Welcome to

SCAPE 2024

10 - 13 October

Ullensvang Hotel
Lofthus, Hardanger
Norway

The 38th
Annual Meeting of the Scandinavian Association for Pollination Ecology

This year's
Committee

Organizers

Bjørn Arild Hatteland
Norwegian Institute of Bioeconomy Research
Bergen

Jørund Johansen
Norwegian Institute of Bioeconomy Research
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Norwegian Institute of Bioeconomy Research
Bergen

On-site

Maren Kristine Halvorsen
Volunteer
Bergen

Helene K. Hertwig
Volunteer
Oslo

along with

Bjørn Arild Hatteland, Anders Nielsen, Anne Muola, Christian Pedersen, Jørund Johansen, Hedda Barfod Ørbæk & Silje Maria M. Høydal

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NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH

NINA
Norwegian Institute for Nature Research

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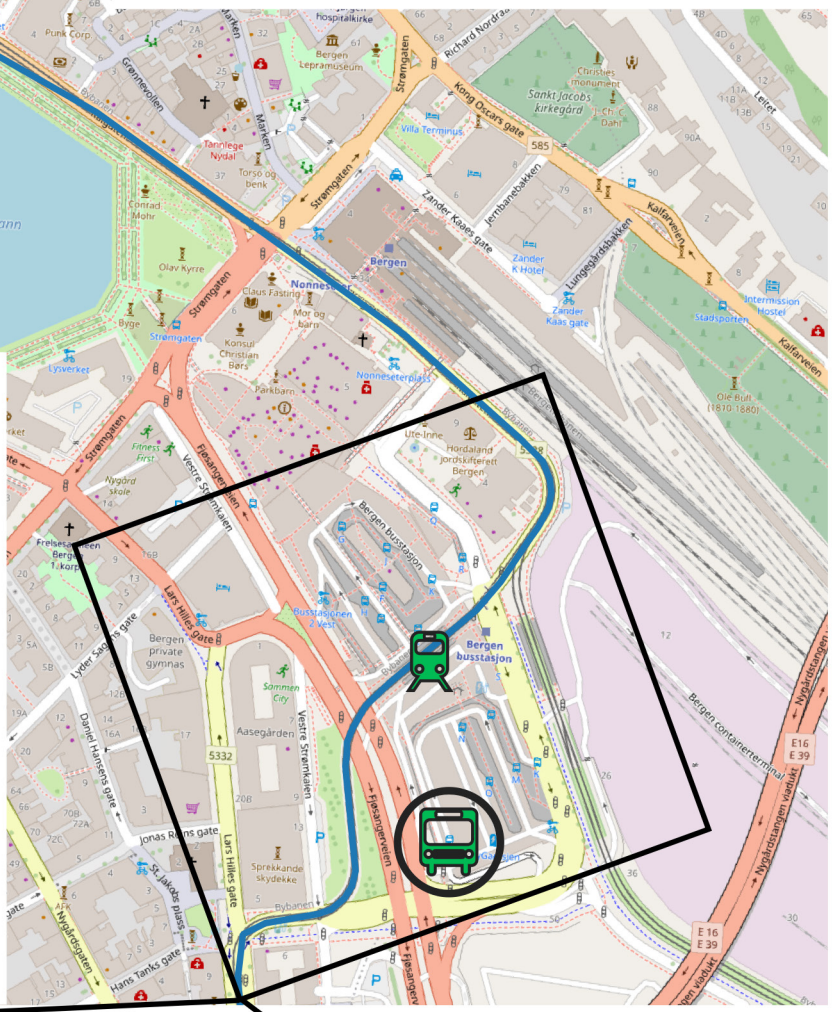
Getting to the SCAPE bus in Bergen



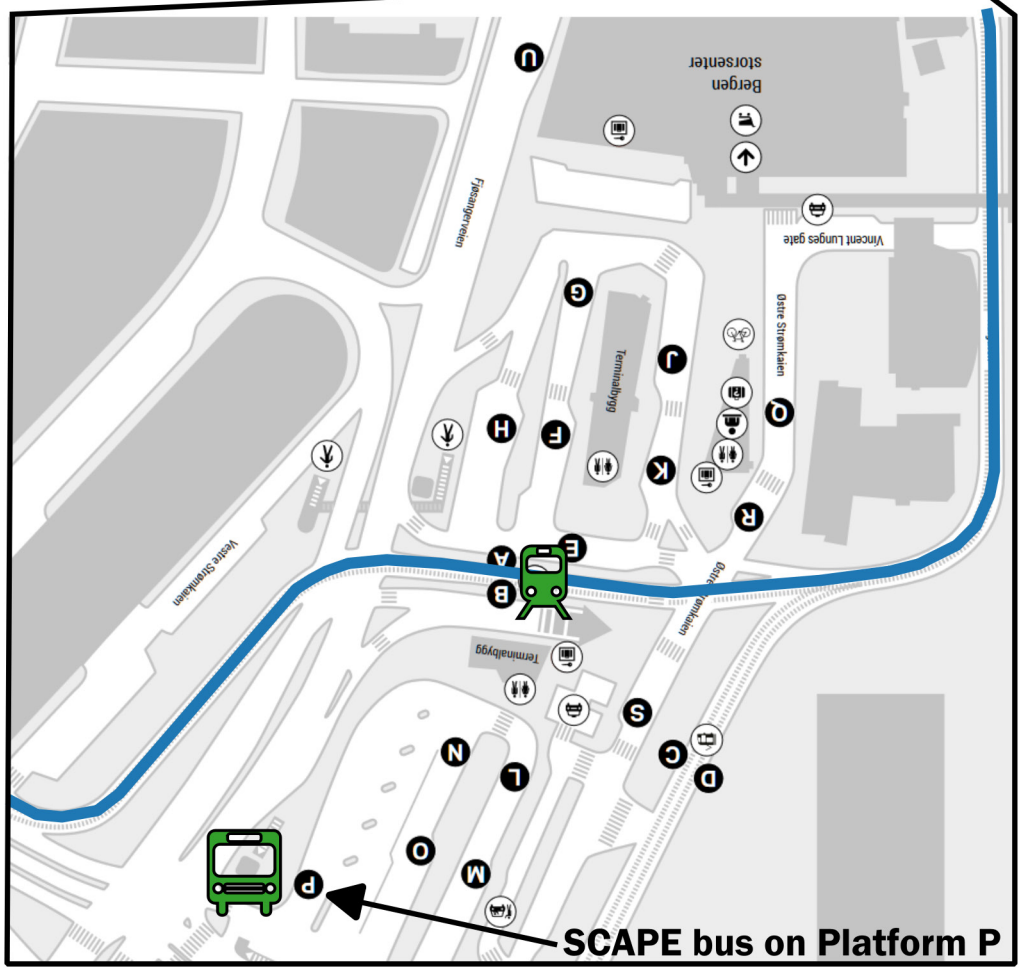
SCAPE-bus

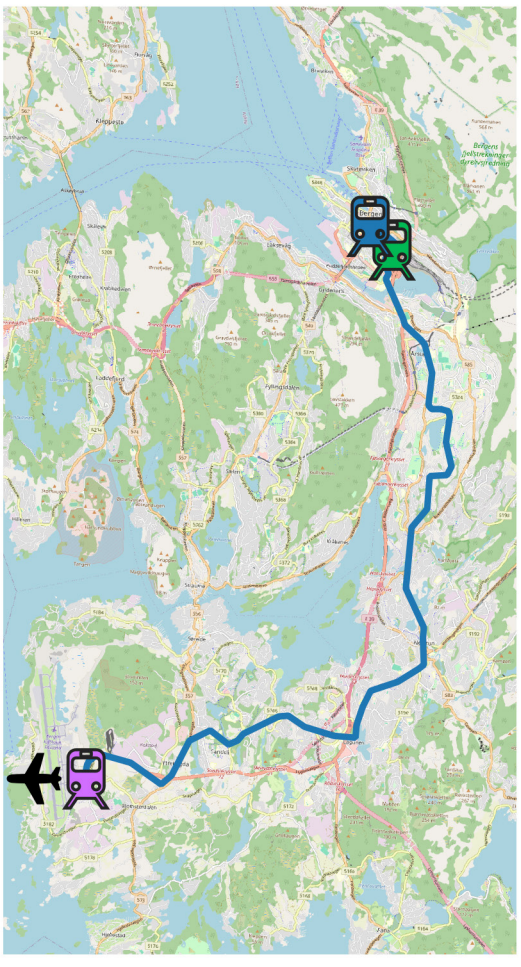
Airport lightrail stop: "Bergen lufthavn"

Bus light rail stop:
"Bergen busstasjon"
(41 mins from airport)

Final light rail stop:
"Byparken"
(43 mins from airport)

Light rail line





Points of interest

- Hotel and venue
- Party venue
- Bus stop
- Super market
- Bar/cider brewery

SCAPE 2024

Conference programme

K = KEYNOTE 40 MIN + 5 MIN DISCUSSION

T = TALK 12 MIN + 3 MIN DISCUSSION

F = FLASHTALK 5 MIN

Thursday, October 10th

18:00	Lobby			**Registration**
	Conf.room			**Plant - Pollinator Networks (w / chair: Bjørn Arild Hatteland)**
19:30		**Bjørn Arild Hatteland**	T00	*Welcome + Practical information*
19:45		**Juan Pablo Cancela**	F01	*Nutrient Enrichment Affects Plant-Flower Visitor Assemblage Interaction Patterns in a Mediterranean Grassland*
19:50		**Melissa Leon-Osper**	F02	*A Poppys Tale: Colour Variation in the West Mediterranean Basin*
19:55		**Thomas A. Veldhuis**	F03	*Visual Mimicry in Ophrys Orchids*
20:00	Dining hall			**Dinner and socializing**

Friday, October 11th

07:00	Dining hall			**Breakfast**
	Conf.room			**Plant - Pollinator Networks (w / chair: Paolo Biella)**
08:30		**Natasha de Vere**	T01	*Temporal Changes in Plant-Pollinator Networks Revealed using Pollen DNA Metabarcoding*
08:45		**Océane Bartholomée**	T02	*Forest Habitat and Forest Dominated Landscapes Filter out Bumblebee Species with Visual Traits related to Light Sensitivity*
09:00		**Maisie Brett**	T03	*Assessing Competition between Domesticated Honeybees and Wild Pollinators in Heathland Habitats*
09:15		**Rudi Crispin Swart**	T04	*Insect Pollinator Diversity in relation to Vertical Strata and Species of Tree in Southern African Temperate Forests*
09:30		**Willem Proesmans**	T05	*Viral Spillover in Plant-Pollinator Networks: a Causal Analysis*
09:45	Hall			**30 min coffee, tea and snack break**
	Conf.room			**Plant - Pollinator Networks (w / chair: Anders Nielsen)**
10:15		**Ferne Kotlyar**	T06	*Nectar Deposition on Stigma Selectively Promotes Pollination*
10:30		**Ellen Baker**	T07	*The Sterols of Pollen are Diverse but Selectively Utilised by Bees*
10:45		**Monika M. Lipińska**	T08	*Orchid Pollination in the Tropics and Why it Matters?*
11:00		**Anna-Sophie Hawranek**	T09	*A Statistical Test for Floral Syndromes in Aquilegia (Ranunculaceae)*
11:15	Hall			**15 min break**

	Conf.room			**Novel Methods in Pollination Ecology (w / chair: Rocio Perez-Barrales)**
11:30		**Marcos Méndez**	T10	*Floral Longevity Goes Multidimensional: Floral Longevity Spaces*
11:45		**Cristina Rueda-Uribe**	T11	*Novel Uses of Old Technologies: an Automated Radio Telemetry System to Infer Pollinator Movement in Tropical Mountains*
12:00		**Kenneth Kuba**	T12	*Shedding Some Fluorecent Light on Micro Plastics: An Exploration of Micro Plastic Pollution in Bees and Flowers*
12:15		**Hamish Symington**	F04	*The Figure-Eight Maze: a Novel Protocol For Studying Bee Cognition and Learning*
12:20		**Aleksandra Splitt**	F05	*Centre of Information and Improvement of Knowledge about Pollinators - Shortcut Presentation of the Project*
12:25		**Jacek Jachula**	F06	*How to Calculate Pollinator Pollen Resources: Scaling up from Species to Landscape*
12:30	Dining hall			**Lunch**
13:30	Conf. room	Professor **Jeff Ollerton**	K01	*Plant-Pollinator Interactions Underpin the United Nations Sustainable Development Goals*
14:15				**15 min break**
	Conf.room			**Conservation of Pollinators (w / chair: Philip Stevenson)**
14:30		**Will R. Glenny**	T13	*Revegetation Across Europe Primarily Benefits Common and Generalist Pollinator Species*
14:45		**Julia K. M. Weber**	T14	*A Matrix of Flowers: Floral Resources from Legumes in Temporary Grasslands and its Potential Benefit for Pollinating Insects*
15:00		**André Krahner**	T15	*Using Pan Traps for Large-Scale Bee Monitoring Programs*
15:15		**Lauren Cobb**	T16	*Wild Pollinators in a Fragmented Landscape: Using Population and Landscape Genomics to Explore Spatial Connectivity in Bumblebees*
15:30		**Philip Stevenson**	T17	*Can Nectar Metabolites Mitigate the Burden of Disease in Bees?*
15:45	Hall			**30 min coffee, tea and snack break**
	Conf.room			**Pollinator Behaviour (w / chair: Klaus Lunau)**
16:15		**Carmen A. Nebauer**	T18	*Perception and Effects of Pesticides in the Food of Bombus terrestris*
16:30		**Han Yan**	T19	*How do Pollinators Perceive Floral Abundance?*
16:45		**Amadeu dos Santos-Neto & Charles B. Fenster**	T20	*The Role of Surrounding Plant Floral Density in Shaping Pollinator Visitation to Native Plants: Insights from Native and Exotic Contexts*
17:00	Hall			**15 min break**
	Conf.room			**Pollinator Behaviour (w / chair: Klaus Lunau)**
17:15		**Maria Clara Castellanos**	T22	*Rapid Evolution of Flowers: The Role of Floral Trait Evolutionary Potential**
17:30		**Jonathan G. Pattrick**	T23	*Discrimination of Nectar Sugars by Bees: Detection, Preferences and Evolutionary Trends*
17:45		**Tzlil Labin**	T24	*Beetles are from Mars; Bees are from Venus? Flower Color Preferences in Anemone coronaria*
18:00	Conf. room			**Poster session 1 - Odd numbers**
19:30 - 21:00	Dining hall			**Dinner (Open until 21:00)**
20:00 - 23:00	Pool area			**Sauna / pool & socializing (Pool area closes at 23:00)**
21:00 - 02:00	Hotel bar			**Socializing (Hotel bar closes at 02:00)**

** Replaced cancelled talk. Theme: Evolution of Pollination.*

Saturday, October 12th

07:00	Dining hall			**Breakfast**
08:30	Conf. room	Professor **Jane Stout**	K02	*Farmland Pollinators and Pollination: Influence of Policy and Practice*
09:15	Hall			**15 min break**
	Conf.room			**Pollination in Agriculture and Horticulture (w / chair: Bjørn Arild Hatteland)**
09:30		**Lisa Wasko DeVetter**	T25	*Pollination Insights - Optimizing Honey Bee Mediated Pollination in Highbush Blueberry*
09:45		**Chloé A. Raderschall**	T26	*Integrated Pest and Pollinator Management in Faba Bean (Vicia faba)*
10:00		**Catarina Siopa**	T27	*The Impact of Landscape Features on Pollination Services Provided to Sweet Cherry*
10:15		**Linn Vassvik**	T28	*Busy as a Bee – What Makes a Good Pollinator of Apples?*
10:30		**Jane Devlin**	T29	*Osmia vs Bombus: Can the Choice of Commercial Pollinator Influence Premature Fruit Loss?*
10:45	Hall			**30 min coffee, tea and snack break**
	Conf.room			**Pollination in Agriculture and Horticulture & Pollination and Climate Change (w / chair: James Thomson)**
11:15		**Merijn Moens**	T30	*Mapping Pollinators in Fine-Scale Agricultural Landscape Elements*
11:30		**Paula Prucker**	T32	*Is Drought Mitigation of Insect Pollinators in Strawberries Limited by Climate-Dependent Activity?*
11:45		**Maxime Eeraerts**	F07	*Synthesis of Apple Pollination Research Reveals Positive Contributions From Wild Bees relative to those of Honeybees*
11:50		**Emily Kate Millerchip**	F08	*The Factors Affecting Pollinator Diversity and Abundance on Crops in Urban Food Growing Spaces*
11:55		**Lucy A. Unwin**	F09	*The Effect of Temperature on Nectar Traits and Plasticity of Phaseolus vulgaris L.*
12:00		**Brandon S. Whitley**	F10	*Plant-Pollinator Networks across an Arctic Latitudinal Gradient*
12:05		**Carolin Mayer**	F11	*JPE - Steps Ahead*
12:10		**Friederike Gehrmann**	F12	*Joint special issue in Nordic Journal of Botany & Journal of Pollination Ecology*
12:15	Dining hall			**Lunch**
13:30	Lobby			**Guided walk: History of Hardanger and Fruit Production (Meet in the hotel lobby)**
	Conf.room			**Evolution of Pollination (w / chair: Renate Wesselingh)**
15:15		**Anina Coetzee**	T33	*The Influence of Nectar Robbers in Shaping Flower Colour*
15:30		**Amy L. Parachnowitsch**	T34	*Evolutionary Ecology of Nectar: SCAPE Update*
15:45		**Felipe Torres-Vanegas**	T35	*Pollinator-Specific Patterns of Phenotypic Selection on Floral Traits in a Pollination-Generalized Plant*
16:00		**Magne Friberg**	T36	*Twelve Years of Research on Floral Scent Evolution (in 12 minutes)*
16:15		**Karin Gross**	F13	*Effects of Whole-Genome Duplications on Floral Scent*
16:20	Hall			**25 min coffee, tea and snack break**
	Conf.room			**Evolution of Pollination (w / chair: Marcin Zych)**
16:45		**Pedro Juárez**	T37	*Speciation and Local Floral Adaptation of Two Neotropical Spiral Gingers with a Pollinator Shift*
17:00		**Constantin Kopper**	T38	*Mountain Colonization Triggered Evolutionary Pollinator Shifts Away From Bee-Pollination in Melastomataceae*
17:15		**Noa L. A. Schwabe**	T39	*Unilateral Adaptation - The Role of Trichomes in Shaping Pollinator Behavior in a Sexually Deceptive Orchid*
17:30		**Yedra García**	T40	*Living with the Neighbours: Co-flowering Community Effects on Reproductive Success and Selection on Floral Traits in Food-deceptive Orchids*
17:45		**Felicitas Wolf**	F14	*Temporally Differentiated Recovery of Plants, Bees and their Interaction in Restored Grasslands in Saxony-Anhalt*
17:50		**Jennifer Rose**	F15	*Basque Bees in a Changing Climate: Preliminary Investigation of the Diversity and Community Structure of a Vulnerable Community*

18:00	Hall	**15 min break**
18:15	Conf.room	**Poster session 2 - Even numbers**
19:30 - 21:00	Dining hall	**Dinner + Closing ceremony and announcements**
20:00 - 23:00	Pool area	**Sauna / pool & socializing (Pool area closes at 23:00)**
21:00 - 02:00	Conf.room*	**Party!**

** The party venue has been changed from an external venue to the hotel, where the conference room will be rearranged to a party venue!*

Sunday, October 13th

07:00 - 09:00	Dining hall	**Breakfast**
07:45		**Departure 1st bus**
10:00		**Departure 2nd bus**

Book of

Abstracts

Keynotes

K01

Plant-Pollinator Interactions Underpin the United Nations Sustainable Development Goals

Professor Jeff Ollerton[1]

[1] University of Northampton, UK & Kunming Institute of Botany, China

The 17 United Nations Sustainable Development Goals (SDGs) provide a framework by which all the nations of the world can progress in an equitable and sustainable way. Biodiversity is of fundamental importance to many of the SDGs, either directly or indirectly, and this is widely recognised.

Plants are the ecological foundation for most terrestrial biodiversity, however, as they lie at the base of the food chain. The vast majority (around 90%) of the 350,000 species of flowering plants rely on animal pollinators for their reproduction. Therefore, plant-pollinator interactions underpin the SDGs in ways that go beyond food security.

This presentation discusses the different approaches to the study of pollination, provides some examples of the importance of plant-pollinator interactions for the SDGs, and how the work of pollination ecologists can contribute to their aims.

K02

Farmland Pollinators and Pollination: Influence of Policy and Practice

Professor Jane Stout[1]

[1] Trinity College, Dublin Ireland

Flower-visiting insects, like bees and hoverflies, provide pollination services to both crops and wild plants in agricultural landscapes. However, these insects are facing decline due to agricultural intensification, the widespread use of agrochemicals and the loss and degradation of suitable foraging and nesting habitats. This decline has become well publicised, and both international and EU-level biodiversity frameworks and targets highlight the restoration of pollinators as a key ambition.

The successful restoration of pollinators on farmland requires understanding of complex networks of interactions between pollinators and local and landscape-level factors, including quantity and suitability of floral resources, type and location of habitat features, pesticide use and residues, and threats from disease and parasites. At the same time, farmers need to maintain yields to sustain food production and their own livelihoods.

This presents a challenge for policymakers, and the design of agri-environmental schemes, as well as for the farmers implementing pollinator action on the ground. Whole-farm and context-specific landscape scale approaches are required, as well as monitoring to determine success. Examples of these approaches from Irish farming landscapes will be presented.

Talks

T01

Temporal Changes in Plant-Pollinator Networks Revealed Using Pollen DNA Metabarcoding

Natasha de Vere[1], Laura Jones[2], Abigail Lowe[3]

[1] Natural History Museum Denmark, University of Copenhagen, Denmark
[2] National Botanic Garden of Wales, UK
[3] Centre for Ecology and Hydrology, UK

Loss of flower-rich habitat for foraging is a key resource limitation for pollinating insects. Here, we use pollen DNA metabarcoding to understand plant-use and plant-pollinator networks at different temporal scales. First, we analysed honey samples from throughout the UK in 2017 and compared these to a survey from 1952. We show how changes in agricultural intensification, crop use and the spread of invasive species have altered the nectar and pollen sources available in the UK. Next, we investigated changes in the diet of honeybee colonies through the flowering season. We found that honeybees visit a wide range of plants, but there is monthly variation in their degree of diet specialisation that relates to periods of floral resource limitation. We conclude that it is important to track floral resource use through the year in order to understand network stability in the face of ecological change. Finally, we analysed the foraging preferences of bumblebees, honeybees, non-corbiculate bees and hoverflies through the flowering season. We show differences in plant use by the different groups of pollinators and use these results to provide recommendations to gardeners on the best plants for pollinators through the year.

T02

Forest Habitat and Forest Dominated Landscapes Filter Out Bumblebee Species with Visual Traits Related to Light Sensitivity

Océane Bartholomée[1], Pierre Tichit[2 3], Jens Åström[4], Henrik G. Smith[1 3], Emily Baird[2], Markus A. K. Sydenham[5], Sandra Åström[4]

[1] Centre for Environmental and Climate Science, Lund University, Lund, Sweden
[2] Department of Zoology, Stockholm University, Stockholm, Sweden
[3] Department of Biology, Lund University, Lund, Sweden
[4] Norwegian Institute for Nature Research, Trondheim, Norway
[5] Norwegian Institute for Nature Research, Oslo, Norway

While functional traits like body size have been extensively linked to species distributions, the influence of sensory traits on species' responses to environmental changes remains underexplored. Particularly, the relationship between light sensitivity and niche segregation across different distributional ranges remains unclear. In this study, we examined bumblebee communities monitored across Norway on grasslands and forests within landscapes varying in forest cover within 1 km radii. We investigated whether the eye parameter – a visual trait measuring the trade-off between light sensitivity (high values) and visual resolution (low values) – was associated with local habitat types and the forest cover at the landscape scale. Additionally, we combined bumblebee-plant interactions with a plant trait, to determine if bumblebee light sensitivity correlated with the shade tolerance of the plants they foraged on.

Our findings showed that bumblebee species with high eye parameters were more common and abundant in forest habitats and areas with greater forest cover, while species with low eye parameters showed the opposite trend. This pattern was also reflected at the community level, as indicated by the community-weighted mean of the eye parameter. Furthermore, bumblebees with higher eye parameters tended to forage on plants with greater shade tolerance. These results suggest that visual adaptations for light sensitivity

contribute to shaping bumblebee species distributions across different scales. These adaptations are closely linked to the light niches of the plants they forage on. Overall, our study underscores the importance of pollinator vision in understanding species niches, in relation to habitat use and foraging behaviour.

T03

Assessing Competition between Domesticated Honeybees and Wild Pollinators in Heathland Habitats

Maisie Brett[1], Ellen Wright[1], Lisa Mijares[4], Ian P. Vaughan[2], Jane Memmott[1]

[1] School of Life Sciences, University of Bristol, UK
[2] Cardiff University, UK
[3] Conservation & Research Unit, Grootbos Foundation, South Africa
[4] Institut Polytechnique de Paris, France

Domestic honeybees can compete with native pollinators for resources such as nectar and pollen. Under what conditions competition occurs is debated, however, and approaches that consider the entire native pollinator community are scarce. Here we assess pollinator competition in Scottish Upland Heathlands, considering the entire pollinator community for the duration of the flowering season. We performed an experimental introduction of hives to 20 two-hectare 'apiary' and 'bee-free' sites in upland heathlands of east Scotland. We compared plant-pollinator networks and bumblebee pollen foraging between treatments, and detected significant network changes during hive introductions. We also found that for bumblebees, the protein content of foraging trips was maintained at sites with apiaries despite changes in diet, suggesting adaptive behaviour. We included a second treatment of land management, with half of the sites being subject to burning and sheep grazing, and the other half regenerating towards woodland. Interestingly, we found that land management interacted with bee introductions, with apiaries having a stronger effect on pollination networks at 'regenerating' sites than at 'muirburn' sites. Muirburn sites are historically subject to burning and grazing pressures, which may maintain floral diversity at important times of year for pollinators.

T04

Insect Pollinator Diversity in relation to Vertical Strata and Species of Tree in Southern African Temperate Forests

Rudi Crispin Swart[1], Sjirk Geerts[2], James Stephen Pryke[3], Anina Coetzee[1]

[1] Department of Conservation Management, Faculty of Science, George Campus, Nelson Mandela University, South Africa
[2] Department of Conservation and Marine Science, Cape Peninsula University of Technology, Cape Town, South Africa
[3] Department of Conservation Ecology and Entomology, Stellenbosch University, Matieland, South Africa

The largest indigenous forest in southern Africa is a naturally patchy biome to the eastern regions of the mega-diverse Cape Floristic Region, along the south coast of the continent. Despite an abundance of work on pollination in the fynbos biome, indigenous forests have been largely overlooked, with the most comprehensive notes on forest tree pollination dating back to 1926. The challenges of spatiotemporal variation in forest tree flowering and accessibility have seen pollination studies in undisturbed forest canopies being unevenly distributed across the globe, mostly restricted to areas where canopy cranes are in place and often covering northern temperate or tropical forest systems. Thus, southern Afrotemperate canopies represent two geographic gaps: southern temperate forests and Afromontane forests. We accessed flowering tree canopies, using rope pulling techniques, and observed flower visitors to four common canopy tree species in a large, undisturbed forest interior. Additionally, anthophilous insects were sampled in aerial pan traps across a standardised range of heights. We show that tree species, despite being generalist in their interaction with flower visitors, support a rich diversity of insect species and that flower traits (petal reflectance and size) partially drive associated insect diversity. Surprisingly, forest patches were found to be significantly more diverse and abundant in anthophilous insects compared to continuous forests. Higher diversity in isolated forest patches were largely driven by distance to edge; as proximity to edge increases, so do insect and species numbers.

T05

Viral Spillover in Plant-Pollinator Networks: a Causal Analysis

Willem Proesmans[1 2], M. Albrecht[3], A. Dalmon[4], A. Gajda[5], P. Neumann[6], R. Paxton[7], O. Schweiger[7 8], J. Settele[9], H. Szentgyörgyi[10], A. J. Vanbergen[2]

[1] Laboratory of Zoology, Mons University, Belgium
[2] Agroécologie, INRAE, Dijon, France
[3] Agroecology and Environment, Agroscope, Zürich, Switzerland
[4] Abeilles et Environnement, INRAE, Avignon, France
[5] Institute of Veterinary Medicine, Department of Pathology and Veterinary Diagnostics, Warsaw University of Life Sciences, Poland
[6] Institute of Bee Health, Vetsuisse Faculty, University of Bern, Switzerland
[7] Department of Community Ecology, Helmholtz Centre for Environmental Research – UFZ, Halle, Germany
[8] German Centre for Integrative Biodiversity Research, Halle-Jena-Leipzig, Leipzig, Germany
[9] Department of Conservation Biology & Social-Ecological Systems, Helmholtz-Centre for Environmental Research – UFZ, Halle, Germany
[10] Institute of Botany, Faculty of Biology, Jagiellonian University, Kraków, Poland

Emerging pathogens are considered a potential threat to wild pollinators. Recent studies have looked at network structure, community composition, landscape or presence of honeybees as potential drivers. However, an all-encompassing causal framework on pathogen spillover has been lacking. We studied transmission of two RNA viruses with wide host ranges – Black Queen Cell Virus (BQCV) and Deformed Wing Virus (DWV) – in plant-pollinator networks in 48 landscapes divided over four countries along gradients of urbanization and agricultural intensification. We used Directed Acyclic Graphs (DAG's) to propose causal hypotheses and calculate unbiased effect sizes on the direct and indirect effects of environmental factors on viral prevalence.

Both viruses were abundantly detected in wild bees and hoverflies. We found that for both viruses, honeybees were the strongest driver of viral prevalence in wild pollinators. Additionally, DWV prevalence was lower in landscapes with high wild pollinator abundance, indicating a potential dilution effect of honeybees. BQCV showed higher prevalences in species with a high niche overlap with honeybees. Modular networks indirectly reduced BQCV prevalence, which was entirely explained by the resulting decrease in niche overlap with honeybees. Surprisingly, while honeybees in urbanized landscapes had a higher BQCV prevalence, wild pollinators showed an opposite pattern. Our study confirms honeybees to be the main driver of the studied pathogens in wild pollinators. While the effects on wild pollinator health and fitness are unknown, our results suggest that spillover through shared flower use serves as an important pathway of viral transmission from honeybees to wild pollinators.

T06

Nectar Deposition on Stigma Selectively Promotes Pollination

Ferne Kotlyar[1], F. A. Jones[2], M. G. Betts[3], M. Atencio-Picado[4], A. Rico-Guevara[5 6], H. H. Wagner[1]

[1] Department of Ecology and Evolutionary Biology, University of Toronto, Canada
[2] Department of Botany and Plant Pathology, Oregon State University, USA
[3] Department of Forest Ecosystems and Society, Oregon State University, USA
[4] Las Cruces Biological Station, Organization for Tropical Studies, Costa Rica
[5] Burke Museum of Natural History and Culture, University of Washington, USA
[6] Department of Biology, University of Washington, USA

Nectar acts as the most common floral resource that is exploited by the largest variety of animals. Analogous to nectar, pollination drops (commonly found in gymnosperms), are a sticky fluid that captures pollen grains, transports them, rehydrates them, and promotes their growth. While chemically similar, nectar and pollination drops have been ascribed distinct functional roles; one for interacting with animals and the other for regulating pollen behaviour. However, there are exceptions on both sides, whereby pollination drops attract pollinators, and nectar triggers pollen germination. We ask: could nectar movement by pollinators

play a role in pollination? To answer this question, we collected two sets of data: **1)** we carried out field experiments to test whether nectar deposition on the stigma ("nectar drop") increases the success of hand pollinations in *Heliconia tortuosa*; and **2)** we analyzed 125 hummingbird visits to *H. tortuosa* inflorescences using high-speed (240 fps), high-resolution (2.7K) videos to assess whether different hummingbird species were more likely to deposit nectar on the stigma. We found that the "nectar drop" treatment (n=127) produced 10 and 6 times more fruit than classic hand pollination (n=86), and nectar extraction (n=103) treatments, respectively ($p<0.001$). We also found significant differences in stigma interactions between different hummingbird species. These findings suggest that nectar-mediated pollen germination may present a novel aspect of plant-pollinator interactions.

T07

The Sterols of Pollen are Diverse but Selectively Utilised by Bees

Ellen Baker[1]

[1] University of Oxford, Department of Biology, UK

Sterols are essential precursors of moulting hormones in bees and are important membrane components for both plants and animals. Plants produce a wide range of 'phytosterols', that differ from cholesterol by their longer chain length. Bees are unable to synthesise sterols *de novo* and therefore rely on pollen for their dietary sterol requirements. However, the sterol profile of pollen is more variable and diverse than vegetative plant tissues, creating a varied sterol landscape that bees must forage from. Here we report the sterol compositions of pollen from over 270 UK plant species and 60 species of bees to better understand the diversity of sterols across plant and bee taxa. Our aim was to better understand the relationship between the sterolome of bees and their pollen food and to consider the availability of sterol nutrients in the UK landscape. The results showed that, sterol profiles varied more widely in plants than in bees but were phylogenetically conserved. Some common and abundant sterols were recorded in a taxonomically and ecologically diverse range of species. Lower levels of Δ5 sterols were recorded in the pollen of Asteraceae flowers compared with other plant groups, a trend which was reflected in the bees that specialised in collecting its pollen. These results will increase our understanding of sterol requirements in wild bees and have future use in the modelling of sterol availability across the UK landscape.

T08

Orchid Pollination in the Tropics and Why it Matters?

Monika M. Lipińska[1], Cecylia Barabasz[1], Charlotte Watteyn[2] [3]

[1] Department of Plant Taxonomy and Nature Conservation, Faculty of Biology, University of Gdańsk, Poland

[2] Department of Earth and Environmental Sciences, KU Leuven, Belgium

[3] Lankester Botanical Garden, University of Costa Rica, Costa Rica

Orchids are renowned for their intricate and specialized pollination strategies, playing a vital role in the Neotropical ecosystems. In the presented study, we used Guatemala as a case study. We synthesize existing data on the pollination of orchid species in this megadiverse country, based on the 2018 checklist that catalogues over 1,200 orchid taxa. We systematically searched academic databases, including PubMed, Web of Science, Scopus, and relevant botanical sources, to assess the pollination data available for these orchids. Of the 1,231 species reported in Guatemala, classified into 221 genera, pollination data were found for only 98 species across 71 genera. This metanalysis highlights significant gaps in our understanding, emphasizing the challenges posed by the immense species diversity, complex pollination mechanisms, and the elusive nature of pollinators in tropical orchids. The findings underscore the need for targeted research to unravel these pollination interactions, which are crucial for the conservation and biodiversity of tropical ecosystems. Through this analysis, we aim to shift the discourse from merely acknowledging the severity of the situation to addressing the underlying causes and determining effective actions.

T09

A statistical Test for Floral Syndromes in *Aquilegia* (Ranunculaceae)

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Aquilegia flowers provide nectar to their pollinators via spurs that differ in length among species. In addition, flowers vary in colour, orientation, and to some extent also in shape. Traditionally, *Aquilegia* flowers have been classified into three floral syndromes associated to bee, hummingbird, or hawkmoth pollination. In Asia and Europe, *Aquilegia* species are mostly pollinated by bumble bees and bees, while in North America, shifts from the likely ancestral bee-pollination to pollination by hummingbirds and hawkmoths have occurred repeatedly. However, these syndromes were never statistically tested using data based on pollination studies. In addition, field observations have shown that *Aquilegia* flowers are almost always visited by a number of different pollen and nectar collectors, and some *Aquilegia* species seem to exhibit mixed pollination systems. Here we use multivariate statistics, morphospaces, and random forest analyses to test for the association among floral traits (e.g. perianth colour, spur length, flower orientation) and pollinators (bumble bee, hummingbird, hawkmoth) in c. 30 species with documented pollinator observations. Although some groups are still poorly represented due to a lack of empirical pollination data, this allows us to statistically describe floral syndromes in *Aquilegia*, distinguishing between nectar- and pollen-collecting pollinators. We finally test whether mixed pollination systems (more than one primary pollinator) display their own floral syndromes or fall into one of the three main syndromes in *Aquilegia*.

T10

Floral Longevity goes Multidimensional: Floral Longevity spaces

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Floral longevity is an important component of floral display. There is a wide range of interspecific variation in floral longevity, driven by two factors: **(1)** a cost-benefit balance between pollen removal and deposition, and **(2)** a host of environmental factors that influence the physiological costs of keeping functional flowers. Traditionally, floral longevity has been estimated as the time from corolla opening to corolla wilt under one of two conditions: **(a)** natural pollination (natural floral longevity) or **(b)** pollinator exclusion (maximum or potential floral longevity). Here, a new framework is put forward that considers floral longevity as a multidimensional trait. In this new framework, three estimates of floral longevity are relevant: potential floral longevity, natural floral longevity and mimimum floral longevity, assessed by hand-pollinating freshly opened flowers. In addition, three time lapses are considered: floral longevity span (difference between mimimum and potential floral longevity), distance to the minimum boundary (difference between natural and natural floral longevity) and distance to the minimum boundary (difference between potential and natural floral longevity). All together, these six estimates allow to build floral longevity spaces. Using a data set of ca. 90 species, I explore the interspecific variation in floral longevity spaces in relation to flower size, dichogamy, self-compatibility, latitude and flowering phenology. In addition, I suggest a protocol for the study of floral longevity spaces along environmental gradients.

T11

Novel uses of Old Technologies: an Automated Radio Telemetry System to infer Pollinator Movement in Tropical Mountains

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Understanding movement patterns of pollinators is crucial to protect plant reproduction across landscapes, yet there are still challenges in tracking very small animals. To generate tracking data of high-mountain pollinators in the tropical Andes, we set up an automated radio telemetry system (ARTS) inside Chingaza National Park in Colombia. The ARTS grid covers approximately 1 km² of a valley with four main vegetation types, and is made up of receiving nodes that continuously detect radio signals and communicate with the central antenna where data is downloaded. Given that there is a relationship between signal strength and distance, locations of transmitters are estimated by multilateration. The localization error caused by a wild landscape with complex vegetation and a rugged terrain may be reduced with signal cleaning, selection and smoothing. We have deployed 0.35 g transmitters on hummingbirds and flowerpiercers and obtained data of individual movement at a fine spatiotemporal scale. In addition, we mapped the vegetation of the valley with orthomosaic images captured by drones at a 5 cm resolution, making the estimation of foraging routines, association to plant species and territorial defence behaviours of pollinators possible. The successful installation and testing of the ARTS grid inside the protected area, along with the development of even lighter transmitters, gives the opportunity to track other pollinators including rodents, bats, and large insects of the highly endemic ecosystems of paramo and high-Andean forest. Also, this project has engaged environmental agencies and local researchers in generating movement data to inform conservation practices.

T12

Shedding some Fluorescent Light on Micro Plastics: an Exploration of Micro Plastic Pollution in Bees and Flowers

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Micro plastics can influence bees negatively as some recent studies indicate. Micro plastic particles can disrupt the gut, impair cognitive functions and increase mortality. However, many previous studies tested only single plastic compounds with adults, and little is known about compound mixtures or their uptake by bees. In our study, we address both the uptake of micro plastic from the environment and the effect of a micro plastic mix on solitary bee larvae. We sampled nectar from pollinated plant species as well as the bee species feeding on them. Both bees and plants were sampled together. We analysed nectar and gut contents of associated bees with a newly developed methodology using Nile Red staining and fluorescent microscopy. The protocol follows Meyers et al. 2022, but was adapted for nectar and gut samples. To additionally assess the effect of micro plastics on solitary bees, we fed local *Osmia bicornis* larvae various diets containing different concentrations of a mixure of three different micro plastics. We recorded sublethal effects on the larval development especially in the mix with lower micro plastic concentration.

For this study we developed a novel method to assess micro plastics in terrestrial samples. Using this, we are providing the first insights into levels of contamination by micro plastic in flower resources that are important for pollinators, as well as into the amount of plastic that ends up in the digestive tract of wild bees. This is especially important for assessing the potential ecotoxicolgical effects of these particles in insects.

T13

Revegetation across Europe primarily Benefits Common and Generalist Pollinator Species

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Active restoration accelerates the colonization and succession of vegetation communities by using manual methods to introduce plant propagules into a degraded area. Active restoration across large areas requires land practitioners to use plants that are produced by seed suppliers at commercial scales (the 'Restoration species pool'). With restoration actions, plants from the restoration species pool may therefore become more common across ecological communities, with unknown consequences for biotic communities in higher trophic levels. We surveyed the literature to identify plant genera that are available for restoration in Europe, and then used plant-pollinator interaction data from 17 different studies to compare the association between plant commonness and pollinator diversity. We predicted that plants from the restoration species pool would already be common in plant-pollinator interaction networks, and that common plants primarily benefit common and abundant generalist pollinators. Plant genera from the restoration species pool were more common and supported more pollinators, than other plant genera, and only a few genera from the restoration species pool are required to support most of the pollinator species. However, common plants supported pollinator assemblages that were redundant with other co-occurring plants, and contributed little to overall pollinator diversity. Finally, simulated seed mixes of common plant species supported fewer rare pollinators, and more generalists, indicating that active restoration could lead to the functional homogenization of pollinator communities. Increasing the availability of plants that support rare, specialized, and unique pollinators can equip land managers to restore ecosystems with taxonomically and functionally diverse communities.

T14

A Matrix of Flowers: Floral Resources from Legumes in Temporary Grasslands and its Potential Benefit gor Pollinating Insects

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In Europe, biodiversity associated with farmland has declined dramatically despite costly efforts to preserve it. These declines have mainly been driven by agricultural intensification, resulting in landscape simplification by loss of non-crop habitat, and increased management intensity of arable fields. Widespread loss of floral resources across agricultural landscapes has been suggested to be the main reason for the decline of many of flower-visiting insects, in particular wild bees. Maintaining flower-rich temporary grasslands, also referred to as leys, may be a cost-efficient way to provide additional flower resources during periods when flower resources in the agricultural landscapes are scarce. We investigated if leys have the potential, in terms of floral resources, to provide complementary flower resources for flower-visiting insects in agricultural landscapes, and if this is modified by management intensity. We analysed data on field level blooming, and we scaled our results to the landscape level to analyse whether the total abundance of floral resources provided by legume leys across entire landscapes vary depending on the amount of leys and the proportion being organic. We found that total legume blooming per landscape was significantly higher in landscapes with higher presence of organic ley. Our analysis also shows that the positive effect of organic leys is stronger later in the season. Synthesising our results from both field and landscape level, we discuss how different management practices might impact floral resources provided by leys on a landscape scale, and highlighting possible benefits that leys might bring for flower-visiting insects.

T15

Using Pan Traps for Large-Scale Bee Monitoring Programs

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Pan traps allow simultaneous bee sampling of many sites, and are a key method in large-scale monitoring programs. Our recent systematic review indicated that pan trap methodologies varied considerably among bee studies for some aspects. In order to close methodological knowledge gaps that may contribute to this variation, and to stimulate further research in this regard, we conducted field experiments investigating the effects of different pan trapping methods on the sampled bee communities. We investigated the effects of different pan-trap diameters and floral context around pan traps on bee samples in replicated flower strips around the City of Braunschweig (Lower Saxony, Germany) in 2021 and 2022, followed by morphological species identification. For assessing how exposure time per sampling event influences bee samples, we used a large-scale sampling scheme covering about one quarter of Germany in 2023, using meta-barcoding for taxon identification.

Large pan traps collected significantly more bee individuals (white and yellow pan traps) and species (all colours) than small pan traps. Large pan traps also collected significantly more bycatch biomass than small pan traps, irrespectively of pan trap colour. Flower cover, interacting with bee taxon, affected detection probability per trap as well as the number of sampled bee individuals per trap. The gain in additional bee OTUs appears to level off after 48h of exposure. We encourage the use of larger pan traps, limiting negative impacts on non-target insects through reduced exposure time. The option to use more small traps per site vs. fewer large traps should be explored.

T16

WILD POLLINATORS IN A FRAGMENTED LANDSCAPE: Using population and Landscape Genomics to Explore Spatial Connectivity in Bumblebees

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Bumblebees are key pollinators which facilitate the reproduction of a wide range of wild and agricultural plants. Their abundance and diversity have been severely reduced by anthropogenic stressors such as widespread land-use change and habitat loss. However, we lack a comprehensive understanding of the effect of landscape fragmentation on bumblebee dispersal, population connectivity, and gene flow. Here, we conduct a population genomics study of two common bumblebee species, *Bombus lapidarius* and *Bombus pascuorum*, by analysing whole genome data of 106 specimens from 7 sites in Northern Europe. We discover unexpectedly fine-scaled population structure (e.g. ~300km) in both species, along with stronger population structure and distinct genomic architecture suggestive of local adaptation in *B. pascuorum*. We expand on these findings by drawing on landscape genomic approaches, integrating bumblebee occurrence data with climate and land-use maps to generate bumblebee landscape resistance models based on predicted habitat suitability. We find that modelled least-cost-path landscape resistance is a significant predictor of individual pairwise bumblebee genomic similarity. Our results also indicate that bumblebee landscape permeability and genetic connectivity are facilitated by grasslands and deciduous forests, and limited by agricultural fields, coniferous forests and precipitation. These observations highlight the necessity of increasing our understanding of bumblebee population structure and genetic connectivity in order to facilitate range-wide bumblebee dispersal networks, and mitigate the impacts of ongoing anthropogenic land-use change.

T17

Can Nectar Metabolites Mitigate the Burden of Disease in Bees?

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Floral nectar is a reward and major source of dietary carbohydrate for flower visitors that pollinate plants and facilitate plant reproduction. Nectar often contains secondary metabolites that may be toxic to some flower visitors or influence their behaviour. Our recent work has identified metabolites in nectar that are bioactive against disease organisms of bees and could potentially benefit pollinator community health. For example, a megastigmane callunene in *Calluna vulgaris* (heather) nectar is bioactive against *Crithidia bombi* an important gut parasite of bumble bees while a related compound in *Arbutus unedo* nectar has a similar activity. Similarly, *Tilia tomentosa* contains a cyclohexadiene-carboxylic acid that is biologically active against *C. bombi*. Their chemical structures are altered during gut passage influencing bioactivity indicating the importance of testing compounds in living systems to provide a complete picture of their benefits for bee health.

Evidence of the benefits of nectar metabolites for bee health are limited to the laboratory. We are now investigating UK lowland heaths, landscapes dominated by *C. vulgaris* and which have undergone historic losses, to determine the benefit of callunene to bumble bee health under field and colony conditions. We are also quantifying production of bioactive nectar compounds across lowland heaths to understand how landscape factors influence variation in occurrence and potentially pollinator health benefit. These data will help understand how lowland heath management can be optimised for bee health. Ultimately, we will provide information to managers of lowland heaths to maximise the health of bees on which heather relies.

T18

Perception and Effects of Pesticides in the Food of *Bombus terrestris*

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The decline of pollinators and its causes have been intensively investigated in the last few years. Most causes for the declines are known: pathogens, urbanization, habitat fragmentation, climate change, intensification of agriculture, etc. As part of agricultural intensification, pesticides were found to play a prominent role, as they are ubiquitous in crop plants and beyond, with sub-lethal to lethal effects on insects. While it is known that pesticides affect insects, it is hardly known whether insects can detect pesticides and potentially learn to avoid them. To address this question, we tested whether the bumble bee *Bombus terrestris* can “taste” the active substance of three systemic pesticides, i.e., Sivanto (Bayer), Closer (Corteva), and Amistar (Syngenta). We performed chemo-tactile PER-conditioning assays on *Bombus terrestris* workers to determine if bumblebee workers can perceive pesticides in pollen with an associative learning paradigm. We additionally investigated the importance of larval feedback, the primary consumers of pollen, which might alternatively or additionally inform the workers about pollen contamination. We performed long-term feeding experiments (over one complete brood development cycle) with queenless *Bombus terrestris* microcolonies in which the workers were exposed to field-realistic concentrations of pesticides in their pollen and nectar. Two different setups were used, ‘choice’ and ‘no-choice’. During ‘choice’, the workers had access to two different treatments, and in ‘no-choice’, only one treatment was presented. We report our findings for pesticide effects on feeding behaviour, brood development, and mortality of colonies.

T19

How do Pollinators Perceive Floral Abundance?

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Null models offer a baseline against which ecological hypotheses can be tested and foraging behaviour not accounted for by neutral processes or sampling biases can be identified. They have been used to test whether pollinators visit flowering plant species more or less frequently than would be expected based on flower abundance, i.e. testing whether pollinators have flower species they favour? Null models require estimates of flower availability and counting flowers is not straightforward given their highly variable structures. Moreover, how floral abundance data is collected could affect the efficacy of null models. This project used *Heracleum sphondylium* (common hogweed) as a model system to test for this effect. *H. sphondylium* is a perennial member of the Apiaceae family, characterized by large, umbrella-shaped inflorescences composed of numerous small white flowers. Plant-pollinator interaction data was collected from three field sites and *H. sphondylium* floral abundance was measured using three different methods at each site: counting individual flowers, floral units, and umbels. Analysis shows that there were few changes in keystone status for *H. sphondylium* between the floral unit and umbel counting methods, however when individual flowers were counted, changes in keystone status was observed. The implications of these results for collecting data on flower abundance will be discussed.

T20

The Role of Surrounding Plant Floral Density in Shaping Pollinator Visitation to Native Plants: Insights from Native and Exotic Contexts

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The spread of exotic species likely dates to early human migration. However, their effects on ecosystems are not fully understood, especially in the prairies of N. America where invasions have a long history, and uninvaded remnants are rare. Especially important is the need for investigation into how invasives affect plant-pollinator interactions. Here, we aim to understand how the floral density of exotic species affects the likelihood of visitation by native pollinators. Data were collected from Oak Lake Field Station, Aurora Prairie, and Sioux Prairie during the 2023 and 2024 spring and summer. At these sites, we established focal native plants and recorded floral abundance for both native and exotic species within a three-meter radius. Additionally, we conducted 10-minute visitor observations. We assess the impact of exotic floral density on visitation likelihood using logistic multiple regression. We identified 68 native species and 15 exotic species during our 687 plot observations. Using visitation as the response variable, we found that increased floral abundance of exotic species significantly enhances visitation to native species (estimate: 0.34318, $Z = 6.895$, $p < 0.001$) and beetles (estimate: 0.30074, $Z = 5.240$, $p < 0.001$). In contrast, bee visitation is more likely to increase with higher floral density of native species (estimate: 0.16362, $Z = 2.968$, $p = 0.002$). Exotic floral density boosts overall visitation and beetle attraction, while native density specifically enhances bee visitation. We will also present other questions we are investigating for feedback.

T21

Nutrient-Driven Foraging Behavior: Pollen Collection Patterns Among Alpine Bumblebee Species

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Many flowering plants depend on pollinators for successful cross-pollination and offer rewards like nectar or pollen in return. Bees, especially, rely on pollen as a crucial resource for raising their young. Pollen varies greatly in nutrient composition—referred to as pollen quality—both among different plant species and within the same species. This nutrient spectrum includes amino acids, fatty acids, sterols, vitamins, minerals, and plant secondary metabolites. As a result, the nutritional suitability of pollen as a food source differs across plant species. Bees must adapt their foraging behavior to select nutritionally appropriate pollen, using chemotactile sensing via their antennae to detect differences in nutrient concentrations.

In our study, we explored whether the nutrient composition of pollen influences the foraging behavior of alpine bumblebee species. We collected pollen from various alpine flowering plants in the Hohe Tauern National Park throughout the season. We analyzed the nutrient composition using gas chromatography-mass spectrometry (GCMS) for fatty acids and sterols and ion exchange chromatography (IEC) for amino acids. Additionally, we gathered pollen loads from alpine bumblebees and hoverflies (as a control group) and performed metabarcoding to identify the pollen's taxonomic origin. Considering the impact of different nutrients on bee health and the bees' ability to detect these variations, we hypothesized: **i)** Bumblebees select pollen from different flowering plant species than hoverflies. **ii)** These differences are driven by the nutritional composition of the pollen rather than by the phylogenetic relationships between plant species. This study sheds light on the intricate connections between nutrient availability, perception, and pollinator foraging behavior.

T22

Rapid Evolution of Flowers: The Role of Floral Trait Evolutionary Potential

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Plants can evolve rapidly after changes in their pollinators and this is an important force behind the evolution of floral diversity. Both floral morphological and nectar traits can be expected to play important adaptive roles, with nectar rewards varying depending on pollinator preference, and morphology optimizing the mechanical aspects of access to rewards and pollination. Yet the response of different floral traits to novel natural selection can vary. Floral morphology is often expected to show high phenotypic integration to maintain pollination accuracy, while nectar traits can be environmentally sensitive. Genetic correlations and phenotypic plasticity can therefore play important roles that are not fully understood, particularly for nectar traits. We explored this in the context of recent pollinator change, using *Digitalis purpurea* as a model. *D. purpurea* shows recent evolution of corolla morphology but not nectar after a range expansion with hummingbirds added as pollinators. We studied plasticity, heritability, evolvability, and integration of morphology and nectar in wild populations and in a multi-population common garden. For morphological traits, we were able to compare marker-based estimates with classic crossing approaches. Overall, morphological traits showed higher heritable variation than nectar traits, and differences in integration match evolutionary responses. Nectar was more plastic than morphology, driven by highly plastic sugar concentration. Nectar production rate showed high evolvability and potential to respond to selection. Our results explain patterns of rapid evolution, show the usefulness of studying quantitative genetics in the wild, and help us understand the mechanisms behind the extraordinary diversity of flowers.

T23

Discrimination of Nectar Sugars by Bees: Detection, Preferences and Evolutionary Trends

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The extent to which floral nectar composition is driven by pollinator selection is a topic that has received considerable research attention. Despite this, we still know surprisingly little about the proximate mechanisms of sugar detection by pollinators and how sugar composition influences floral choices. In particular, obligate flower visitors like bees may have adaptations which give them high acuity for compounds such as sugars which are important for their survival. Here, we address this knowledge gap using an approach which combines chemical analysis of nectar sugar composition from a wide range of UK plant species with electrophysiological and behavioural methods to identify mechanisms and implications of sugar discrimination in three common bee species: *Apis mellifera*, *Bombus terrestris* and *Osmia bicornis*. We found that bees have specialised mechanisms for the perception and encoding of different sugars in nectar and that nectar preferences strongly vary depending on the relative proportions of the three common nectar sugars sucrose, fructose and glucose. This 'landscape' of nectar sugar preferences varies considerably between bee species but is relatively independent of concentration. Our results indicate that sugar identity may be more important to bees than sugar concentration. We also found that the proportions of different nectar sugars are relatively consistent within plant species. We consider the overall implications of these findings on the potential of bees to exert selective pressure on plants to produce nectar suited to their metabolic needs.

T24

Beetles are from Mars; bees are from Venus? Flower color preferences in *Anemone coronaria*

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Flower colour polymorphisms (FCP) along plants' distribution ranges are often attributed to pollinator shifts across environmental clines. How do such shifts interact with seasonal changes in pollinator assemblages, and can these interactions promote FCP? We addressed these questions using *Anemone coronaria*, a geophyte with complex geographical and seasonal FCP patterns. We created experimental arrays of *A. coronaria*, comprising its main flower-colour morphs (red, white, purple) in three field sites along its distribution in Israel (north, centre, south) and three timepoints (early-, mid- and late-season) over two years. We recorded flower-colour choices of insect visitors. We also captured insects in colour-matched pan traps in the second year.Bees and flies visited the flower arrays mainly in early season in the north and centre sites. Beetles visited mostly in late season in the southern site. The composition of insects caught in pan traps varied less between sites and timepoints than in flower arrays. Red flowers were over-visited in the south but under-visited elsewhere. Visits to red flowers increased towards late season, while visits to purple flowers decreased. Bees preferred red flowers in the south, but purple in the north. Among the beetles, glaphyrids specialized on red flowers. Beetles of other families preferred non-red flowers.Visitors shifted along *A. coronaria*'s seasonal and geographical axes. This resulted in spatio-temporal trends in the visitors' colour choices, which are consistent with the plant's FCP pattern. FCP may thus contribute to *A. coronaria*'s reproductive success by broadening its pollinator range over time and space.

T25

Pollination Insights - Optimizing Honey Bee Mediated Pollination in Highbush Blueberry

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Honey bees (*Apis mellifera*) are a significant contributor of pollination services in commercial highbush blueberry (*Vaccinium* spp.) production systems. Despite this, insufficient pollination frequently limits growers from achieving their full yield potential and research-based recommendations to inform pollination strategies are lacking. The objective of this presentation is to summarize how the cross-disciplinary and multi-institutional Blueberry Pollination Project has addressed some of these barriers by investigating best practices to achieve optimal honey bee-mediated pollination and formulate decision-aid tools. Findings that will be highlighted include: how partial self-sterility necessitates cross-pollination for optimal yields in northern and southern highbush blueberry cultivars, the role of honey bee hive placement in optimizing flower visitation and reducing pesticide exposure, improved measures of honey bee density and its relationship to flower visitation and pollination success, and the impacts of weather on pollination outcomes. Decision-aid tools that predict bloom phenology for timely arrival and departure of honey bee hives, and guide optimal hive stocking densities, will be introduced. Continued research complemented with outreach and adoption of recommended best practices resulting from this research will contribute towards evidence-based integrated crop pollination that will in turn benefit beekeepers and blueberry growers. Outputs from this project will be provided for blueberry growers and their advisors via the project website at www.blueberrypollination.org.

T26

Integrated Pest and Pollinator Management in Faba Bean (*Vicia faba*)

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Despite increasing evidence that supporting ecosystem services and crop management practices interactively shape crop yields, crops are mostly managed separately for pollination and pest control goals and interactive effects between conventional pest management and ecosystem services, such as pollination, are poorly understood. Understanding such interactions is necessary to identify trade-offs or synergies between ecological intensification and conventional practices. Faba bean is a mass-flowering crop providing floral resources for bumblebees and honeybees, whose pollination benefit crop yield. At the same time, faba bean yield is compromised by weeds, plant diseases and insect pests. In two separate projects, we **1)** tested how pollination, weed removal and fungicide application interactively shapes crop yield and yield components in faba bean using a cage experiment, and **2)** assessed synergies and trade-offs between insect pest control and crop pollination using a cultivar trial.We found that insect pollination and weed removal increased crop yield mostly additively, with insect pollination being the most important component to maximise yield. The fungicide treatment did not affect crop yield but attracted more bumblebee visits. In addition, preliminary results suggest that late-developing cultivars could provide a viable solution to reduce insect pest pressure, while concurrently benefitting long-tonged bumblebees and crop pollination in faba bean.We discuss the importance of better understanding the relative contributions of conventional management versus ecosystem services on crop production to ensure a transition to more sustainable crop management.

T27

The Impact of Landscape Features on Pollination Services Provided to Sweet Cherry

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Agricultural landscapes can have detrimental impacts on pollinators, which play a crucial role in pollinator-dependent crops like sweet cherry (*Prunus avium*). The higher proximity to semi-natural habitats can mitigate these effects, once these habitats provide essential support, food and nesting resources to sustain pollinator communities. We assessed how the percentage of semi-natural habitats in the proximity of sweet cherry orchards in the Beira Interior region, Portugal, impacts pollinator's visitors. Pollinator richness, abundance and visitation rates were recorded. The percentage of semi-natural habitats and agricultural areas in a 500 m and 1000 m radius of the studied orchards was calculated to quantify its impact in pollinator variables and sweet cherry production.

Half of the visiting pollinators were wild pollinators, showcasing the region's high pollinator diversity and their potential contribution to the pollination services of sweet cherry. Landscapes with a higher percentage of semi-natural habitats supported greater species richness, and wild pollinator abundances and visitation rates. Honeybees negatively impacted wild pollinators, with lower abundances and visitation rates of wild pollinators in orchards with higher honeybee activity. However, landscape composition and pollinator variables did not impact fruit production. These findings highlight the importance of implementing landscape-scale measures to conserve and protect semi-natural and natural areas to benefit pollinator communities and, therefore, potential sustainable pollination services to pollinator-dependent crops. Effective management of sweet cherry should account for the critical role of wild pollinators, ensuring that orchard and local management practices are pollinator-friendly, promoting and sustaining wild pollinator communities.

T28

Busy as a Bee – What Makes a Good Pollinator of Apples?

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Land use change is a primary driver of the decline of wild pollinators globally. In response, horticultural systems are increasingly reliant on managed honeybees for pollination services. However, honeybees are less effective pollinators than wild bees, potentially causing pollination services within horticultural systems to be suboptimal. Apples, an obligate out-crossing plant, have flowers with easily accessible nectar and pollen and therefore can be pollinated by a wide array of pollinators. Effective pollinators of apples have been shown to differ in their morphological and behavioural traits, and different apple cultivars attract different species, therefore maintaining a diverse pollinator community is important for overall apple quality and yield. We investigated the following questions: **(1)** which species of bees are commonly present in apple orchards, **(2)** how do they behave, and **(3)** how do various pollinator communities affect apple quality? Our study focused on six different locations, in two apple growing regions in Eastern and Western Norway, each containing orchards with three different apple cultivars. During the flowering season, we used pan traps to collect pollinators, observed pollinator activity on apple flowers directly, and recorded pollinator handling time, flight time, flight distance, and contact with the stigma in each orchard. In the fall we harvested apples and measured quality parameters important for commercial apple production. Here, we present the first results obtained from this study.

T29

Osmia vs *Bombus*: Can the Choice of Commercial Pollinator Influence Premature Fruit Loss?

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In Scotland sweet cherry undergo a natural phenomenon colloquially known as June drop, a process by which immature fruit are abscised from the tree. June drop is unpredictable and can dramatically affect fruit yields. The variation in the quantity of fruit lost per annum drives the need to understand factors influencing June drop. This increased understanding can provide growers with the ability to mitigate and stabilise fruit loss. This study aimed to use time-lapse cameras to monitor the pollinating behaviour of two commercially available species, to determine if pollinating species as well as pollinator activity plays a role in fruit retention during June drop. Twelve cameras recorded the activity of pollinating bees on cherry flowers for 16 days between 11am and 5pm, when pollinator activity was at its peak. The cameras were deployed within two distinct pollinator treatments designed to contain an equal number of either *B. terrestris* or *O. bicornis*. The different species compositions were achieved using either commercially reared bumblebee colonies or solitary bee cocoons in netted areas to simulate possible scenarios that can be found in cherry orchards. Cameras in *B. terrestris* areas captured distinctly more pollinator activity with 860 floral visits compared to only 28 in *O. bicornis* sections. Furthermore, *B. terrestris* areas retained a higher proportion of fruit than those in *O. bicornis* areas with 78% of all harvested fruit originating from the *B. terrestris* treatment. This study shows remote monitoring can help identify variations in pollinator behaviour and their subsequent roles in fruit loss.

T30

Mapping Pollinators in Fine-Scale Agricultural Landscape Elements

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Species distribution models can be powerful tools for mapping the distribution of a species, with applications in conservation such as identifying source populations and potential reintroduction sites. However, the accuracy of these models is influenced by factors like uneven sampling effort in the occurrence data (e.g., oversampling in urban areas) and the omission or lack of information relevant to the species' distribution. We hypothesized that without information on linear landscape elements (LEs), species distribution models are likely to overpredict habitat suitability in agricultural fields and underpredict habitat suitability in LEs. We tested this and found that the addition of LEs considerably improved many of the models, and thus is crucial for understanding the spatial distribution of pollinators in agricultural fields. Among the different types of LEs, herbaceous vegetation stood out as the most important variable, but model improvement was also found for woody LEs. Models incorporating this information show statistically significant improvements, including when validated with independently collected field data and also when compared against randomized controls. The resulting prediction maps become more nuanced, indicating lower predicted species richness within the agricultural fields and higher species richness at the edge of the fields, where the LEs are located. The LE variable could be added as distance to the nearest LE to increase scalability and to include the effect nearby LEs may have on the nearby landscape. These findings are valuable from both an ecological and a modelling perspective.

T31*

Local-Scale Tree Cover Modulates Pollination Services and Crop Production In Tropical Smallholder Agroforestry Farms

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Context: Global agricultural practices threaten pollinator communities, potentially impacting crop yields. Agroforestry offers promise, but its effects on pollination services and crop yield components in East Africa remain unclear. **Objectives:** This study investigated the impact of tree cover in Rwandan smallholder agroforestry systems on pollinator visitation and subsequent bean yield components at various spatial scales. Given the critical role of pollinators in agricultural productivity, particularly in tropical landscapes, understanding these relationships is essential for promoting sustainable and resilient farming practices in Rwanda. **Methods:** Two common bean (*Phaseolus vulgaris* L.) varieties, Kiryumukwe and Kivuzo, were studied in northeastern Rwanda. Eighteen farms with varying levels of tree density (measured as the number of trees within a 51m x 51m plot) were selected. Within each farm, a 5m x 5m bean plot was established. To assess the effects of pollination, 180 bean plants were subjected to two treatments: one branch per plant was bagged to prevent pollinator access, while the other remained open for natural pollination. Pollinator surveys were conducted by capturing flower visitors in 15-minute intervals and classifying them into six taxonomic groups. **Results:** Our findings demonstrate a significant influence of pollinator visitation on bean pollination and subsequent yield components. Open-pollinated flowers exhibited a notable increase in yield compared to bagged flowers, highlighting the critical role of insect-mediated pollination in enhancing bean production. We observed that both local tree density at the plot level and landscape-scale tree cover within a 100-meter radius significantly impact pollinator visitation and, consequently, bean pollination within these smallholder tropical agroforestry systems. **Conclusions:** Our findings highlight the importance of landscape management in maximizing crop yields, like those observed for common beans. This study highlights the importance of increasing on-farm tree cover and considering small-scale tree effects on pollinator abundance and crop performance to optimize crop production.

* Cancelled talk. Will not be presented.

T32

Is Drought Mitigation of Insect Pollinators in Strawberries Limited by Climate-Dependent Activity?

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Insect pollinators are crucial for agricultural yields, particularly for crops like strawberries. However, rising temperatures and drought alter floral cues and insect communities, thus posing challenges for crop–pollinator interactions. To explore how changed pollination affects strawberry yield, a combined field and climate chamber experiment was conducted with plants grown under either best practice or drought. One set of plants were placed at the margins of agricultural fields in a cool-wet vs. warm-dry region to understand effects of wild pollinators. The other plants were exposed to hoverflies, solitary bees or social bees in cli-

mate chambers with simulated current and future climates. Compared to self-pollination, insects increased fruit mass under warmer climate in the controlled environment, but not in the field. This was due to reduced activity of hoverflies in warm-dry regions. The climate chambers revealed a trend towards higher fruit set following hoverfly pollination, but only under current climate conditions. For drought-stressed plants, insect pollination led to fruit mass similar to regular watering under current but not under future climate or field conditions. The study underscores the role of insect pollinators in mitigating climatic effects on crops, though their effectiveness is limited by climate-dependent pollinators, especially for cold-adapted pollinators, such as hoverflies. Thus, climate adaptation strategies should include conservation measures for heat- and drought-tolerant pollination aiming at a functional diversity of pollinators to secure future agriculture.

T33

The Influence of Nectar Robbers in Shaping Flower Colour

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While the influence of pollinators in driving floral signals is relatively well known, the role of flower antagonists is less known. Flowers face a trade-off in attracting effective pollinators but avoiding antagonists such as nectar robbers; flower visitors that take nectar without pollinating the flowers. One solution is to produce signals (e.g. flower colours) that are detectable to pollinators but less detectable to nectar robbers. This is possible if the visual systems of these two flower visitor types differ, which is the case with birds and insects. Bird-pollinated *Erica* species in the Fynbos are pollinated by sunbirds and predominantly robbed by bees, and display a high diversity of flower colours within and between species. We applied visual modelling to 62 *Erica* species to test if bird-pollinated species are less conspicuous to bees than to birds. The results showed this to be true for some metrics of colour discrimination and flower conspicuousness. We also tested the prediction that flower conspicuousness to bees is correlated to other bee-avoidance traits (corolla length, aperture and stickiness, and sepal size) and found a negative correlation with sepal size. This study suggests that insect nectar robbers have contributed to shaping flower colour evolution in bird-pollinated *Erica* species.

T34

Evolutionary Ecology of Nectar: SCAPE update

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The importance of nectar in plant-pollinator interactions and the diversity of animal pollinated flowers has long been appreciated. However, nectar traits have generally been neglected in estimates of natural selection in populations. While researchers appreciate that nectar may be a target of selectin in populations, it can be a challenging trait to quantify in the numbers necessary for phenotypic selection studies. Here I will outline some of the challenges and opportunities for studying selection on nectar. I will also outline lessons we've been learning as my lab attempts to fill this important gap in our understanding of the evolution of floral traits. I'll show that nectar can be but isn't always a target of selection. Abiotic conditions can also change selection patterns on nectar. Quantifying selection on nectar traits may be particularly important to understand the impacts of our changing climate on floral evolution. Nectar can be a plastic trait influenced by current conditions, many which are changing, such as temperatures and water availability. Therefore, understanding the relationship between phenotypic plasticity and natural selection will be particularly important for furthering our understanding of the evolution of nectar.

T35

Pollinator-Specific Patterns of Phenotypic Selection on Floral Traits in a Pollination-Generalized Plant

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Floral trait evolution mediated by pollinators is a main driver of the diversification of flowering plants. A robust literature has focused on the role of pollinators as agents of floral trait evolution, with hundreds of studies distributed across a myriad of ecosystems. However, we currently lack comprehensive knowledge on how particular pollinator taxa contribute to the overall patterns of floral trait evolution. This is especially relevant for pollination-generalized plants, which interact with a broad range of pollinator taxa. Here, we performed flight cage experiments with functionally distinct pollinator taxa to estimate pollinator-specific patterns of phenotypic selection on floral traits in *Viscaria vulgaris*, a perennial herb of dry meadows. We found that legitimate and illegitimate flower visitors (*Bombus*), as well as a butterfly (*Pieris*), differed in their contribution to plant reproductive success. The variance in plant reproductive success was greatest for plant individuals that interacted with *Pieris*. We also found that the patterns of phenotypic selection on floral traits varied across the functionally distinct pollinator taxa, in particular for floral traits that determine flower-pollinator fit. However, these disparities were largely driven by variation in the strength of phenotypic selection on floral traits and do not necessarily impose strong pollinator-mediated trade-offs that produce valleys in the fitness function of *Viscaria vulgaris*. Our study is one of the few that have dissected pollinator-specific patterns of phenotypic selection on floral traits in a pollination-generalized plant and represents a first step to understand the relative importance of particular pollinator taxa as agents of floral trait evolution.

T36

Twelve Years of Research on Floral Scent Evolution (in 12 minutes)

Magne Friberg[1]

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For a long time, research on floral scent was technically challenging, and largely inspired by studies of insect pheromones where single chemical compounds trigger specialized antennal receptor(s) that guide insect behavior. During recent decades, increased research attention has been paid to understanding the ecological function and evolutionary diversification of floral scent. In this talk, I will attempt to summarize a dozen years of ecological and evolutionary insights from our research group (and others), highlight the many unknowns still lingering in floral scent research, and discuss future challenges.

Topics include our endeavours to understand the temporal and spatial scales of floral scent variation; the costs, constraints and trade-offs involved in floral scent production; the impact of adaptive and passive phenotypic plasticity; and recent efforts to understand the genomic architecture behind floral scent variation. And most importantly of course - the role of floral scent for mediating interactions between plants and their specialized and generalized insect pollinators.

T37

Speciation and Local Floral Adaptation of Two Neotropical Spiral Gingers with a Pollinator Shift

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Adaptation to different environments drives population divergence and the origin of new species. In animal-pollinated plants, local adaptation to distinct pollinator environments can lead to pollinator shifts, promoting the evolution of new pollination syndromes and reproductive isolation. Our field experiments on floral adaptation and isolation in two sister species of Neotropical spiral gingers — *Costus kuntzei* with ancestral bee pollination and *Costus wilsonii* with derived hummingbird pollination — shed light on the causes and consequences of evolving a new pollination system and its role in speciation. We conducted reciprocal translocations to examine local floral adaptation across an elevational gradient in Costa Rica, including sites within and outside the range of each species and at their parapatric range boundary. Pollinator effectiveness increased for hummingbird-adapted *C. wilsonii* at higher elevations, while bee-adapted *C. kuntzei* showed uniform bee effectiveness across habitats and elevations. These results suggest that local adaptation to "hummingbird habitats" in montane cloud forests drove the evolution of hummingbird pollination in *C. wilsonii*. We also examined pollinator behavior (preferences and constancy) and mechanical fit in experimental and natural sympatry scenarios. Our findings indicate that these floral isolation components can result in nearly complete reproductive isolation, implying that pollinator behavior and floral morphology alone can generate isolation upon secondary contact. In conclusion, our results suggest that the pollinator shift in *C. wilsonii* was driven by local floral adaptation to different pollinator environments, facilitating reproductive isolation between these Neotropical understory herbs.

T38

Mountain Colonization Triggered Evolutionary Pollinator Shifts Away From Bee-Pollination in Melastomataceae

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The importance and availability of different pollinator groups changes across elevational gradients, shaping the distribution of pollination systems. In the tropics, we might expect consistent shifts from bee- to vertebrate pollination in lineages that colonized mountains since vertebrates are more abundant and reliable pollinators than bees in cool and wet mountain climates. The few available studies of the environmental context of pollinator shifts indicate that climatic niche shifts precede pollinator shifts. Pollinator shifts therefore seem to be a consequence of the reduced pollination efficiency of the ancestral pollinator in the newly colonized environment. Ancestral pollinators may be retained, if species adapt to their reduced availability, (i.e., evolution of traits maximizing pollen transfer). Such traits include investment in overall floral display, which is positively correlated with pollination rates and traits regulating pollen dispensing (i.e., anther dehiscence).

Comparing the elevational distribution and pollination system (bee-pollinated versus shifted) of 333 Melastomataceae species, we show that pollinator shifts indeed associate with occurrence in cool and wet mountain environments across the family. By reconstructing the evolutionary history of pollinator shifts and elevation we show that colonization of mountains repeatedly triggered, and hence preceded shifts away from bee pollination. Also, we show that bee-pollinated species at higher elevation are confined to warmer areas compared to species which shifted pollinators. Finally, we show that floral traits potentially facilitating pollen transfer (petal- and pore-size) associate with montane environments and hence might have enabled bee-pollinated species the initial mountain colonization, and to retain bee pollination in warmer montane areas.

T39

Unilateral Adaptation - The Role of Trichomes in Shaping Pollinator Behavior in a Sexually Deceptive Orchid

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The specialized pollination system of the sexually deceptive orchid *Ophrys* and its pollinators offers a unique opportunity to explore evolutionary dynamics. *Ophrys* flowers resemble female bees and attract males for pollination in a species-specific manner. After attraction males engage in 'pseudocopulation', during which pollinia are transferred. To unravel the mechanisms of floral evolution in this interaction, it is crucial to examine the pollination-relevant traits of the labellum, the flower's lip, which directly comes into contact with pollinators during pseudocopulation. While the involved chemical cues have been intensively studied, the intraspecific significance of the labellum's morphological surface structures remains poorly understood. This study focuses on the role of trichomes on the labellum, aiming to link variation in phenotypic traits to differences in flower reproductive success in *Ophrys sphegodes*, a species which is pollinated by solitary *Andrena* males. Detailed field experiments were conducted in which untreated flowers (control) and flowers with trichomes removed from specific regions (basal, median, and apical) were presented to male pollinators. The results showed notable behavioral changes in pollinators, particularly with basal and apical trichome removal. Specifically, the absence of basal trichomes led to a significant decrease in the frequency of pollinia removal, directly affecting the plant's reproductive success. By manipulating trichome density in different labellum regions, we assessed the importance of their spatial distribution highlighting the ecological function of these structures. This study enhances our understanding of the role of trichomes in plant-pollinator interactions and their critical impact on plant reproductive success.

T40

Living With the Neighbours: Co-flowering Community Effects on Reproductive Success and Selection on Floral Traits in Food-Deceptive Orchids

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Interactions between co-flowering species for shared pollinators are common and can influence plants' reproductive success and ultimately natural selection acting on floral traits. However, studies considering a co-flowering community perspective are still rare mainly due to lack of appropriate statistical methods. Food-deceptive orchids provide suitable models to test for community effects on plant fitness as they often depend on rewarding co-flowering species to attract pollinators. Here, we applied recent statistical models within the Hierarchical Modelling of Species Communities (HMSC) framework to test for effects of the whole co-flowering community structure on pollination performance, reproductive success and phenotypic selection on floral traits in two food-deceptive orchids in Sweden. Our results revealed that the animal-pollinated co-flowering community had strong effects on the pollination success and reproductive fitness via fruit set in both orchid species, yet these effects did not change patterns of selection on floral traits. Moreover, the influence of the animal-pollinated co-flowering species remained strong even after accounting for non-animal-pollinated species in the community. By considering a community perspective trough the HMSC framework, our work yielded new insights on the biotic factors influencing the success of food-deceptive species. This approach can be extended to other pollination systems and plant communities and highlights the importance of considering the co-flowering community to understand the ecology and evolution of flowering plants in multispecies communities.

Flashtalks

F01

Nutrient Enrichment Affects Plant-Flower Visitor Assemblage Interaction Patterns in A Mediterranean Grassland

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Nutrient enrichment effects on plant community can cascade to higher trophic levels. Yet, little is known about the underlying mechanisms involving plant-visitor interaction patterns, that mediate such changes. Here, we use a long-term experimental site in a Mediterranean grassland where six different nutrient input treatments were applied for the past seven years, to evaluate how nutrient enrichment affects plant-visitor assemblages and interaction patterns. Nitrogen (N), phosphorous (P) and potassium (K) affected floral resource and pollinator assemblage composition and diversity, as well as flower visitation network metrics. The coaddition of N and P decreased flowering floral resource richness while increased flower abundance. This increased the diversity (abundance and richness) of pollinators visiting flowers in such plots (hence, network size), these changes being driven by increases in Diptera and Coleoptera. These changes were also associated with increased generality (higher plant generality, interaction evenness and reduced pollinator species specialization, d'). Conversely, when added alone, P and K decreased flower abundance and flower visitor diversity (hence network size). The addition of P also led to more unique sets of visitors (higher within-treatment species dissimilarity and higher dissimilarity of visitors between C and P), that visited less plant species (increased pollinator specialization metrics) in a less even way. Overall, this study shows that nutrient soil enrichment affects how flower visitors perceive flower resources altering diversity and interaction patterns, P having contrasting effects on network generalization patterns depending on whether is added alone or in combination with N. These results can help predict the impacts of the ongoing global changes of biogeochemical flows (particularly those of N and P) on ecosystem functioning, and reinforce the role of environmental eutrophication as driver of pollinator declines.

F02

A Poppy's Tale: Colour Variation in the West Mediterranean basin

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The color of *Papaver rhoeas* flowers provides a fascinating example of color variation in the ultraviolet wavelength range that is linked to the visual preferences of local pollinators. In the Eastern Mediterranean, where the flowers are primarily pollinated by the red-sensitive beetle *Pygopleurus israelitus*, they do not reflect UV. In contrast, in Central Europe, where non-red-sensitive bees serve as the main pollinators, *P. rhoeas* flowers reflect UV. This shift in UV reflectance is achieved through reduced quantities of UV-absorbing

flavonoids in the petals. Consequently, local pollinators could act as selection agents and drive this variation in flower color. Our study aims to test the hypothesis proposed by Dudek and collaborators (2020) within the southwestern Mediterranean Basin and extend it to *Papaver dubium*, another red poppy species that frequently blooms simultaneously and in the same populations as *P. rhoeas.* We predict that *P. rhoeas* flowers pollinated by bees should reflect UV light to attract them. Given that bees are the primary pollinators of both species in the Western Mediterranean, we aim to validate this hypothesis and explore the biochemical causes of this color variation across the Mediterranean Basin. Our results show that both poppy species reflect strongly in the UV which increases their conspicuousness to bees. We also found small quantities of UV-absorbing flavonoids. To accomplish this, we captured UV and visible pictures of both *P. rhoeas* and *P. dubium*, measured their reflectance spectra, and conducted HPLC analyses to identify and quantify their pigments.

F03

Visual Mimicry in *Ophrys* Orchids

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Insect mediated pollination relies heavily on a flowers' ability to effectively attract and advertise rewards to their desired pollinators. The most common example of this plant-pollinator interaction is the promise of a food source in the form of nectar or pollen. It is not uncommon for flowers to employ deceptive signals to attract pollinators, in which case the signals produced by the flower do not accurately represent the availability of a reward. While several species dupe pollinators by falsely promising a nutritious food source, some members of the Orchidaceae family use an even more remarkable strategy; sexual deception. These orchids mimic the signals created by female insects in order to attract males of the imitated species, who attempt to mate with the flower and in the process collect and transfer the orchids' pollinia. The genus *Ophrys*, a well known group utilizing sexual deception, has been studied extensively in the past, but current knowledge on the visual aspect of their mimicry is limited. In my PhD research I use various methods, including light spectroscopy and visual modeling, to investigate the different optical properties of *Ophrys* flowers. The main focuses of my research are the strength and specificity of the visual signals of *Ophrys* flowers, confirming the existence of a "double deception" in these flowers, and the role and mechanisms of gloss in these orchids. In my flash talk I will discuss the current progress of my research, and present some exciting preliminary results concerning the visibility and mimicry of various *Ophrys* structures.

F04

The Figure-Eight Maze: a Novel Protocol for Studying Bee Cognition and Learning

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Understanding whether or not an animal can perceive a stimulus is traditionally accomplished by pairing that stimulus with another which it is known that the animal can sense - colour, scent etc. – and then testing if the animal learns the association of stimulus and reward. In bumblebees in the laboratory, this is most often done in a free flight arena with one bee at a time, which typically uses a large amount of bench space and means only one experimenter at a time can work with a colony. The figure-eight maze addresses these issues: it is compact and disconnected from the colony, meaning several experiments can be run concurrently by different researchers.

It is quick and cheap to 3D print, results are easy to interpret and are obtained swiftly, and the setup lends itself well to computer vision analysis. This talk introduces the figure-eight maze and invites suggestions for its further use, including in the field.

F05

Centre of Information and Improvement of Knowledge About Pollinators - Shortcut Presentation of the Project

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As part of the programme of the Ministry of Science and Higher Education entitled 'Science for Society', the project 'Centre of information and improvement of knowledge about pollinators' was subsidised to enable educational and workshop activities by employees of the largest Polish institution conducting research on bees – namely Apiculture Division of the National Institute of Horticultural Research. It was foreseen that each topic of the workshops offered by scientists would be conducted at least five times for an audience of around 20 people. Meanwhile, so far, even before the project was completed, a total of 62 workshops have been held for a total of almost 1,400 recipients - almost twice as many as planned, due to the huge interest. Throughout the project, the audience's expectations of the content of the workshops were evaluated in order to adapt them as far as possible to achieve the planned goals. In addition, depending on the topic, participants received nesting constructions, designed plant compositions and seed packets of nectar- and pollen-producing plants. The increased interest in the project among potential recipients of the workshops indicates that further activities of this type are expected by the Polish society in the future, and many people would be willing to take advantage of such an educational offer to deepen their knowledge of both pollinators and the state of the Polish science in this field.

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F06

How to Calculate Pollinator Pollen Resources: Scaling Up From Species to Landscape

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The data on pollen production per flower is scarce and usually hard to compare and compile as some of them are shown as mass, while the others as volume of pollen produced. At the same time, there are only several published papers dealing with calculations of habitat- or landscape-scale pollen resources for pollinating insects. Therefore, there is a growing need for a time- and labour-saving method to estimate pollen supplies. The proposed method, in brief, includes assessment of flora composition, recording flowering phenology and abundance of polleniferous species, quantification of pollen production per flower and calculations required to scale the results up.

The method allows to calculate the total amount and illustrate the temporal distribution of pollen as well as to designate habitats that are of key importance in safeguarding pollen supplies in order to undertake proper conservation efforts.

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F07

Synthesis of Apple Pollination Research Reveals Positive Contributions From Wild Bees Relative to those of Honeybees

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Apple (*Malus domestica*) is one of the most important entomophilous crops in the world. To safeguard future yields, it is essential to understand which pollinating insects contribute to its pollination across production regions. Here we present a set of meta-analyses of site-replicated, observational studies on insect-mediated pollination in apple cultivation. Using raw data from 30 studies, totaling 546 site replicates, we determine the contribution of honeybees (*Apis mellifera*) and wild bees to apple pollination. We find that the honeybee is the most abundant pollinator (72.9% on average) compared to wild bees across all studies. From our meta-analyses we conclude that increasing honeybee visitation, wild bee visitation and bee species richness did not affect fruit yet. Fruit weight increased with increasing wild bee visitation while unaffected by honeybee visitation or bee richness. In contrast, seed set was not affected by honeybee visitation while enhanced by wild bee visitation and bee richness. In sum, a diverse community of bees contributes to apple pollination and yield. The positive effect of wild bee visitation and bee species richness on fruit weight and seed set is in line with previous crop pollination research concluding that wild bees provide better-quality pollination for most crops. Our synthesis highlights the general importance of conserving pollinator diversity to maintain pollination services.

F08

The Factors Affecting Pollinator Diversity and Abundance on Crops in Urban Food Growing Spaces

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Urban food growing holds significant potential for providing nutritious food to the increasing urban population. However, the dynamics of urban landscapes as food-growing environments remain understudied. Many crops commonly grown in urban areas benefit in yield quality or quantity from insect pollination, yet little is known about crop-pollinator interactions in these settings or how within-site and external landscape factors influence these relationships. This study examines pollinator species richness and visitation rates across seventeen commonly grown crop species over one growing season in urban allotments in Brighton and Hove, UK. Alongside, flower-insect timed counts, a myriad of landscape factors were analysed, such as ornamental flower cover, percentage tree cover, and proximity to remaining natural land cover, to understand their effects on the pollinator communities. Results indicated that both pollinator visitation rates and species richness significantly increased with the size of the allotment site. Moreover, pollinator species richness increased with individual plot level percentage tree cover, which was higher in larger allotment sites. These findings suggest that larger allotment sites support a greater diversity of pollinators with higher crop species visitation rates, likely due to increased tree cover and floral abundance, enhancing habitat quality. This study underscores the importance of supporting and implementing large growing spaces within urban landscapes to improve crop-pollinator interactions and maximize urban crop yields.

F09

The Effect of Temperature on Nectar Trait Plasticity of a Common Crop

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Plant-pollinator interactions are vital in maintaining global sustainable agricultural production, ecosystem function, and food security, yet they are threatened by pressures such as climate change. Floral nectar is crucial in these mutualistic relationships, influencing the foraging behaviour of pollinators and, consequently, pollination success and yield. Elevated temperatures are known to influence floral traits in plants, reducing nectar volume and altering flower size, impacting crop-pollinator interactions. However, comprehensive studies on the plasticity of floral and nectar traits in response to changing temperatures are limited. We explored the impact of changing temperatures on floral size, nectar characteristics, and their plasticity, in the common bean *Phaseolus vulgaris* L., a globally important crop in the Fabaceae family. *P. vulgaris* individuals were grown in controlled greenhouse conditions, then incubated at temperatures of 16, 23, and 30 °C for 3-day periods. Floral and nectar traits were measured at the end of each temperature treatment. Individual plants experienced multiple temperature treatments to assess plasticity in floral traits. Our preliminary findings reveal no effect of elevated temperatures on nectar volume, but a significant negative impact on flower size in *P. vulgaris*. Flower size is in turn significantly positively correlated with nectar volume. Nectar volume and flower size show significant plastic responses to temperature variations in *P. vulgaris*, suggesting that environmental stresses can influence the variability of rewards and potentially pollinator interactions. Understanding the plasticity of floral traits in crop species will provide key information on the potential to breed highly rewarding cultivars that benefit both yields and pollinators.

F10

Plant-Pollinator Networks Across an Arctic Latitudinal Gradient

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In the rapidly changing Arctic, where the availability of pollen resources is limited and the growing season is variable, the analysis of plant-pollinator networks can reveal important ecosystem properties and vulnerabilities. Our project focusses on DNA metabarcoding the pollen found on Greenlandic pollinators to characterize plant and pollinator diversity and network structures across different Arctic habitats and latitudes. By focusing on the pollen carried by individual pollinators, we examine network properties at both the species and individual levels. We hypothesize that certain generalist pollinators will be common across various habitats and that most networks will show high levels of nestedness due to the variable Arctic environment. With increasing latitude, we predict lower species diversity but increased interaction diversity, along with more specialized interactions among individuals and decreased network modularity. Ultimately, the structure, composition, and degree of species and individual specialization within these Arctic networks will determine their functional capacity to adapt to climate change.

F11

JPE – Steps Ahead

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The Journal of Pollination Ecology (JPE) is a non-profit, open access, peer-reviewed, online journal that aims to promote the exchange of original knowledge and research in any area of pollination and pollinator ecology. In this talk, we would like to share some important news with the SCAPE community.

JPE changes publisher: Our original publisher, Enviroquest Ltd., is run by Emeritus Prof. Peter Kevan and his wife Sherrene. After all these years we believe they should benefit from a well-deserved retirement. We have thus been searching for a new not-for-profit publisher and are happy to announce that the Royal Botanical Society of Belgium, a non-profit organisation dedicated to the understanding and conservation of plant biodiversity, agreed to take over the publishing of JPE. This change will guarantee JPE's sustainability while keeping its ownership and independence. It will also help us overcome some obstacles JPE has encountered with being indexed by Clarivate. The reapplication to Clarivate for adoption in the Web of Science has already been submitted.

JPE pays tribute to late pollination ecologists: Recently, two obituaries have been published by JPE (S Nicolson and D Eisikowitch). If you would like to propose pollination ecologists whose life and work should be remembered, please contact us or one of our Associated Editors.

(re-)New(ed) financial support for JPE The FNRS (Belgian Science Foundation) accepted to support JPE during the next three years further develop the cited-by service.

We will further share the latest statistics regarding article publication, time for decision, downloads, etc.

F12

Joint special issue in Nordic Journal of Botany & Journal of Pollination Ecology

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The Journal of Pollination Ecology (JPE) and the Nordic Journal of Botany (NJB) are joining forces to make a joint special issue on pollination ecology primarily giving the opportunity for participants and presenters at the 38th meeting of the Scandinavian Association for Pollination Ecology (SCAPE 2024) to submit manuscripts. There will be no specific topic, so manuscripts on any topic in pollinator and pollination ecology are within the scope of the joint special issue. We encourage authors of studies with a stronger focus on pollinators to submit to JPE, and those with a stronger focus on plants to submit to NJB, but final editorial decisions will depend on the number of submissions. An invitation to submit manuscripts will also be announced broadly to the community of pollination ecology. Deadlines for submissions will be announced at SCAPE 2024.

F13

Effects of Whole-Genome Duplications on Floral Scent

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Whole-genome duplications (polyploidizations) are an important driver of the evolution and diversification of flowering plants. Species comprising more than one ploidy type are ideal to study how whole-genome duplications affect plant phenotypes, such as floral traits that are involved in the interaction of the plants with pollinators and herbivores. Several studies have shown effects of whole-genome duplications on floral morphological traits. Here, we quantified floral scent, which is key to many interactions of plants with pollinators and herbivores, of established polyploids and diploids grown in a large-scale greenhouse common garden and of neo-polyploids synthetically generated from diploids to assess the direct effects of a whole-genome duplication on floral traits in the plant *Lithophragma bolanderi* (Saxifragaceae). This species exhibits an exceptionally high variation in floral traits and comprises three major ploidy types – diploids, tetraploids, hexaploids. It is pollinated by two highly specialized moth pollinators of the genus *Greya* (Prodoxidae), one of which – *G. politella* – is also a seed parasite, but also by more generalized pollinators in some populations. We present data on how floral scent differs among ploidy types across and within populations and on changes in floral scent in synthetically generated polyploids compared to their diploid progenitors. Together our results provide novel insights into the effects of whole-genome duplications on floral scent and how these could affect the interactions of plants with pollinators and herbivores.

F14

Temporally Differentiated Recovery of Plants, Bees and Their Interaction in Restored Grasslands in Saxony-Anhalt

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Semi-natural grasslands, managed through extensive grazing or mowing, play an important role in biodiversity, carbon sequestration, soil health and water regulation in Europe. However, these grasslands have been degraded by intensive farming and conversion to arable land. The restoration of species-rich grasslands is crucial to ensure future ecosystem services. This is the aim of numerous nature conservation initiatives. However, grassland restoration focuses primarily on the restoration of plant communities. It remains unclear whether plant-centered restoration measures are effective in restoring other parts of the community, such as pollinators. To understand how successfully grassland communities reassemble during restoration, it is important not only to study how plant communities change over time, but also to include pollinator communities and their interactions with plants. Over the course of 15 years several sites near Halle/Magdeburg (Saxony-Anhalt, Germany) where restored from arable fields to extensively mown hay meadows. Based on a space for time approach, this study investigates whether plant and bee communities, as well as their interactions follow the same trajectory of recovery following restoration. The study thereby shows **(1)** how plant and pollinator alpha and beta diversity, as well as community composition develop in relation to the time since restoration began; **(2)** how the reconstruction of interaction networks between plants and pollinators depends on the recovery of plant and pollinator communities. The results highlight the importance of evaluating the success of restoration measures based on more than a single community, but also bring into focus the challenges of evaluating non-standardized restoration efforts.

F15

Basque Bees in a Changing Climate: Preliminary Investigation of the Diversity and Community Structure of a Vulnerable Community

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The native bee diversity in northern Spain, particularly in the Basque Country, remains largely unexplored. Given the potential threats posed by climate change, habitat loss and competition with managed species to plant-pollinator communities globally, it is crucial to understand how wild pollinator communities may respond in order to develop effective conservation strategies. As part of my PhD research, I aim to address these questions by first establishing a comprehensive checklist of the current bee fauna in Gorbeia National Park, the region's largest natural park, as well as documenting their associated floral interactions. Since 2020, 5-16 sites > 800m a.s.l. have been extensively sampled as a preliminary assessment to characterize the pollinator community. Currently, we have documented >100 bee species including three species ranked "near threatened" by the IUCN European Red List of Bees. Understanding the community present is crucial because in the spring of 2025, we will implement a large experimental study introducing an abundance of managed *Apis mellifera* spp. iberiensis at selected sites to create a disturbance in the system. Our goal is to assess the resilience and robustness of the plant-pollinator interaction network within this mountain ecosystem after this perturbation.

Posters

P01

IntraFlor – Effects of Land Use Intensity on Intraspecific Floral Trait Variation and Subsequently on Pollinator Interactions and Pollination Success

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Evolution is driven by the variation of traits within a species. Environmental changes are often a cause of intraspecific trait variation, as seen in *Cucurbita pepo* as increased pollen grain size due to increased soil nitrogen content, pale *Brassica rapa* flowers due to sulphur deficiency, and smaller flowers and decreased nectar content under drought conditions for *Epilobium angustifolium*. These trait changes can affect the attractiveness of a flower towards the pollinator, thereby affecting the cross pollination, and finally the reproductive outcome of a plant individual. Conversely, the resilience of a plant population may be enhanced by local intraspecific variation, as diverse traits can attract a broader range of pollinators, therefore increasing the overall attractiveness of a plant individual.

In this project, we study the changes in the floral traits of two common meadow species – *Ranunculus acris* and *Trifolium pratense* with respect to land use intensity components, namely grazing, mowing, and fertilization. This study is conducted under the framework of Biodiversity Exploratories, hence the samples are taken from three very different habitats in Germany – Schorfheide Chorin, Swabian Alb, and Hainich Dün. We looked at the changes in floral attraction cues such as flower size, colour, and scent as well as floral rewards such as nectar and pollen quantity and quality. Furthermore, we looked at the effects of floral traits on pollinator visitation and pollination outcome by measuring the seed set. Our results suggest that floral traits, especially the attraction traits, show variation along a land use intensity gradient, particularly with fertilization.

P02

Colour and Chemistry: How Flowers Signal Reward-Quality to Pollinators

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The majority of flowering plants depend 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 vertical shift between pollinator systems and how signals provide pollinators with reliable information about the quantity and quality of the reward offered. To answer this question we are going to 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 will analyse the optical properties of floral displays and through different visual models 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 reward, if signals are correlated and if a common pattern of floral trait evolution is shared in unrelated angiosperm lineages. The project is in its early stages so I will present some preliminary data on the optical properties of Solanaceae (*Nicotiana* and *Petunia*), the fragrance profile for some species and the hypotheses framework.

P03

Heat Stressed Pollen – Implications for Plants and Pollinators

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The worldwide pollinator decline creates pollen limitation and thus greater reliance of plants on self-fertilization for plant reproductive success. However, global temperatures rises and heatwaves threaten the possibility of self-fertilization due to heat induced plant sterility. Heat stress can sterilize plants through a reduction in pollen grain production, reduced pollen viability or female sterility. Furthermore, heat stress can also alter pollen grain protein and lipid concentrations, although the results are still scarce, conflicting or case specific. Nevertheless, it is clear that heat stress may reduce the nutritive quality of pollen grains for pollen feeding pollinators. The reduction of pollen grain quality for pollinators may put pollinators health at risk and by such feed into worldwide pollinator decline and thus into the increased dependency of selfing in plants. In our project we plan to address: **a)** the impact of heat stress on wild strawberry reproduction through *plant sterility* (both male and female), and **b)** the impact of heat stressed *pollen grains* on the *nutritional value* for pollinators. We also utilize the inherent underlying genetic diversity of a crop wild relative to test local adaptation and screen for pollen heat tolerant varieties and candidate genes. Come see our poster if you are interested in collaborating.

P04

The Best Trees for Bees

Janine Griffiths-Lee[1], P. C. Stevenson[1]

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Trees are often overlooked in habitat management strategies for pollinators. However, with a small landscape footprint, they can provide vast sources of pollen and nectar for pollinators. In our urban landscapes, there is an urgent need to inform landscape development about the trees that can be most beneficial to pollinators, with diversity that cover multiple seasons, while selecting trees that are most resilient to a changing climate. The 'Best Trees for Bees' project is being conducted at RBG Kew, Wakehurst. Wakehurst is a large, wild botanical garden with over 1,500 species of native and exotic tree and woody plant species. The site covers 217 hectares of diverse landscapes including wet woodland, SSSI sites, ancient woodland, plantations, and formal gardens. Therefore, bees have an extensive choice of diverse tree pollen.

The first part of the project focuses on pollen collection from bumblebees, honeybees, cavity nesting solitary bees, and ground nesting solitary bees. Rather than collecting insects ad-hoc, the non-destructive collection methods are targeted toward the bees returning to their nests. The second part of the project involves citizen science: recruiting Wakehurst visitors to aid in recording pollinator visits to trees of interest in the landscape. With this data, we hope will be able to inform urban planners and landscape architects on which trees to plant in urban landscapes to best support pollinators.

P05

Are Impacts of Commercial Insecticides on Bumblebees Accurately Captured by Experiments that Use Active Ingredients? A Case Study Using Sulfoxaflor

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Agrochemical insecticides are a compelling candidate driver of bee declines worldwide, threatening ecosystem stability and food security. Insecticides undergo regulatory testing prior to licensing to assess for environmental damage, however the effects of co-formulants (which are added to insecticides to increase the efficacy of the active ingredient) have been historically neglected. Sulfoxaflor is an insecticide active ingredient which has been shown to reduce the growth rate and reproductive output of bumblebee colonies in the field, but it is not clear whether commercial formulations will produce effects of a similar scale.

In this experiment, bumblebee (*Bombus terrestris* audax) colonies were exposed to field-realistic doses of sulfoxaflor, the commercial sulfoxaflor-based formulation GF-2626, or a negative control. We then examined colony-level traits, including foraging activity and the number of emergent new worker bees, to compare impacts of exposure between the active ingredient and the formulation. We found that colonies exposed to either sulfoxaflor or the formulation (GF-2626) experienced a reduction in pupae and worker production, and also a reduction in foraging activity, in comparison to the control colonies. These effects are likely due to a reduction in the consumption of treated feed. No differences reaching statistical significance were found between colonies exposed to sulfoxaflor and formulation treatments. Taken together, these results reiterate that sulfoxaflor, and its commercially-available formulation GF-2626, pose a substantial risk to bees in the absence of appropriate mitigation measures, but provide no evidence that the commercial formulation will have different impacts to those already documented for the active ingredient alone.

P06

Biases in Pollen Limitation Estimates due to Resource Reallocation Crossmodular Levels in an Alpine Herb, *Veratrum Grandiflorum*

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Pollen limitation has been regarded as a key factor influencing plant breeding system evolution. It is prone to be overestimated due to potential resource reallocation among flowers. Pollen supplementation experiments at the whole-plant level can reduce the biases by treating the plant as a single resource pool. However, little empirical research has tested resource reallocation across different modular levels using alternative response variables, especially in alpine environments with limited pollinators. To evaluate the impact of resource reallocation and components of reproductive success, we sought evidence for pollen limitation in the perennial alpine herb *Veratrum grandiflorum* in the East Himalaya-Hengduan Mountains. The experiment was carried out at the flower, inflorescence, and whole-plant levels. We specifically asked whether resource reallocation biases occur at different scales. Our results showed that *V. grandiflorum* was limited by pollen availability, with hand-outcrossing manipulation significantly increasing seed production across all hierarchical levels. The finding of highest pollen limitation at the flower level and lowest at the whole-plant level points to an important role of resource reallocation among flowers, as previously thought. However, different levels of reallocation had no strong effect on fruit set. These results highlight the importance of multiscale and multi-metric approaches for accurately assessing pollen limitation and suggest that it may be overestimated in alpine species using current methods.

P07

Biodiversity Impacts of Carbon Farming Practices

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The two global challenges; climate change and biodiversity loss are interlinked. To enhance carbon sequestration to soil, carbon farming practices have been developed and implemented globally as well as in Nordic countries. At the same time, knowledge on realized biodiversity impacts of different agricultural practices is needed. We addressed this knowledge gap by collecting data from 20 farms practicing different carbon farming methods: adaptive grazing, 8 species ley mixture, under sown cover crops and 'all-in' treatment. In our experiment, farmers applied carbon farming vs. control practices on a three-hectare field plot divided in to two for five consecutive years. After five years of carbon farming experiment, we performed detailed biodiversity surveys in the farms to investigate how carbon farming practices impact biodiversity in different species groups. We collected data on multiple above ground species groups: plants, foliar microbes, birds, arthropods, as well as on topsoil nematodes. In our analyses, we compared different biodiversity indices using our data to understand which index best describes change in different species groups. Our results suggest that different carbon farming practices may have an impact on species diversity and abundance in local scales and that best biodiversity index to be used depend on species group in question.

P08

Scale Dependence is Specific to Species-Landcover Associations in Bees

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The threat to biodiversity from human land use and climate change has spurred the growth of ecological subfields centered on conservation. Conserving biodiversity requires the ability to accurately link biodiversity patterns to ecological processes and generalize across systems and species. However, biodiversity patterns are known to be scale-dependent, and the issue of spatial scale is commonly left unaddressed in commonly used statistical models. This is especially true for community ecology, where multiple species distributions are modelled simultaneously. Biodiversity patterns are ubiquitous in ecological systems and can be found across a wide range of spatial scales, and the choice of spatial scale in a study affects the ability to accurately detect and link pattern to process and affects the level of autocorrelation in the data. In this study we use a previously published dataset of species occurrence and abundance to investigate and model the scale-dependency of species-landcover relationships in a heterogeneous landscape. We find that scale-dependency in bee species-landcover associations is more pervasive and complex than previously assumed. Also scale-dependency of species-landcover associations is not a species-specific trait but depends on the combination of species and landcover, so that the scale of effect cannot be predicted by body size (ITD) or inferred from closely related species. Overall, we conclude that we cannot reliably assess patterns in biodiversity unless we address the complexity of scale-dependence. It is paramount that scale-dependence be addressed in species and multi-species models to avoid erroneous inference about biodiversity processes.

P09

New Pollinators for Seed Production in Horticulture: Pollination of Lettuce by Sweat Bees

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The production of fruit and seeds of more than three-quarters of our crops requires pollination by insects or other animals. This also applies to the seed production of most horticultural crops such as lettuce, onions and leeks, leafy vegetables and kitchen herbs. The economic value of insect pollination and food production increases, so does the importance of good pollination and suitable pollinators. The aim of this research is to find suitable pollinators for lettuce and related crops for which available managed pollinators such as honeybees, bumblebees and mason bees are unsuitable. After observing flower visitation and pollination in the field, flower strips were sown to test if they can attract *Lasioglossum* spp. Pollen analyses will be carried out to determine the diet of *Lasioglossum* spp., and pollination experiments will be carried out with candidate species. Pollination experiments will be carried out in the field and in greenhouses. Candidate pollinators will then be tested to see if and how they are suitable for large-scale pollination. This could be in the field near larger natural populations or by breeding the species. The roadmap for alternative pollinators can be used for commercial purposes after this project. This research will focus on three areas where lettuce seed production is an important activity for Dutch seed producers, namely the Netherlands, Spain and Australia.

P10

Does Bee Size Give a Hint on the Status of Agroecosystems?

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The Apoidea include species of various size ranges, from very small to very large. The difference in size influences foraging ranges, brood production costs, bee-mediated pollination services, etc. Various species inhabit the agricultural environment. Does it emerge any bias in size? Is that linked with the type of agroecosystem? Out of the monitoring project BeeNet, we analysed data from 12 sites located in 6 regions spanning from northern to southern Italy. Bees (n=4572) were collected along fixed transects by hand net in intensive and seminatural agroecosystems, and identified at species level (n=289). Monitoring occurred (March-October) during 3 years. According to effective size ranges defined for each species, we redistributed our data in three classes: small (2-8 mm) medium (8.5-12.5 mm) and large bees (>13 mm).

We recorded roughly the same number of species in small and medium classes, while the large one contained only 10.7%. This trend is respected notwithstanding the farming practice. Numbers of individuals follow a descending path inversely to size: the small class had the largest number of individuals. However, more individuals belonging to the large class are recorded in seminatural agroecosystems, compared to intensive ones. Size is a main topic in biological investigations, due to the multifaceted links with various ecological variables. The public attention towards bee decline and the numerous projects dealing with dissemination and citizen science often refer to bee size to facilitate grouping of field records. Size may be a trait sufficiently easy to detect and able to give advice on the status of the environment.

P11

Influence of the Latitudinal Gradient on the Flowering Time and Establishment of Flower Strips

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Flower strips have been proposed as an agri-environmental scheme (AES) to support declining pollinator communities due to agricultural intensification. Most of the seeds used to make flower strips are produced in Southern Europe and Australia, which may result in an evolutionary mismatch between flowering time and pollinator activity in cold, northern climates. Regional seed mixtures derived from locally adapted seeds may improve the efficacy of flower strips and better support pollinator communities in agricultural landscapes.

We established flower strips in three regions in Norway (Viken, Trøndelag and Nordland) to investigate the influence of latitudinal gradient on the flowering times of flower strip seed mixtures. Site specific perennial plant mixtures were developed by the Norwegian Institute of Bioeconomy Research (NIBIO) for each site. Flower availability (number of flowers) and pollinator visitation rates within NIBIO mixtures were compared to the annual plant commercial mixture STRAND70 and the perennial plant commercial mixture SPIRE Insektvenn (Trøndelag and Nordland only). Preliminary results indicate that the beginning of flowering in the annual seed mixture is delayed at high latitudes. We also observed that the commercial mixtures in Nordland attracted more bumblebees than hoverflies. This trend was opposite in Trøndelag where more hoverflies were observed. This points to the importance of regional mixtures.

P12

Movement Patterns of Bees in The City Centre of Oslo

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The goal of this master's degree project is to study the connectivity of wild bees in an urban landscape. It is also part of the BEE-DIVERSE project, collaborating with Norwegian Institute of National Research (NIN), and the municipality of Oslo. Oslo is a 'hotspot' for wild bees, and to mitigate further biodiversity loss, the Oslo municipality recently implemented flower-rich meadows around the city. However, it is uncertain if these areas serve as green corridors for insects, enabling bees to disperse and gather resources. Using the capture-mark-recapture method, I aim to investigate bee foraging patterns, hoping to get insight into the effect of established green areas on the connectivity of wild bees in the city.

P13

Impact of an invasive generalist pollinator on the ecology and evolution of the plant *Lithophragma bolanderi*

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Invasive species can directly alter local ecological interactions with rippling effects on the ecosystem. In addition, invasive species may affect evolutionary trajectories of native species and coevolving interactions. One invasive species of global interest is the honeybee (*Apis mellifera*) that not only outcompetes native pollinators, but also may reduce progeny performance and increase selfing in the local flora. To fully appreciate the impact of honeybees on native ecosystems, it is important to understand their evolutionary effects on the native flora.

Here, I present the first tentative results of my master's thesis work on the putative evolutionary impact of honeybee introductions on the coevolving interaction between woodland star plants (*Lithophragma*) and their major *Greya* moth pollinators. Recent studies have shown that invasive honeybees are very common floral visitors in some populations of the Californian species *Lithophragma bolanderi*. In my thesis, I evaluate potential evolutionary effects of this novel introduction of a supergeneralist on floral traits of documented importance for the *Lithophragma-Greya* interaction.

Using a common garden and commercial honeybee hives, we performed a series of experiments to identify the efficacy of honeybee pollination across multiple *Lithophragma* populations of varying floral morphology, pollen and nectar production. Our aim is to first identify the *L. bolanderi* traits that are under phenotypic selection from honeybees and thereafter evaluate if populations currently interacting with honeybees also conform to the predicted "honeybee phenotype". Collectively, this work strives to disentangle the impact of an invasive generalist pollinator on the ecology and evolution of a specialized plant-pollinator interaction.

P14

Register of Melliferous Plants in Bulgaria Based on Literature Review

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Melliferous vegetation in Bulgaria plays a key role in maintaining biodiversity and providing ecosystem service pollination. The diversity of melliferous vegetation is essential for the sustainable development of honeybee (*Apis mellifera* L.) colonies. The aim of this study is to provide an overview and analysis of research on melliferous vegetation in Bulgaria and to summarize the available scientific information on melliferous species prevalent in its geographical conditions. A database structure has been developed including information on 63 indicators characterizing melliferous plants, including distribution, flowering period, abiotic environment, landscape structure, and others.

During the study, 153 scientific literature sources (monographs, encyclopedias, and articles) published in the period 1896 – 2023, were reviewed, of which 50 were identified as the main informative sources. The review covers native, cultivated, and introduced species. Melliferous plants were found to be represented by 996 species of 88 families. A total of 89 melliferous species are protected by the Biodiversity Act. As a result, a register of melliferous plants in Bulgaria was created, which will be expanded and enriched with new data. 258 of these species have been verified in field studies in Vratsa Region, Northwest Bulgaria (312 km²) from 2019-2023. A comprehensive compilation of this information is crucial for the development of targeted conservation efforts and sustainable beekeeping and ecological practices. By synthesizing existing data, this review aims to provide a basis for future research and to encourage the development of sustainable melliferous management strategies.

P15

Variation in Pollen Limitation and Self-Pollination Across a Latitudinal Gradient an Alpine Plant Communities

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Cold ecosystems at high latitudes experience an impoverished diversity of pollinators, often with entire taxonomic groups absent. This reduced diversity could shape both plant community composition and have a strong impact on mating. Accumulating evidence reveals that plants in these ecosystems have longer flowering times and produce more pollen than those in other regions. However, broad evidence of the effects on mating strategies is largely missing.

In this poster, we will present preliminary data from pollination experiments conducted on approximately 80 different species (120 populations) from three distinct alpine plant communities. We will focus on how these plant communities differ in terms of self-pollination rates and pollen limitation. We will demonstrate that both self-pollination strategies and pollen limitation are widespread in the northern sites across various plant species. Furthermore, by comparing species that are disappearing across the latitudinal gradient to those that are persisting or are found exclusively in the northern communities, we will infer whether changes in pollination strategies have biogeographical consequences on plant community composition.

P16

Flowering Timing and Synchronization With Pollinators - Central for Arctic Plant Reproduction

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The Arctic's rapid warming alters vegetation patterns and flowering times, potentially disrupting the alignment between flowering and the activity of pollinators. To explore this, we studied *Silene acaulis*, a species that blooms shortly after snowmelt and thus exhibits varied flowering times across a landscape with heterogeneous snowmelt. We tracked the flowering of 300 plants of *S. acaulis* and assessed their reproductive success. Additionally, we monitored insect activity throughout the season using pan traps and compared it with *S. acaulis* flowering dynamics.

Our results revealed a unimodal relationship between flowering time and seed set per flower, peaking on July 8th. Flowering time and insect activity together explained 9.8% of the variation in seed set per flower, with flowering time alone accounting for 3.6%. Interestingly, early-flowering individuals produced more flowers, leading to a higher total seed set as compared with late bloomers. These early bloomers likely benefit from longer snow-free periods, allowing them to accumulate more energy for reproduction. While mid-season flowering favors pollination success, early-season flowering may enhance total reproductive output due to increased resource availability. Our study highlights that changes in the pollination conditions and in the growing season length will influence future reproduction of Arctic plants.

P17

The Paramount Contribution of Pollen Analyses in Plant-Pollinator Networks

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Andrena and *Lasioglossum* are recorded in agricultural landscapes along field edges, relatively rich of floral resources. When using hand netting along transects as a monitoring method, data disentangle the relationship between plants and pollinators. However, the record refers to a single specimen and the single visited plant. More catches of conspecifics enlarge the dataset and pollen analyses provide additional information on visited plants. Out of the Italian monitoring project BeeNet, at one site in Emilia-Romagna (2021-2022) we monitored bee individuals on flowers and carried out palynological analyses of the pollen loads. We collected 55 *Andrena* and 165 *Lasioglossum* individuals. Along the transect we identified 66 plant species. All specimens were identified at species level, plants as far as possible.

Andrena and *Lasioglossum* species showed different phenological patterns. The 18 *Andrena* species were generally concentrated in spring, with a clear succession among species. Most of the 18 *Lasioglossum* species were collected during summer months, frequently overlapping. Data from the field observations revealed that *Crepis* species were the most frequently visited plants, with over half of both, *Andrena* (52.7%) and *Lasioglossum* (58.2%) individuals collected on them. Another species (*Cichorium intybus*) was frequently visited by *Lasioglossum* (17.6%). The palynological analyses recorded 63 pollen taxa, only 40% overlapping with those of the transect. A conspicuous increase of visited plant species. Palynological analyses are mandatory to understand Apoidea feeding preferences. They even underline a special role played by trees. It would be advisable to integrate the transect-monitoring with planned pollen analyses, at least for the less-known Apoidea species.

P18

Bumblebee Monitoring in Agricultural Landscapes in Germany: The Informative Value of Structured and Unstructured Data

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Bumblebees are important pollinators of wild plants and crops, yet their populations are declining worldwide. Among the main pressures are the intensification of agricultural land use and climate change. To better understand bumblebee population trends and the role of impact factors such as land use, large scale acquisition of bumblebee population data is needed. To obtain such large biodiversity data sets, citizen science (CS) approaches have become increasingly popular. Their ability to provide robust data on species distributions and population trends have, however, yet to be evaluated. We compare data on bumblebee populations in Germany sourced from two different CS programs: first a standardized transect-based monitoring scheme in agricultural landscapes and second unstructured data from app-mediated occasional observations. In both cases, observations were validated by experts solely on the basis of voucher photos. As could be expected, we found differences in terms of spatial and temporal coverage between the two CS programs. The unstructured scheme delivered far more observations in total, but a representative coverage of agricultural areas could be better achieved by a structured scheme.

We also compared the number and share of species, as well as the proportion of observed individuals that cannot be determined to species level with certainty. We found that both CS-schemes can deliver data for different purposes such as distribution maps, bumblebee phenology and resource utilization. For a comprehensive understanding of large-scale bumblebee population trends, we suggest an integrated analysis of both structured and unstructured data in the future.

P19

Gap-Cutting Cannot Replace Restoration Burning to Promote Forest Insect Pollinators

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Intensive silviculture in boreal forests has led to reduced structure and composition, with negative effects on forest biodiversity. Active forest restoration measures are increasingly used to halt declining trends in biodiversity, and promote important functional groups such as pollinators. In the present study, the abundance and species richness of forest and non-forest associated insect pollinators collected using pan-traps in stands treated using restoration methods (gap-cutting and restoration burning) are compared to control forest stands. In total, 10,257 pollinators, comprised of 3,375 Coleoptera (beetles, 33%), 6,246 Diptera (true flies, 61%) and 636 Hymenoptera (bees and wasps, 6%) were collected. The abundance and species richness of Coleoptera and Hymenoptera were consistently higher in burns compared to gap-cut treated and control stands. The abundance of forest associated Diptera pollinators was significantly higher on gap-cuts compared to controls, and burns compared to gap-cuts. Species composition differed most strongly between burns and the other two treatments, driven by higher Coleoptera and Hymenoptera abundances. Species composition was more heterogenous in stands treated with restoration burning, comprised of more non-forest associated species than gap-cut treated and control stands. Indicator analyses revealed the taxa driving these trends are not only forest associated species, and that restoration measures may be beneficial to non-forest taxa as well. In addition, the lack of information for some species, particularly within the Diptera, may lead to undervaluing their importance as pollinators in boreal forests.

P20

Connecting Urban and Peri-Urban Ecosystems: Network Models of Plant-Pollinator Interactions (a Case Study of Sofia City, Bulgaria)

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This research is a part of the development of a PhD thesis that is investigating how peri-urban areas can benefit from pollinators that find refuge in urban environments. To analyze these benefits, the study develops a methodology to track plant-pollinator interactions in urban and peri-urban settings and uncover available network structures. The results presented are based on pilot studies from May 2024 for Sofia City, the Capital of Bulgaria. Using the AppSheet platform, a mobile application was developed to collect data in three structural-functional elements: a central urban area with inherited natural vegetation, a residential neighborhood with organized green areas, and a suburban agricultural area. The observations were conducted at 11 sites, each 64 sq.m, with a predefined location relative to the urban green infrastructure composition, with a duration of 30 minutes for each site. Species identification was initially performed via the iNaturalist platform and subsequent verification via the Atlas of European bees.

The results were processed with the software's Cytoscape & RStudio. Initial network models indicate that on average there are 15 nodes in the peri-urban, 13 in residential, and 7 in central urban areas. Internally connected interactions include a total of 125 nodes (71) unique. Based on metrics like number of nodes,

network density, and centralization, the results are encouraging for connecting urban and peri-urban areas in Sofia City for pollination and supporting biodiversity and ecosystem resilience. We accept the developed mobile application as effective for research, biodiversity monitoring, and citizen science purposes.

P21

Fluctuating Temporal Phenotypic Selection on Pollination Traits in *Viscaria vulgaris*

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Phenotypic selection on floral traits can vary due to spatial and temporal differences in the ecological context experienced by specific plant populations. However, there are few long-term empirical studies that assess the role of spatial and temporal variation as a factor that can lead to divergent outcomes in the patterns of phenotypic selection on floral traits in generalized plant-pollinator interactions. In this study, we examined temporal variation in the strength and direction of phenotypic selection on floral traits in *Viscaria vulgaris*, a perennial herb that interacts with a wide diversity of pollinator taxa. We conducted phenotypic-selection studies over a period of four years (2021-2024) in a single *Viscaria vulgaris* population located in southern Sweden. For each year, we estimated and compared mean-standardized selection gradients for a suite of floral traits functionally involved in the pollination process.

We found that the strength and direction of phenotypic selection on some floral traits remained constant during the four-year study period. However, other floral traits, in particular those involved in flower-pollinator fit, experienced detectable variation in the strength and direction of phenotypic selection. Such variation may follow temporal changes in the composition of the pollinator community. We underscore that *Viscaria vulgaris* is subject to temporal variation in phenotypic selection on floral traits and that the scope for such variation is contingent on the function of each floral trait.

P22

Do Flower Size and Nectar Rewards affect Pollinator Behaviour in Blueberry Cultivars?

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Highbush blueberry depends on insect pollinators to produce market quality fruits. However, pollination is far from being a simple process and is affected by several interacting factors. Among these factors, flower morphology and nectar rewards play a key role in determining visitation rates and flower visitors' behaviour. In this study, we seek to identify the main pollinators for several blueberry cultivars and relate pollinator visitation rates to flower morphology and nectar rewards. The study was conducted in the spring of 2024 at an experimental field in Centro region, Portugal, and thus all cultivars were under the same growing conditions. Six individuals per cultivar were used to monitor plant-pollinator interactions, as well as for evaluation of nectar rewards and flower morphological traits. Plant-pollinator interactions were obtained by direct observations, and visitor identity, as well as the number of flowers visited, were recorded in 5 minutes periods distributed throughout the day. Flower morphological traits related to pollination such as corolla length and corolla opening were measured in 6 flowers per individual. Nectar volume and sugar content were measured in 3 to 5 flowers per individual. A total of 23 insect species were observed interacting with blueberry flowers, as pollinators, robbers or both. Preliminary analyses indicate variation in flower morphology and nectar rewards among cultivars, as well as variation in visitation rates.

P23

Impact of Impatiens glandulifera on the pollination of native Stachys sylvatica in the South Downs National Park

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Biological invasions pose a significant threat to the biodiversity of British wildlife, with over 900 'alien' plant taxa recorded in the UK since 2000. Managing these invasive species can be costly and challenging. A deeper understanding of how these invaders disrupt native ecological processes is crucial for developing effective control strategies. This study focuses on *Impatiens glandulifera* (Himalayan Balsam), an invasive species introduced to Britain in 1839, which has since become well-established, often outcompeting native flora and dominating the ecosystems it invades. The species attracts bumblebees by offering abundant pollen and nectar, potentially altering native pollination dynamics. Our research, conducted across six sites within the South Downs National Park, examines the impact of *I. glandulifera* on the reproductive success of the native species *Stachys sylvatica*, as well as its influence on bumblebee visitation rates, frequencies, and the levels of pollen carried by pollinators. We measured native plant fitness by counting conspecific pollen transfer on *S. sylvatica* stigmas. The results revealed that native plants in invaded sites received significantly fewer pollen grains compared to those in pristine sites. Interestingly, while *I. glandulifera* did not directly compete with native species for bumblebee visitation, it did reduce the native pollen loads carried by bumblebees. The likelihood of invasive pollen being found on pollinators varied according to pollen placement on the body, and the degree of specialization in the bumblebee-flower interaction. Moreover, introducing *I. glandulifera* to a pristine site resulted in an 80% decrease in pollen load on native flowers over four days. The comparative analysis of heterospecific versus conspecific pollen transfer showed a decline in conspecific transfer, accompanied by only a slight increase in heterospecific transfer. This reduction in pollen transfer to *S. sylvatica* stigmas led to decreased female fitness in the native species. This study contributes to our understanding of how *I. glandulifera* impacts ecosystem functions, pollination processes, and insect diversity. It highlights the invader's potential to reduce the reproductive success of native flowering species, even those with diverse floral morphologies.

P24

Coevolutionary Response to Defaunation in Pollinator Networks

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Pollination is an essential ecosystem service, facilitating the ecology (e.g. reproduction and survival) of both plant and pollinator species, representing a cornerstone of ecosystem functioning and biodiversity maintenance. Pollination also has economic value, as many crops are pollinator-dependant. However, anthropogenic changes over recent decades have impacted pollinator species, generating declines in native populations. The evolutionary consequences of the pollinator loss, i.e. defaunation, are hard to predict. Plants and pollinators form complex and interconnected eco-evolutionary networks, wherein species affect each other both directly and indirectly. As evolutionary effects cascade through the network of interacting species, changes in a single species may be felt throughout the entire network, affecting the phenotypic patterns and interaction structure at the community level. Given this interdependence, to explore the consequences of pollinator loss to ecosystems it is necessary to combine different approaches. Here, we combined mathematical modelling, network theory, and empirical data to explore the potential effects of defaunation in pollinator networks. We simulated the loss of vulnerable pollinators (according to the IUCN characterization) on empirical network and explored: **i)** how fitness of directly and indirectly linked species was affected; **ii)** how the network structure was affected, and; **iii)** how defaunation changes the morphospace occupied by the community.

Our preliminary results indicate that defaunation may further stress metacommunities through larger-scale cascading effects, affecting the overall community fitness and the distribution of the traits mediating the interaction.

P25

Nocturnal Pollination Services in Agroecosystems: A Case Study Examining Apple Horticulture in Norway

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Apples (*Malus domestica*), the most grown fruit crop in Norway, depend on insect pollination to achieve high yields of profitable fruit. To date, there are limited research on the contribution of nocturnal pollinators to apple production. To address this, I explored the contribution of night-active insects on two commercial apple farms in eastern Norway during the flowering season of 2023. Light traps and field-cameras were used to assess the diversity and activity of the nocturnal pollinator community, and a pollinator exclusion experiment was implemented to assess the contributions of nocturnal pollinators to apple quantity (fruit set) and quality (seed set). I found that the nocturnal pollinator community within my sites was limited both in terms of species richness and abundance. Only sixteen moths were captured in the light traps and their absence in the camera images suggests they do not visit apple flowers. Lacewings (Neuroptera) were frequently observed visiting apple flowers during the night and may be contributing to nocturnal pollination services. However, little is known about the role of lacewings in apple pollination and future studies should aim to test this insect group as potential providers of pollination services at night.

Overall, nocturnal pollinators do not appear to play a substantial role in apple pollination in Eastern Norway. However, exclusion of night active insects did result in pollination deficits (lower seed set), which suggests that they may have positive effects on apple production. Further research is needed to increase our understanding of the contribution of nocturnal pollinators in agroecosystems.

P26

Bilberry Pollinators in the Subalpine-Alpine Zone of Armenia

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Bilberry (*Vaccinium myrtillus*) grows in Armenia above the tree line at the altitudes of 2300-2900 m, which represent the southern edge of its global distribution. Compared to more central parts of bilberry distribution area, the data on bilberry distribution and associated pollinator communities in Armenia is extremely limited. As a mountainous country with dry continental climate Armenia is highly vulnerable to climate change. The increase in annual temperature and decrease in precipitation is likely to affect indirectly biotic interactions, including the ones between the bilberry and its pollinators. The aim of this pilot study is to understand the role of insect pollination on bilberry reproduction in the alpine areas of Armenia. This will be done by investigating the bilberry phenology and insect pollinator communities along the elevation gradients in Kotayk province. The collection of the pollinators was done directly from the bilberry flowers. The bilberry pollinator community was comprised of several bee, bumblebee and hoverfly taxa. The detailed identification of the pollinators is in progress.

P27

Trait-Based Connectivity Modelling of Wild Bee Populations

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Connectivity allows species to move and access resources, also maintaining genetic flow between populations. The success of established flower-rich habitats for wild bees depends on the bees ability to disperse and reach new areas. As wild bees vary in their ability to disperse, ecological determinants (i.e., species functional traits) can improve predictions of dispersal ability and thereby the connectivity of wild bee populations in the landscape.

Here, we will combine data of ~2000 occurrences of flower-visiting wild bees from structured transect walks in Norway to model the connectivity of bee populations. We will investigate what traits are important predictors of dispersal ability and what habitat types are important locations for dispersal. Using species-specific estimates of suitable habitats, we will model landscape resistance by using functional similarity composition between site pairs. The resistance matrix will be used to model least cost paths (i.e., likely dispersal route) for specific functional groups of bees. By locating areas with high functional diversity ('hot spots') and barriers or corridors to dispersal, we will identify target areas of priority for conservation management.

P28

Quantifying the Impact of Increasing Honeybee Density on Wild Plant and Pollinator Populations: A Meta-Analysis

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In recent years, much of the research on honeybees has concentrated on their presence or absence within ecosystems and its implications for ecosystem functioning. However, land managers often require quantitative insights to make informed decisions about honeybee hive placement. This study addresses this gap by providing a comprehensive meta-analysis of the effects of varying honeybee densities on wild plant and pollinator populations. We aggregated data from multiple studies to evaluate how increasing honeybee densities influence wild plant reproductive success and the abundance and diversity of native pollinators. Our analysis reveals nuanced interactions between honeybee density and ecosystem dynamics, shedding light on both positive and negative outcomes. We discuss the implications of these findings for land management practices and ecosystem conservation, highlighting the need for a balanced approach that considers the benefits and potential drawbacks of honeybee introduction. Our results offer valuable, quantitative information that can guide land managers in making evidence-based decisions regarding honeybee hive management, ultimately supporting more sustainable and effective pollinator and habitat management strategies.

P29

Evolution of Flower Shape in a Coevolved System

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Pollination interactions typically provide mutual fitness benefits to individuals of species interacting. Variation in the fitness benefits creates opportunities for natural selection to shape the traits mediating the interaction. Often, plant-pollinator interactions are mediated by multiple traits, and their combination ultimately determines the final interaction outcome. Furthermore, genetic correlations underlie phenotypic variation, constraining each species' potential to adapt. Plant-pollinator interactions face additional complexity, as change in one species may drive evolutionary change also in the interacting species, i.e. coevolution. *Lithophragma bolanderi* and *Greya politella* represents a coevolved system, in which the moths pollinate *L. bolanderi* passively when ovipositing into the floral ovaries. *Lithophragma bolanderi* is also visited by more generalized pollinators, including e.g. invasive honeybees as well as native solitary bees, lepidopterans and bombyliid flies. The dynamic nature of coadaptation imposes a challenge for understanding how complex traits evolve in both species, and the reciprocity of evolution will depend also on the importance of the surrounding pollinator community. Here, we begin to address this topic from the plant perspective by investigating trait modularity and integration of *L. bolanderi* flowers, as flower modular organization is a key aspect to ensure evolvability. We sampled over 300 individuals of *L. bolanderi* along two trails, while performing pollinator observations. For each individual, we measured 15 different floral traits and investigated their covariation. Additionally, we used landmark-based geometric morphometrics to quantify petal and calyx shape variation. In this talk, I will discuss how floral modularity and integration may play a role in coevolutionary dynamics.

P30

Optimising the Pollination of *Vicia faba*

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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.

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 study 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, the study examines 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. This research aims to identify *V. faba* floral traits that optimise pollinator visitation and improve yield while contributing to broader efforts to support declining pollinator populations.

P31

A New Tool to Improve the Estimates of Interaction Rewiring Considering the Whole Community Composition

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Understanding temporal dynamics in ecological networks is crucial to predict their capability to cope with global changes. Despite this, proper quantification of network dynamics still remains a challenge. Temporal dynamics are typically studied using data of interaction networks over time, through the evaluation of interaction turnover and its two components: changes related to species turnover (species gains and losses) or rewiring (switching partners among the set of species shared over time). However, with this approach based exclusively on network data, dynamics are computed similarly for species that are truly missing from the community at a given temporal period, and for species occurring in the community but that do not interact with any other. This might lead to an underestimation of the real extent of rewiring, while overestimating the species turnover component of interaction turnover. Here, we developed a method to calculate turnover components accounting also for the species that occurred in the communities at different times but did not appear in some of the temporal networks (non-interacting species), and tested its efficiency using empirical data and simulations. As expected, disregarding the non-interacting species led to the underestimation of rewiring and the overestimation of species turnover as components of interaction turnover. Effect size was moderate when independent pollinator data were included, and large when including plants or both trophic levels. Considering the non-interacting species reduced biases at the time of identifying changes due to the different interaction turnover components, particularly when sampling effort was low and when dynamics were calculated seasonally.

P32

Farmers Monitoring Moths

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Longitudinal data on insect populations are scarce globally. The Farmer led Moth Monitoring EIP allowed farmers to monitor and record moths on their farms. Farmers in Ireland recognise the importance of pollinators, but farmland has experienced wide-scale loss of wild pollinators over the last fifty years. Pollinators benefit nearly 80% of wild plants in Europe. The farmed landscape has a large role to play in conserving and restoring pollinators across Europe and farmers are uniquely positioned to be part of the solution to halt and reverse pollinator decline. A pilot group of 20 farmers independently operated moth traps and successfully monitored moths on their farms. Collectively, the moth traps were operated on 180 occasions by the farmers between. the end of June and mid-October 2022. A total of 112 moth species were recorded across the 20 farms. The project has provided information on whether the number of moth species vary according to farm type (beef, dairy, mixed and tillage) and land use within the farm.

The Biodiversity Strategy, and the Nature Restoration Law, have created a policy window for increased pollinator monitoring activities. This project enabled farmers to engage with citizen science and monitor moths on their farms. It has helped farmers to better understand and engage with nature on their land and has created a monitoring protocol that is accessible to all. This project has led to a longer-term monitoring scheme whereby the distributions and population trends of moths on Irish farmland will be accurately monitored.

P33

Testing Whether New Camera Methods could Detect Change in Pollinator and Pollination Biodiversity Across Different Ecological Context

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The reproduction of most crops and wild plant species depends on interactions with animal pollinators, which are declining globally due to climate change and human activities. Understanding changes in pollinator populations and plant-pollinator interactions is crucial for predicting and mitigating biodiversity loss. Traditional methods for collecting these data are time-consuming, costly, and require specialized expertise, posing integration challenges due to varying methodologies and scales. Camera vision methods, utilizing machine learning and computer vision, offer a promising alternative for capturing, counting, and identifying pollinators. This study aims to train and test these methods to capture pollinator and plant-pollinator interaction diversity across different biogeographic contexts. The initial focus is on prioritizing plant species for monitoring with limited camera resources, using data from the EU project SafeNet. Results indicate that monitoring the most common plant species captures the highest pollinator diversity. The second focus addresses whether automated pollinator monitoring can detect changes in pollinator diversity and interaction network structures as effectively as traditional methods across different environmental gradients. This is being tested in the EU project SEPPI with the hypothesis: **H0**, that network metrics are consistent across methods and taxonomic grains once rarefied for interactions, or **H1**, that metrics differ if taxonomic identification influences the detection of rare species and biodiversity changes. The final focus is on developing a model to identify hoverflies, crucial pollinators with diverse morphologies and color patterns due to Hymenopteran mimicry. Currently, no AI efforts target Dipteran pollinators. We aim to train and test a model for Syrphid species identification in Germany.

P34

Small-Scale, Mixed Food Production Systems and Semi-Natural Grasslands Support Complementary Pollinator Populations

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Habitat loss and agricultural intensification are among the main drivers of pollinator decline. Despite efforts, uptake of measures to halt these declines at both landscape-level (e.g., habitat restoration) and farm-level (e.g., flower strip) is low. Implementation of a new crop production paradigm is therefore a suggested solution to provide food security while at the same time minimizing environmental degradation and associated biodiversity loss. Indeed, various agricultural diversification strategies (e.g., crop diversification, organic farming) are known to promote multiple ecosystem services and even crop yield. Yet, the effect of agricultural diversification on pollinator populations in farm-scale, observational studies remains understudied. Here, we examine the importance of mixed, high-diverse food production systems in their capacity to support wild pollinator communities. Floral resources and wild pollinators (bees, hoverflies, wasps and butterflies) were sampled in both mixed food systems and semi-natural grasslands in 16 landscapes in Belgium. During summer, the time when fieldwork was done, these grasslands provide an important source of floral resources whereby they serve as a benchmark habitat in this study, to which the mixed food systems are compared.

Our study highlights the value of mixed food production systems as they provide diverse and abundant floral resources compared to semi-natural grasslands. In addition, floral resource composition was found

to be complementary between both habitats. Pollinator diversity and abundance between both habitats was found to be equal, while pollinator community composition was different. The latter indicates that different pollinator communities used the complementary resources provided by both habitat types.

P35

Planting Herbaceous Perennials as an Enhancement Measure for Oligolectic Bees in an Urban Environment

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Cities can be home to diverse bee communities when urban environments provide suitable resources to support them. It is a widely used practice to establish annual and perennial plants from seed mixes to enhance bee diversity and abundance. However, certain plant species, e.g., species within the Campanulaceae, can be difficult to establish when using seed mixes. Plantings of such perennial species may represent a feasible alternative when designing urban spaces for polylectic and oligolectic bees alike. Our study focused on mixed perennial plantings at different sites within the inner city of Braunschweig, Germany. We recorded and identified bees visiting flowers at patches of four *Campanula* species (*C. persicifolia, C. rotundifolia, C. trachelium and C. punctata*) during a series of 15 min focal observations. Sites were surveyed between June and August in the year of planting in 2020 and again in 2024. In addition, we extracted and identified pollen loads from flower-visiting bees. Even newly established plantings attracted a range of bee species, including three oligolectic species, which visited flowers at a high rate. Bee-collected pollen loads included pollen from eight plant families and were dominated by Campanulaceae pollen even when extracted from polylectic bees. Our data shows that bees readily integrated plantings of flowering perennials into their food web. Although initially more costly than flower strips established from seed mixes, such plantings may have a high potential to support certain groups of oligolectic bee species.

P36

Spillover of Managed Bumble Bees from Mediterranean Orchards Causes Minor Ecological Impacts

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Commercial bumble bee colonies are routinely used for crop pollination in greenhouses, and are increasingly introduced into orchards. Bumble bee spillover to natural habitats neighboring the orchards may interfere with local wild bees and impact the pollination of non-crop plants. Concurrently, foraging in natural habitats may diversify the bumble bees' diets and improve colony development. To evaluate these potential effects, we placed commercial *Bombus terrestris* colonies in blooming Rosaceae orchards, 25-125 m away from the margins. We recorded the colonies' mass gain, population sizes, composition of stored pollen, and thermoregulation. We monitored bee activity, and seed sets of the non-crop plant *Eruca sativa*, along transects in a semi-natural shrubland up to 100 m away from the orchards, with managed bumble bees either present or absent. Rosaceae pollen comprised ~1/3 of the colonies' pollen stores at all distances from the orchard margins. Colonies nearest to the margins showed prolonged development, produced fewer reproductive individuals, and had poorer thermoregulation than colonies closer to the orchards' center. Possibly, environmental stressors interfered with the bumble bees' development near the orchard borders. Wild bees were as active during the colonies' deployment as after their removal. *E. sativa*'s seed sets decreased after bumble bee removal, but a similar decline also occurred near a control orchard with no managed bumble bees.

Altogether, we found no short-term spillover effects of managed bumble bees on nearby plant-bee communities during the orchards' three-week flowering. The colonies' prompt removal after blooming can reduce longer-term ecological risks associated with managed bumble bees.

P37 Always Scented, Sometimes Pollinated - Diel Patterns of Scent Emission and Pollination in Alpine Rock-Cress

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Plants that depend on animals for reproduction often use complex floral traits to attract pollinators. Floral scent is recognized as part of the pollinator attraction module and can be shaped by plant-pollinator interactions. In recent decades, research has started to reveal the dynamic properties of floral scent, identifying patterns of spatial and temporal variation in floral scent emissions at various scales. Here, we investigate the levels at which floral scent varies in two populations of the generalist, perennial herb *Arabis alpina* (Brassicaceae) and if scent variation co-varies with pollinator activity, which would be expected if scent production is costly. We ask if floral scent composition varies at small geographic scales and if this is reflected in pollinator community assemblage. Then, we investigate diel variation in floral scent emission rate and pollinator activity to reveal indications of synchronization between plants and pollinators. Further, we sampled volatiles from dissected floral parts to determine where floral scent compounds are produced in *A. alpina*. The two populations were pollinated by partly different communities of diurnally active insects, and scent composition, explained by differences in petal and reproductive organ scent, differed between the two neighboring populations. However, we found no evidence of synchronization between floral scent emission and insect activity, as *A. alpina* emits similar amounts of scent regardless of time of day and temperature. Thus, floral scent emission seems to carry low costs, but varies at short spatial scales in potential concert with variation in pollinator assemblage.

P38 Disentangling Effects of Flower Symmetry and Orientation on Pollination – *Saxifraga* as a Study Case

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Some *Saxifraga* species possess an intraindividual variation of flower symmetry and orientation: Radially symmetrical flowers are oriented horizontally, whereas monosymmetrical flowers are oriented vertically. Petal size, petal colouration, sequence of stamen movement, and interpetal angles are induced by gravity and thus correlate with symmetry and orientation. The flower-visitors' response to flower symmetry and orientation was tested in the field with fly-pollinated *Saxifraga* stellaris and *S. cuneifolia*. The video-analysis of approach and landing behaviour of flies showed that syrphid flies inspect the flower longer than muscid flies before choosing the landing site and that the flies' movement on the flower is more constrained by the vertical orientation of the flowers. The landing site on the flowers was independent of flower symmetry and orientation. The flower visitors' body axis was aligned with the flowers' symmetry axis, since most flies land with their heads facing upwards. In a lab-based experiment the pollen surrogate deposition on stigmas of *S. fortunei* was tested using *Episyrphus balteatus* hoverflies that have been dusted with pigment particles before a single flower visit. Hoverflies deposited more pigment particles on vertically oriented flowers, irrespective of flower symmetry. It is discussed whether vertically oriented monosymmetrical *Saxifraga* flowers benefit from the avoidance of self-pollination and reduced pollen clogging. The role of differences in zygomorphy among *Saxifraga* species with regard to display of floral guides in the upper petals, initiation of stamen movement in the lower stamens, petal length and interpetal angles are discussed in the context of pollination efficiency.

P39

The Role of Caffeine and Floral Scent in the Mortality of Bumblebees under Lime Trees

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Flowering plants use chemical strategies to attract and manipulate pollinators. They often enhance pollination services and are positive for pollinators. However, some strategies may occasionally act detrimentally on some pollinators. The silver lime *Tilia tomentosa*, which produces caffeinated pollen and powerful floral scents, has long been associated with bumblebee mortality. Although it is known that bees fell under the *Tilia*, remaining immobile, and died of starvation, why bumblebees starve to death is still unknown. This study aimed to determine whether caffeine in the pollen and floral scent of *T. tomentosa* are associated with bumblebee mortality. For this, foraging bees as well as dead bumblebees found under *T. tomentosa* were collected and dissected to check for ingested *Tilia* pollen. Behavioural experiments were also carried out to assess the bumble bee preference for caffeinated versus non-caffeinated pollen. Finally, we analysed the behavioural effect of specific floral scent chemicals emitted by *T. tomentosa* on bumblebee behaviour. Caffeinated pollen was equally found in the gut of dead and foraging bumblebees, which matched our preference experiments, in which bees did not show any preference between caffeinated and not-caffeinated pollen. Thus, ingestion of caffeinated *Tilia* pollen is not harmful to bumblebees. However, bumblebees exposed to specific floral scents became static after prolonged exposure but did not die and fully recovered after some time. Therefore, we suggest bumblebee mortality results from the interaction between *Tilia* floral scent emission and environmental factors such as harsh weather conditions (e.g. high and low temperatures, heavy rain).

P40

How pollinator-friendly is the City of London?

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Pollinators are vital for pollination services in agricultural and natural ecosystems. However, they are threatened by several disturbances, such as climate change, habitat loss, pesticide use, reduction in floral resources and spread of parasites and pathogens from managed bee species. Pollinating London Together (PLT) is a pan-livery initiative focusing on halting the decline of pollinators in the City of London and its immediate environs. PLT is assessing pollinators' diversity and habitat quality in the City of London. Four rounds of surveying took place in 2023 on sixty-three sites. We recorded 44 bee, 23 hoverfly, five butterfly, and three moth species. Fifty-seven per cent of recorded pollinators were honeybees. Although only five sites were roof gardens, 21 % of total pollinators were recorded on roof gardens. Pollinators were recorded on 72 % of flowering plants in the City of London. Two hundred fifty-four plant genera were visited by pollinating insects. The top three plant genera for pollinator visits were Salvia, Rudbeckia, and Nepeta.The survival of bees is highly dependent on both food and nesting resources. There are 270 bee species in the British Isles; approximately 70 % are ground-nesters, and the rest (except *Apis mellifera*) are cavity-nesters. From recorded specimens, 94 % were cavity-nesters, and 6 % were ground-nesters. This finding reflects the limited availability of suitable nesting habitat for ground-nesting bees. The diversity and abundance of pollinators can be enhanced in urban habitats byproviding suitable food and nesting resources and creating pollinator corridors and networks.

P41

FlowerPower Your Garden: Monitoring Flower Visitors in Experimental Grasslands

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Populations of flower-visiting insects are declining due to habitat loss, especially in Belgium, a country with high levels of urbanization and intensive agriculture. Private gardens make up 12% of the area in Flanders (northern part of Belgium), so increasing flower abundance and diversity in people's gardens may benefit flower-visitors. The citizen science project 'FlowerPower Your Garden' asked its 492 participants to install 3 experimental plots in their lawns to create a species-rich grassland. Flower abundance and flower-visitors were monitored by the citizen scientists. We verified the quality of the data collected by the citizen scientists with validation measurements by an expert in 27 gardens. While the data collected by the citizen scientists was clearly correlated with the expert-data, we found that the citizen-data often underestimated the actual species richness of the flower visitors. The complete dataset revealed more flower visitors were observed in June than in August. We further investigated which local garden and landscape factors influenced the flower visitors attracted in the experimental plots. Flowering plant abundance and richness had a positive effect on the number of flower visitor species. However, in June, a significant negative relationship was also observed between the proportion of trees and shrubs in the surrounding landscape and the number of flower visitors. This correlation disappeared in August, likely due to the end of the flowering period of shrubs and trees, which may have a diluting effect on the observed flower visitors.

P42

Synthesis of Apple Pollination Research Reveals Positive Contributions From Wild Bees Relative to those of Honeybees

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Apple (*Malus domestica*) is one of the most important entomophilous crops in the world. To safeguard future yields, it is essential to understand which pollinating insects contribute to its pollination across production regions. Here we present a set of meta-analyses of site-replicated, observational studies on insect-mediated pollination in apple cultivation. Using raw data from 30 studies, totaling 546 site replicates, we determine the contribution of honeybees (*Apis mellifera*) and wild bees to apple pollination. We find that the honeybee is the most abundant pollinator (72.9% on average) compared to wild bees across all studies. From our meta-analyses we conclude that increasing honeybee visitation, wild bee visitation and bee species richness did not affect fruit yet. Fruit weight increased with increasing wild bee visitation while unaffected by honeybee visitation or bee richness. In contrast, seed set was not affected by honeybee visitation while enhanced by wild bee visitation and bee richness. In sum, a diverse community of bees contributes to apple pollination and yield. The positive effect of wild bee visitation and bee species richness on fruit weight and seed set is in line with previous crop pollination research concluding that wild bees provide better-quality pollination for most crops. Our synthesis highlights the general importance of conserving pollinator diversity to maintain pollination services.

P43

Linking Changes in Pollinator Behaviour with their Effect on Male Fitness in Buzz-Pollinated Flowers

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Bees play a crucial role in mediating patterns of pollen transfer that affect plant fitness. In studies of floral ecology and evolution, the role of pollinators as agents of pollen transfer is often treated as a black box. One case in point is the behaviour of some bee species that use their thoracic muscles to vibrate and remove pollen from flowers in a phenomenon known as buzz pollination. Buzz pollinated flowers usually offer pollen as the only reward. Buzz pollination is an innate behaviour and naive bumblebees buzz on their first visits. After vibrating a flower, buzz-pollinating bumblebees groom their bodies, collecting and packing pollen grains in specialised structures on their hind legs. This groomed pollen is removed from the pollination process and affects how many pollen grains are available to fertilise flowers on subsequent visits. In this work, I investigate how bee behaviour affects the male fitness of the flowers they visit, using captive bees of *Bombus terrestris* and flowers of *Solanum sisymbriifolium* as a model. We hypothesise that bees will differ in their behavioural response to pollen removal, for example by altering their grooming patterns. Visits will take place in a flight cage where each bee has access to a set of flowers. These visits will be recorded, and information on visit duration, buzzing time and grooming time will be collected, as well as bees and stigmas for later pollen counting. My main aim is to relate variations in pollinator behaviour to the relative efficiency of pollen transfer.