator species, but their value is still often not recognised by the organisations managing these sites. Edinburgh Napier University's Minding the Gap project, in collaboration with construction company Balfour Beatty, aimed to estimate the biodiversity value of brownfield sites owned by the UK's Historical Railways Estate and make recommendations on the most cost-effective methods for long term surveys. To do this we surveyed a wide range of taxa within a selection of brownfields and nearby ancient woodlands (including plants, mammals, birds, ground invertebrate and soil eDNA). As part of this wider survey, flying insects were collected using malaise trapping. From these samples, flying insects, and specifically flower visitor taxa, were analysed. Flying insect biomass was positively associated with estimated nectar availability and vegetation diversity, indicating that vegetation structure and floral resources are key drivers of site productivity. Flower visitor richness varied markedly across sites, with some brownfields supporting diversity comparable to ancient woodlands, and was positively correlated with estimated nectar availability. The results highlight the importance of railway brownfield sites for the provision of resources for flower visitors and will inform the management of similar brownfield sites managed by government and industry across the UK.





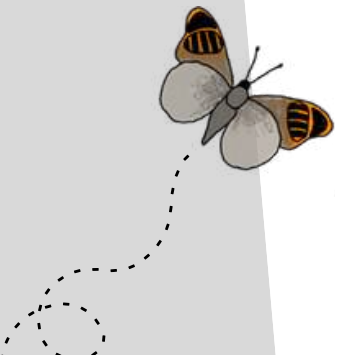
S7 Floral soundscapes: vibrating bees alters the acoustic soundscape nearby buzz-pollinated flowers

Leidy Kelly Guimarães Cunha

Federal University of Uberlândia, Brazil

Abstract

During buzz pollination, bees produce vibrations that are transmitted through the flower, generating detectable acoustic components. However, whether this activity creates a distinct acoustic signature that differentiates the immediate floral environment from the surrounding soundscape remains poorly understood. Thus, we investigated whether the activity of buzzing bees makes the soundscape near flowers acoustically distinct from the surrounding environment. We conducted acoustic recordings on Miconia serrulata, a pollen-rewarding plant intensively visited by buzzing bees, using two microphones positioned simultaneously near the flowers and in the surrounding environment. The soundscape was subsequently analyzed in 5-s windows using temporal, spectral, ecoacoustic, amplitude-based, and frequency-based acoustic descriptors. The soundscape near flowers differed from the surrounding environment across multiple descriptors, particularly spectral features, including total and spectral entropy, dominant frequency, and spectral bandwidth. In contrast, amplitude-related descriptors, such as RMS and peak amplitude, remained relatively similar between the two environments. These results indicate that bee acoustic activity does not primarily alter sound intensity near flowers, but rather modifies the spectral structure of the local soundscape and the distribution of acoustic energy across frequencies. Buzzing bees therefore leave a detectable acoustic signature in the immediate vicinity of flowers. Our findings reveal a largely unexplored acoustic dimension of plant–pollinator interactions and highlight the potential of acoustic monitoring as a tool for detecting and characterizing these interactions under natural conditions.





S7

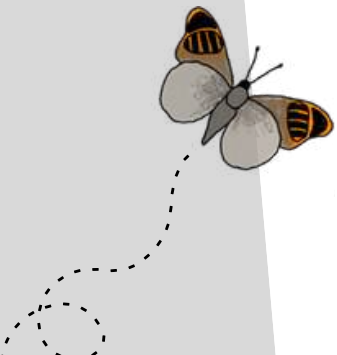
Tag glue attachment and effects on bumblebee longevity and colony development

Joseph Gillson, Tariq Saeed, Geraldine Wright, Jonathan Pattrick

Department of Biology University of Oxford.

Abstract

It is routine in bee research to mark bees for individual identification using small numbered discs. The practice and equipment originated with beekeepers, where marking queens remains an important aspect honeybee management. Over the years, a diversity of tag types have been used across the literature, including numbered tags, RFID tags, and 2D barcodes. The types of glues used are equally diverse, including cyanoacrylate-based, natural shellac, UV-curing, polyurethane, and resin glues, among others. However, the impact that these different glues, and the tagging process itself, have on bees has never been studied. The toxicity of these glues to bees is unknown, as is the impact of handling stress during marking and the subsequent behavioural implications of carrying a tag. It is assumed that the impacts are negligible, but this is unconfirmed. Since the practice of marking bees is enmeshed in behavioural bee science, it is vital that potential impacts of glue choice are assessed to avoid introducing unintentional biases into research. We set out to test these assumptions for three glues (cyanoacrylate-based glue, natural shellac glue, UV-curing glue) commonly used in beekeeping and bee research, using *Bombus terrestris* audax as our model organism. We found that mortality and tag retention were not associated with any of the glue treatments. Our experimental method involved housing worker bees in microcolonies, allowing us to monitor the effects on reproduction of the adults receiving a glue treatment. We found that bees glued with shellac or the cyanoacrylate glue produced male offspring which eclosed later, but which were, on average, larger than those produced by control microcolonies. We suggest that, since there were no observable differences in mortality or tag retention, that glue choice between the three tested is inconsequential for bee marking, though the slight effects on colony development indicate that, within an experiment, a single glue type should be used. Though this work used bumblebees, the cuticular structure across bee species is similar, thus we anticipate the implications of this research to be applicable across bee science, and invertebrate science more generally.





S7

Beyond pollinators: Exclusion bags also shape the floral microbiome

Sewwandi Rasangika, Kumari Kankanamalage, Qingyang Gao, Nataliia Khomutovaska, Johan A. Stenberg, Carolina Diller

Swedish University of Agricultural Sciences, Department of Plant Protection Biology

Abstract

Pollinator exclusion bags are widely used to assess the contribution of pollinators to floral microbial communities. However, bags may also restrict environmentally dispersed microorganisms and alter the floral microenvironment, complicating interpretation of exclusion experiments. We investigated these effects using nutrient yeast dextrose agar (NYDA) plates and wild strawberry (*Fragaria vesca*) flowers in complementary exclusion and pollinator-visitation experiments. We compared culturable fungal abundance between exposed and enclosed NYDA plates to test whether bags restrict environmental microbial deposition, and between exposed and excluded flowers to assess the combined effects of environmental deposition and pollinator access. Pollinator observations and fruit quality measurements provided evidence of pollinator activity, while single-visit experiments tested whether pollinators increased fungal abundance on flowers. Exclusion bags reduced culturable fungal abundance on NYDA plates, demonstrating that they can restrict environmental microbial deposition, which was associated with warmer, more humid, and less windy conditions. The opposite pattern occurred on flowers, with higher fungal abundance on excluded than exposed flowers. Yet, flowers visited once by hoverflies had higher fungal abundance than unvisited controls, indicating pollinator-mediated microbial inoculation. While pollinator visitation was rare during diurnal observations, exposed plants had higher fruit quality than excluded plants. Overall, our results show that, exclusion bags can influence floral fungi beyond preventing pollinator visits. While bags restrict environmental microbial deposition, prolonged exclusion may also alter conditions surrounding flowers in ways that favor fungal establishment. Furthermore, in the wild strawberry flower, environmental exposure and weather conditions appear as stronger drivers of fungal abundance than pollinator-mediated dispersal.





S7

Pollinator response diversity and turnover buffer pollination networks from habitat loss in human-modified landscapes.

Nerea Montes-Pérez[1,2], Francisco Rodríguez-Sánchez[2], Ignasi Bartomeus[1]

[1]Estación Biológica de Doñana, Department of Ecology and Evolution, Spain
[2]Universidad de Sevilla, Departamento de Biología Vegetal y Ecología, Spain

Abstract

Agricultural intensification and habitat fragmentation are major drivers of biodiversity loss, yet their effects on ecological interaction networks remain elusive. In plant–pollinator systems, many species disappear with habitat transformation, but network responses remain inconsistent across studies. We hypothesize that this mismatch arises because local observations often overlook the response diversity of the regional species pools. To test this, we compared observed plant–pollinator networks along a land-use gradient with expectations under hypothetical closed-community simulations. Using data from 30 sites in the Doñana Protected Area (southern Spain), we found that spatially connected communities maintained a stable network structure despite habitat loss. This stability was driven by pollinator response diversity, leading to marked species turnover across sites. In contrast, simulated closed communities showed reduced buffering capacity and predominantly negative trends in network metrics such as pollinator richness, total visits, and plant link density. Our results indicate that network stability can emerge from spatial connectivity rather than purely local processes.





S7

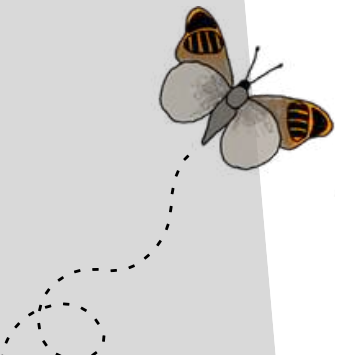
Pollen and sterol content differentially affect solitary bee development

Carlos Martel[1,2], Josef Kreidt[1], Jennifer Scott[3], Janine Griffiths-Lee[1], Ernesto Rázuri-Gonzales[4], Geraldine A Wright[3], Philip C Stevenson[1,5]

[1]Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE, United Kingdom
[2]Instituto de Ciencias Ómicas y Biotecnología Aplicada, Pontificia Universidad Católica del Perú, San Miguel 15088, Lima, Peru
[3]Department of Biology, University of Oxford, Oxford, OX1 3SZ, United Kingdom
[4]Senckenberg Research Institute and Natural History Museum Frankfurt, Frankfurt am Main, Germany
[5]Natural Resources Institute, University of Greenwich, Chatham, Kent, ME44TB, United Kingdom

Abstract

Pollen sterols are essential micronutrients for bees, with roles as membrane components, hormone precursors and for regulating gene expression. It is historically accepted that bees are unable to produce sterols de novo or modify them and use them as they occur in pollen. This may require adaptation by bees to specific plants because pollen sterols vary dramatically across taxa. Here we investigated the effects of pollen with different sterol composition or supplementation on development of solitary red mason bees, *Osmia bicornis*, comparing bee provisioned pollen, with *Castanea sativa* pollen containing campesterol a key *Osmia* sterol, a sterol supplemented *C. sativa* pollen, a polyfloral pollen from which the key campesterol and cholesterol sterols were almost absent, and a combination of polyfloral and *C. sativa* pollen. DNA barcoding was used to characterise the *Osmia* pollen, which comprised at least 38 taxa but was mostly Quercus spp. Pollen diet significantly affected the larval final weight, larval development time and development over time. Larvae fed chestnut pollen supplemented with sterols developed significantly faster over time compared to those from the other treatments, including the chestnut pollen with no sterol supplementation. Despite sterol composition being distinctive among pollen diets, sterol profiles were more similar among bees from different pollen foods (i.e., different treatments) than between bees and their pollen foods. Moreover, bees fed on polyfloral pollen had much higher relative concentrations of campesterol (~8.5 %) and cholesterol (~26 %) than the pollen itself (~3 % and ~ 0.7 %, respectively), addressing the possibility that *Osmia* bees are highly efficient in sterol selective accumulation or possible transformation of sterols in *Osmia* bees. Our results suggest greater flexibility in sterol handling in bees than previously assumed.





S7

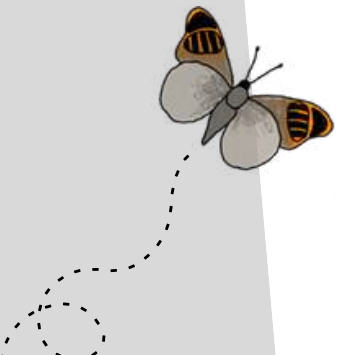
Assessing rapid assessment method effectiveness in capturing pollinator abundance and richness patterns across Europe

Nick Rosenberger

University of Freiburg, Germany

Abstract

The European Union's Nature Restoration Law requires member states to ambitiously reverse pollinator declines by 2030. Yet sampling capacity across such a large region may be exceptionally challenging given available resources to monitor these trends, making it essential to develop quick, easy to implement methods that can provide meaningful pollinator abundance data. Within the multinational Horizon project "RestPoll," which aims to restore pollinator habitats in agricultural landscapes across Europe, we developed a rapid assessment method for measuring pollinator abundance that stakeholders (e.g. farmers, bureaucrats, citizen scientists, students, etc.) could use. We validated this tool during the 2025 field season by pairing 5-minute rapid assessments with walking transects, then comparing researcher- and stakeholder-conducted rapid assessments to test whether stakeholders could match researcher-level observations. We then followed up with a feedback survey which assessed stakeholder interest in using the method as part of a larger monitoring scheme. We found that rapid assessments captured the abundance patterns observed in research transects, though this varied by pollinator morpho-group, and that stakeholders could produce observations comparable to researchers after brief training. Most stakeholders found the method easy to implement and expressed willingness to use it in a broader monitoring scheme. These results suggest that our methods for stakeholder-implemented rapid assessments would be a valuable tool for large-scale pollinator monitoring within the European Union and for stakeholders seeking to improve local environmental conditions for pollinators.





S7

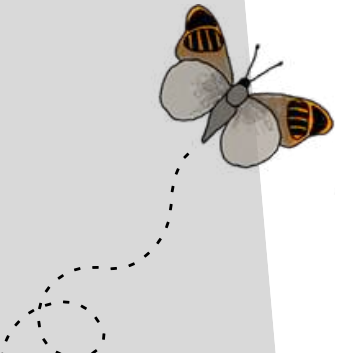
Different floral resource use across European agricultural landscapes: richer pollen loads in bumblebees and greater heterogeneity among solitary bees

Epp Valdaru[1], Olivia Bernhardsson[2], Tsipe Aavik[1], Virve Sõber[1], Mari-Liis Viljur[1], Tiit Teder[1], Ants Kaasik[1], Tomáš Dostálek[3], Zuzana Münzbergová[4], Hana Pánková[3], Jan Plue[5], L. Marie Ende[6], Sabrina Träger[6], Hans Jacquemy[2]

[1]University of Tartu
[2] KU Leuven
[3]Czech Academy of Sciences
[4]Charles University
[5]Swedish University of Agricultural Sciences
[6]Martin Luther University Halle-Wittenberg

Abstract

Diverse pollinator communities are essential for ecosystem functioning. Bumblebees, one of the more well-studied groups of pollinators, are considered key contributors to pollination in temperate ecosystems. In contrast, the role of solitary bees, despite their high diversity and abundance, remains less understood in plant-pollinator networks. To address this knowledge gap, we investigated plant-pollinator communities in semi-natural grasslands across five European countries. Wild bees were collected using hand-netting, and the pollen they carried was analysed using DNA metabarcoding to assess floral resource use. We found significant floral resource partitioning between bumblebees and solitary bees, with approximately 50% of plant species visited exclusively by one of the two groups. Furthermore, solitary bees utilised a broader range of plant species, whereas different bumblebee species tended to visit similar plant taxa within their group. These patterns were consistent across study countries. Our findings highlight the complementary roles of bumblebees and solitary bees in maintaining plant-pollinator networks and underscore the importance of conserving diverse bee communities for ecosystem resiliance.





S8

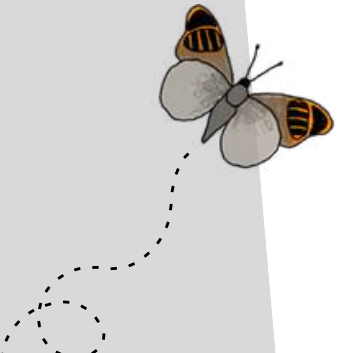
Beyond the honeybee: Flupyradifurone toxicity in the hoverfly *Eristalis tenax* and the butterfly *Pieris napi*

Natalia Davila

Lund University

Abstract

Pollinators can encounter pesticides through multiple routes, including ingestion of contaminated food resources and contact with pesticide residues. Pesticide risk assessments for pollinating insects are largely based on toxicity tests with the honey bee (*Apis mellifera*). However, pesticide sensitivity can vary substantially among pollinator taxa, raising concerns about whether current testing standards adequately capture effects on the broader pollinator community. To address this knowledge gap, we assessed acute pesticide sensitivity in two non-bee pollinators: the common drone fly *Eristalis tenax* and the green-veined white butterfly *Pieris napi*. Acute median lethal doses (LD50) were determined following oral and contact exposure to dimethoate and flupyradifurone to capture potential route-specific differences. A rearing facility for *P. napi* was established at Lund University to provide a sufficient and reliable supply of test insects, while *E. tenax* were purchased as pupae from POLYFLY SL and allowed to emerge under controlled conditions. Individuals were exposed to a range of doses, and mortality was recorded at defined intervals, with observations continuing beyond 48 hours. Comparable toxicity tests are being conducted on additional pollinator species within the PollinERA project using harmonised protocols. By combining data across species, we can assess whether the honey bee is sufficiently sensitive to serve as a protective model for other pollinators or whether some species are more vulnerable. This is important for determining when a single model species can reliably represent broader pollinator diversity in pesticide risk assessment and when additional species may need to be considered to ensure adequate protection across taxa.





S8

The role of visual and olfactory cues in attracting the invasive bee *Megachile sculpturalis* to its main host plant in Europe

Julia Witter[1], J. Lanner[1], J. Bila Dubai[2], G. Beluši[3], R. Fuchs[1], S. Dötterl[1]

[1]Department of Environment and Biodiversity, Paris-Lodron University of Salzburg, Hellbrunner Str. 34, 5020 Salzburg, Austria
[2]Faculty of Biology, University of Belgrade, Studentski trg 16, 11000 Belgrade, Serbia
[3]Department of Biology, Biotechnical Faculty, University of Ljubljana, Večna pot 111, 1000 Ljubljana, Slovenia

Abstract

Due to globalisation, invasive pollinators are increasingly able to establish themselves in non-native ecosystems, such as the East Asian bee Megachile sculpturalis. An crucial initial step for establishment in a new habitat is locating suitable foraging resources. However, there are significant gaps in understanding how introduced bees find host plants in new ecosystems and the floral traits involved in attraction. The first part of our project revealed that European-native and Asian-native host plants exhibit a wide variety of floral scents, many of which eliciting physiological responses in the antennae of *M. sculpturalis*. Moreover, we found that most flowers appear blue and UV-blue in bee vision. Indeed, naïve bees showed a preference for bee-blue flowers in our behavioural tests, but this changed through learning after training for a different bee colour. Behavioural tests with *Styphnolobium japonicum*, the main pollen source in Europe, indicated the additional importance of scent in attraction. When testing synthetic floral scent compounds, we identified terpenes as the scent class responsible for attracting *M. sculpturalis*. Overall, our data suggest that *M. sculpturalis* has a specialised innate search image with respect to floral colours, though this is flexible due to colour learning. In contrast, it is more generalistic with respect to floral scent cues. This combination of high capacity for learning and ta opportunistic foraging behaviour could explain why this bee is so successful in invading non-native ecosystems.

