# ECOLOGY OF APHIDOPHAGA 16

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# BOOK OF ABSTRACTS

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# KEYNOTE LECTURES

## Disruption of biocontrol based IPM cereal Systems in the US

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### Abstract
In the Southern Plains of the United States, aphid management programs in cereal crops have relied on naturally occurring biological control by a guild of parasitoids and predators. These natural enemies and their services have been conserved by infrequent insecticide use and diversification of landscapes in time and space. This relatively stable system has been dependent upon green crop bridges for hosts and natural enemies between summer and winter wheat in agricultural landscapes but persistence of aphid suppression may be threatened by two emerging trends. Firstly, summer crops are becoming more intensively managed with insecticides because of emerging and invasive pests. Secondly, unjustified insecticidal seed treatments in winter wheat are becoming more common which may break green bridges for hosts and natural enemies. Both have the potential to threaten natural enemy survival leading to aphid outbreaks. Available data on insecticide use trends, pest outbreaks and natural enemy impact over time indicate a potential threat to the stability of current cereal IPM systems in the US Southern Plains.

**Keywords**: Aphids, Parasitoids, Landscape, Biological Control, Winter wheat, Sorghum.

## Hoverflies as key players in integrated aphid control

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**Abstract**
Hoverflies (Syrphidae) comprise over 6,600 known species worldwide, exhibiting remarkable diversity in morphology, size, and coloration. Many species mimic Hymenoptera or other Diptera, making field identification challenging, except by their characteristic rapid, hovering flight. Adult hoverflies are important pollinators, either due to specific morphological adaptations or their frequent floral visitation for nutritional resources. In contrast, larvae display diverse feeding strategies, making them valuable bioindicators of ecosystem health.
Roughly one-third of hoverfly species are predatory, primarily feeding on aphids, key agricultural, urban and forestry pests. Consequently, hoverflies play a critical—though often overlooked—role in natural aphid population control. Field and laboratory studies have supported efforts in the mass rearing of several native species, leading to the commercial availability of at least three hoverfly species, now routinely released in European crops for aphid management.
This presentation examines the morphological, anatomical, biological, and behavioral traits that position predatory hoverflies as effective biological control agents. It also explores their compatibility—and potential synergy—with other Integrated Pest Management (IPM) strategies, while addressing the influence of anthropogenic pressures and lesser-known factors such as migration on their effectiveness.

This study forms part of the AGROALNEXT programme (AGROALNEXT/2022/052-BIOPESTNEW) supported by MCIN with funding from European Union NextGenerationEU (PRTR-C17.I1) and by Generalitat Valenciana.

**Keywords**: aphidophagous syrphids, IPM, migration, flowerflies.

## Preventive strategies for biological control of aphids in greenhouse crops

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**Abstract**
Augmentative biological control is a well established and widely adopted in the European greenhouse sector. However, biological control of aphids has always been challenging due to their rapid reproduction rate. Although a wide range of natural enemies are commercially available, most of them are specialists, such as parasitoids, predatory midges and predatory beetles, which only survive for a short time in the absence of aphids. Consequently, most biocontrol strategies are curative and risky, because aphid densities get soon out of control when natural enemy releases are delayed. Preventive strategies involving the establishment of natural enemy populations before the arrival of pests (standing army) are generally very effective, but this comes with many challenges as well. Firstly, these natural enemies need food sources and shelter to survive in the absence of pest aphids. Secondly, the competition with other species of natural enemies for shared resources, as well as interspecific interference, can hinder long-term establishment. Here we will provide an overview of the natural enemies that have been selected and evaluated for use in preventive strategies to control aphids in Dutch greenhouses, focusing on strawberries, peppers and chrysanthemums. We will then discuss the potential for complementarity among species, but also show examples of potential disrupting food web complexities. Finally, we will discuss the need to engineer habitats and diversify monoculture greenhouse crops to enhance aphid control, and we will present examples of banker plant systems, artificial shelters, and functional biodiversity that we are currently studying in ongoing projects.

**Keywords**: generalist predators, standing army, augmentative biocontrol, niche differentiation.

**Reciprocal synergism between plant resistance and aphid biological control on annual crops**

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**Abstract**
Aphids are notorious as pests with remarkable outbreak potential, particularly following host shifts and invasions of novel geographic regions. In grain crops, the selection of cultivars with antibiotic traits has traditionally been a primary tactic to reduce the rate of aphid population growth following such events. The conventional wisdom has been that the development of resistant varieties, given adequate support from biological control, is fundamental to maintaining aphid populations below economic thresholds in large-scale monocultures. Historically, the evolution of resistance-breaking aphid biotypes has plagued this approach, often voiding years of selective plant breading. So are resistant varieties, aided by biocontrol, truly the foundation of effective aphid population suppression in small grains? Or does effective, broad-based biocontrol negate the need for specific resisitance traits? Drawing on several historical examples from the High Plains region of the USA, I argue that selection of cultivars with 'single gene' antibiotic traits does not provide a stable solution to epidemic aphid populations, although it can assist the evolution of 'natural' biocontrol. On the contrary, it is the establishment of an effective foundation of biological control that can preserve the effectiveness of specific antibiotic traits and prevent the evolution of biotypes, sometimes precluding the need for resistant cultivars entirely.

**Keywords**: antibiosis, biotypes, effective population size, evolutionary rate, mutation rate.

# Aphidophagy in cotton agroecosystems: cropping system diversification and conservation biological control for cotton aphid population suppression

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**Abstract**
A comprehensive long-term study comprised of laboratory and field studies demonstrated a significant predator-induced aphidophagy in cotton agroecosystems to avoid the need for pesticide intervention altogether. In the laboratory, the cotton aphid, *Aphis gossypii*, predation rate of convergent lady beetle, *Hippodamia convergens*, averaged 40, 100, 150, and 200 aphids within 1, 4, 8, and 24 h, respectively, at maximum density of 200 aphids per predator. Predators showed a curvilinear feeding response in relation to total available time, indicating that lady beetles have the potential to suppress larger populations of aphids through continuous feeding by regulating their predation efficiency during feeding. An analysis of age-specific mortality in absence of prey revealed that lady beetles could survive for an extended period (>2 weeks) without prey. The ability of a predator to survive without prey delays or prevents the rebound of pest populations that is a significant factor in natural biological control. A 2-year field sampling of cotton arthropod predators showed that spiders (27%) were the most dominant predators followed by convergent lady beetles (23.5%), hooded beetles (13.5%), minute pirate bugs (11%), green lacewings (9.5%), bigeyed bugs (7.5%), scymnus beetles (3%), soft-winged flower beetles (2%), damsel bugs (1.5%), and assassin bugs (1.5%) that collectively suppressed cotton aphid field populations below economic thresholds. A field cage study showed that one *H. convergens* adult per plant released at prey density of one aphid per leaf kept the aphid population below economic threshold for the entire growing season. Because early colonization of natural enemies suppressed the aphid population below economic thresholds for the entire season, a relay intercropping of winter and spring strip crops with cotton was used to conserve and enhance predators of the cotton aphid for early season colonization in cotton. The intercrops acted as a reservoir for predators during the non-cotton season; these intercrops `relayed' aphid predators from canola and wheat in the winter to sorghum in the spring and finally to cotton in the summer. Average aphid abundance was lower in relay intercropped cotton than in isolated cotton. Average predator numbers were higher in relay intercropped cotton than in isolated cotton, and predators appeared in higher numbers earlier in the summer in relay intercropped cotton than in isolated cotton. Results from this study demonstrated that where cotton is grown without insecticides, relay intercropping aids the early arrival and continuous population increase of predators in cotton, thereby reducing numbers and postponing the initial population increase of the cotton aphid.

**Keywords**: aphid biological control, predator colonization, relay intercropping, predator conservation, economic thresholds

## Advancements in plant-aphid interactions: exploring the role of induced defense signals for enhanced resistance

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**Abstract**
The activation of plant defenses through natural elicitors is emerging as a promising strategy for sustainable crop protection. This presentation will provide an overview of several years of research using citrus as a model system to investigate how the induction of defensive responses, triggered by volatile compounds such as (Z)-3-hexenyl propanoate, can shape plant-insect interactions. Our work has demonstrated that elicited plants activate hormonal and antioxidant pathways associated with resistance, as well as alter their volatile emission profiles, resulting in ecologically significant outcomes, such as repelling herbivores, including the citrus aphid *Aphis spiraecola*, and attracting their natural enemies, such as coccinellids and hymenopteran parasitoids. Long-term field trials conducted over three consecutive seasons have consistently demonstrated a substantial reduction in aphid populations on plants that have been defensively induced. In parallel, a transcriptomic approach has been employed to investigate gene expression changes in aphids exposed to activated plants, to understand the physiological and adaptive responses that may underpin their persistence. This presentation will highlight the underlying plant mechanisms involved in induced resistance and the physiological and adaptive responses observed in aphid populations. The potential of these findings for the development of innovative biotechnological tools and their integration into ecologically based pest management strategies is also addressed. Overall, this work highlights the importance of examining plant-insect interactions across molecular, physiological, and ecological scales to enhance the development of more resilient and sustainable agroecosystems.

# Aphidophagous communities respond to intraspecific variation in aphid defense

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**Abstract**

In this talk, I will discuss the current state of knowledge of the mechanisms by which aphids protect themselves from enemies, how these defenses might vary within and among aphid species, and how such variation might affect the ecology and evolution of aphidophagous communities, particularly with respect to generalist predators. I will provide empirical demonstration that predators can differentially exploit fine-grained niches generated by variable, heritable and selective defenses within a single prey species. For example, some, but not all, clones of the aphid *Aphis craccivora* are toxic towards several natural enemies, including a dominant invasive predatory ladybeetle, *Harmonia axyridis*. However, other less competitive ladybeetle species are not affected by the aphid's toxic trait. In laboratory and open field experiments, we showed: (i) that subdominant ladybeetle species were able to exploit the toxic aphids, benefitting from the suppression of the dominant predator; and (ii) that this narrow-spectrum toxicity can function as an anti-predator defense for the aphid, but depends on enemy community context. More generally, intraspecific variation in aphid defensive traits may arise from a variety of sources, including heritable symbionts and chemical sequestration, all of which may promote diversity and stability of enemy communities, which in turn provide biological control services. Understanding this interplay becomes increasingly important in a world where global species introductions and climate change are constantly rewriting the map of interacting species.

**Keywords**: aphid defenses, *Aphis craccivora*, behavioral avoidance, community interactions, *Harmonia axyridis*, niche differentiation.

# ORAL PRESENTATIONS

# Unlocking the bioprotection potential of wool

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**Abstract**
Wool pellets are a natural, slow-release amendment that primarily supplies nitrogen in the form of ammonium ($NH_4^+$), deliverers plant-available sulfur (S), decreases leaf nitrate ($NO_3^-$) content, and improves the soil's water-holding capacity. In this open-field experiment, we investigate the effects of placing wool pellet into the holes for planting kapia pepper (*Capsicum annuum*) on the populations of aphids (Hemiptera: Aphididae) and their key natural enemies (Chrysopidae, Coccinellidae, Thomisidae). We hypothesize that the conversion from $NO_3^-$ to $NH_4^+$ nutrition modifies phloem amino-N profiles in ways that reduce aphid settling and fecundity. While, simultaneously, the sulfur released by wool triggers plant's defense mechanisms, thus negatively affecting the preferences of aphids. Furthermore, improved water retention and nutrient balance should allow developing young pepper plants to establish vigorously, causing a bottom-up effect that may transiently support aphids, yet gradually benefit natural enemies. During a ten-week monitoring, wool-amended and control plots will be investigated for leaf $NO_3^-$ and $NH_4^+$ concentrations, sulfur status, aphid presence, and predator abundance. We anticipate that wool treatment will result in significantly reduced foliar $NO_3^-$ levels while elevating $NH_4^+$ and S, correlated with lower aphid establishment and sustained natural enemy activity. This demonstrates synergistic pest suppression through nutrient-mediated plant resistance and habitat-mediated conservation biological control. The results have the potential to place wool pellet as a multi-purpose tool in integrated nutrient and pest management for open-field pepper production.

**Keywords**: predation, tritrophic interactions, enzyme activity, pepper.

## Successful integration of macrobial and microbial biological control agents against the cannabis aphid, *Phorodon cannabis*

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**Abstract**
The cannabis aphid *Phorodon cannabis* is a specialist insect pest occurring on cannabis in Asia, Europe and North Africa. In the last decade, *P. cannabis* had also emerged in North America, where cannabis is a high value crop whose cultivation flourished to supply the pharmaceutical industry. Due to its therapeutic purposes, cannabis is subjected to strict regulations concerning the application of chemical pesticides. Therefore, biological solutions are needed to control this pest. Both macrobial natural enemies, *i.e.* an egg parasitoid (Aphipar-M®) and a lacewing predator (Chrysopa-E®), and microbial agents, *i.e.* an entomopathogenic fungus (Mycotal®), were included in this project. Firstly, the different biological agents involved in this study were tested individually, in semi-field conditions. Thereafter, the combination of the natural enemies was investigated *in-vitro* in a compatibility study. Finally, the products were all integrated together in a semi-field study. In this poster, our findings from lab to greenhouse experiments indicated that the integration of macrobial and microbial biological control agents can provide a sustainable solution to control the cannabis aphid in cannabis when integrated together in an insect pest management strategy.

**Keywords:** natural enemies, entomopathogenic fungus, parasitoids, predators, integrated pest management.

**Integrated Pest Management of willow carrot aphids (*Cavariella aegopodii*)**

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**Abstract**
The willow carrot aphid (*Cavariella aegopodii*) is a prominent pest of carrot and related crops, known for its high reproductive capacity and host-alternation behaviour. Although traditionally viewed as an Apiaceae specialist, recent studies reveal its adaptability to non-apiaceous species causes direct/indirect damage. This project aims to understand the host range of *C. aegopodii,* opening up new dimensions of research on this species. This expanded host range highlights the need for early monitoring and strategic interventions to disrupt pest cycles and mitigate damage. So far, the results show that this apiaceous-specialised aphid, *C. aegopodii*, adapts well to some of the non-host species, such as Brussels sprout, swede, potato and beet, under controlled environment conditions. Alongside understanding host variation, as a part of the IPM strategy, it is paramount to identify sources of host plant resistance to *C. aegopodii* to inhibit initial pest immigration and reduce insect colonisation. In this project, I am investigating the susceptibility levels of different carrot accessions from the VeGIN Carrot Diversity Set (VeGIN (warwick.ac.uk)) to *C. aegopodii* based on antibiosis and antixenosis mechanisms through field and controlled environment screening and molecular diagnostics to determine the presence of Carrot Red Leaf Virus (ctRLV) – the important carrot virus this aphid transmits. In addition, we are developing field and laboratory aphid bioassays to determine the effects of companion cropping in combination with non-host plants or alternate host plants, either to interfere with host plant finding or to attract natural enemies of aphids, and thus reduce aphid pressure. Notably, garlic chives have shown potential as a companion crop to influence certain life history traits of *C. aegopodii*, including fecundity, biomass and survival. Therefore, this project will consider how various approaches can be integrated to optimise pest control and ensure the economic and ecological sustainability of cropping systems.

**Keywords**: host ranges, resistance, companion cropping, ctRLV.

**Impact of the hyperparasitoid *Alloxysta brevis* on *Aphelinus certus*, a natural enemy of the soybean aphid**

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**Abstract**
*Aphelinus certus* is a parasitoid of the soybean aphid (*Aphis glycines*) – an invasive soybean pest in North America. Though *Ap. certus* has displayed the capacity to suppress aphid infestations below pesticide spray thresholds, it does not consistently control soybean aphid populations in the field. Previous work has reported moderate hyperparasitism rates of *Ap. certus*, but the impact of hyperparasitism on the ability of *Ap. certus* to suppress aphid populations remains unclear. *Alloxysta brevis* is a common aphid hyperparasitoid in North America, and the dominant hyperparasitoid of *Ap. certus* in Minnesota, USA. Here, we investigate some basic aspects of the natural history of *Al. brevis* and use a laboratory mesocosm study to assess its impact on *Ap. certus* and soybean aphid populations. First, we performed dissections of newly emerged *Al. brevis* females to determine egg load upon emergence and egg maturation rate. Second, we investigated *Al. brevis* host life-stage preference and development time from egg to adult. Finally, we used a cage study to evaluate population dynamics between soybean aphid, *Ap. certus*, and *Al. brevis*. Our results show that adult *Al. brevis* females emerge with 9 eggs and mature 2.4 eggs daily over the first 5 days of their life. *Alloxysta brevis* preferentially parasitize 1st-instar *Ap. certus* larvae, but can successfully develop in older larvae. In our mesocosm cage study, hyperparasitism by *A. brevis* significantly reduced *A. certus* emergence but did not eliminate its ability to suppress aphid populations.

**Keywords**: biological control, parasitoid, multitrophic interactions.

**Chemical alarm signalling in *Dysaphis plantaginea*: characterization and ecological implications**

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**Abstract**
*Dysaphis plantaginea* (Hemiptera: Aphidinae) (Passerini, 1860), the rosy apple aphid, is a major pest in European orchards, negatively impacting tree health and fruit quality. With the use of broad-spectrum insecticides in decline, alternative pest management strategies, relying on chemical ecology, are needed. Alarm pheromones, composed of volatile compounds such as terpenes, play a key role in aphid defence by inducing escape responses in conspecifics while simultaneously attracting natural enemies. Their dual ecological function makes them promising candidates for sustainable pest management. This study focuses on the comprehensive chemical characterization of the alarm pheromone blend of *Dysaphis plantaginea*, using GC-MS analysis of cornicle secretions combined with behavioural assays to evaluate repellence. The results will deepen the understanding of aphid chemical communication and support the development of environmentally friendly control strategies in apple orchards.

**Keywords**: Alarm pheromone, chemical ecology, mass spectrometry, aphids.

## Effects of sweet alyssum strips on aphid populations and their natural enemies in conventional field lettuce production

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### Abstract

One approach to conservation biocontrol is to provide floral resources for natural enemies, such as pollen and nectar. *Nasonovia ribisnigri*, the currant-lettuce aphid, is an important contaminant pest in field-grown lettuce in North America and Europe. Strips of sweet alyssum (*Lobularia maritima*) are used to control this pest in organic lettuce in California, USA. Sweet alyssum attracts syrphids, whose larvae can control *N. ribisnigri* populations. However, this approach has not been widely adopted in other regions with different climates and arthropod communities, nor in conventional production. The distance at which alyssum strips can protect crops remains unclear.

We conducted an experiment over three summers to evaluate the effects of sweet alyssum strips on the densities of aphids, including *N. ribisnigri*, and aphid natural enemies in commercial lettuce production in Québec, Canada's top lettuce-producing region. The experimental design comprised plots with either an alyssum strip or a no-intervention control. Densities of aphids and their natural enemies were monitored twice weekly through non-destructive observations at 1, 5, 20, 50, and 100m from the flower strip until one week before the harvest. Flying natural enemies were captured with sweep nets at 5, 20, and 100m. Destructive sampling was conducted before harvest to evaluate aphid and natural enemy densities at crop maturity.

The most abundant aphid species were *Macrosiphum euphorbiae*, *Acyrthosiphon lactucae*, and *N. ribisnigri*. Coccinellids, particularly *Harmonia axyridis*, dominated the aphidophagous insect community. Syrphids, *Orius*, lacewings, and cecidomyids were also present. Parasitoid mummies were rarely seen at most sites. Aphid and natural enemy densities as a function of flower treatment, date, and distance from the flower strip will be discussed, along with ecological factors that may have affected insect abundance. Conditions in the lettuce fields varied by site, production period, and year; as a result, the trends in the insect communities were context-dependent.

**Keywords**: Conservation biological control, integrated pest management, agriculture, Syrphidae, Coccinellidae.

**Does greening vacant land influence recruitment of native and alien Coccinellidae?**

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**Abstract:**
Growing concern for beneficial insects, including Coccinellidae, has resulted in many urban greening initiatives. While well-intended, questions regarding which practices effectively support insect fauna of conservation concern remain. Post-industrial cities are a prime target for establishing insect habitat due to their large holdings of vacant land. As people depart, these cities become burdened with an abundance of abandoned homes that are eventually demolished, creating these open spaces. Vacant land is associated with many negative attitudes and perceptions, but it also presents an opportunity to create habitat and yield ecosystem services. The Cleveland Pocket Prairie Project was established in 2014 to examine how different vacant land management strategies influenced insect conservation. This network of research sites included unaltered vacant lots containing urban spontaneous vegetation ("vacant lots"), vacant lots seeded with native wildflowers ("pocket prairies"), and vacant lots transformed into produce farms ("urban farms"). We compared recruitment of native and alien lady beetles to these urban habitats and their suburban analogs: wildflower grasslands managed by the Cleveland Metroparks ("Metropark grasslands") and suburban produce farms ("suburban farms"). Lady beetles were collected from each habitat (n=8 per habitat) during 2018 and 2019 using yellow sticky card traps. The most common species found was the alien *Propylea quatuordecimpunctata*, representing 53% and 41% of total trap catches in 2018 and 2019, respectively. This species was most common within urban vacant lots and pocket prairies. Native coccinellid captures included three aphidophagous, three coccidophagous, and one fungivorous species. Aphidophagous natives were most abundant within urban and suburban farms, whereas coccidophagous species were most common within vacant lot and pocket prairies. Our results highlight that urban greenspaces support an equivalent or greater number of native and alien coccinellids compared to their suburban analogs. Further, diet breadth and species origin appear to be linked to distinct patterns of habitat use.

**Keywords:** Conservation, landscape, urban, city, greenspace, *Propylea quatuordecimpunctata.*

**Spatio-temporal variability of aphidophagous coccinellid communities and aphids in agricultural landscapes**

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**Abstract**
Coccinellids are one of the main predators of aphid pests. They colonize crops from other habitats, but most of the literature ignores how these natural enemies occupy different habitats during the year. Agricultural landscapes in central Chile are very heterogeneous, including natural and semi-natural habitats and crops. In this work, we studied the spatio-temporal variability of coccinellid communities and aphids in the agricultural landscape. We sampled coccinellids and aphids during fall, winter, spring, and autumn 2023 and 2024, with yellow sticky traps and foliage beatings in covers representing a gradient of disturbance (from less to most disturbed): sclerophyllous matorral, tree hedgerows, abandoned fields, vineyards, maize, and alfalfa. In total, we collected 4098 coccinellids from 28 species (18 natives and 10 exotics). In all covers, they were mostly collected in fall, spring, and summer. Coccinellids were most abundant in alfalfa and maize, while aphids were most abundant in alfalfa and abandoned fields. Both taxa were least abundant in hedgerows and matorral. Coccinellid taxonomic diversity was highest in alfalfa and matorral, although functional dispersion -based on diet breadth, body size, and habitat generalization- was lowest in alfalfa and maize. Community composition varied among cover types according to a disturbance gradient, with matorral and hedgerows communities opposing alfalfa and maize. In fall and winter, vineyard communities were more similar to matorral and hedgerows, but in spring and summer, they were more similar to maize, abandoned fields, and alfalfa. Distinct species were associated with one or more cover types, except during winter. Few species changed among cover types between seasons. Our results show that coccinellid communities in agricultural landscapes vary in space and time, but some species are constantly associated with cover types according to their disturbance. This information might be crucial for species conservation and conservation biological control. Fondecyt 1230073.

**Keywords**: community composition, agricultural landscapes, ladybeetles, taxonomic and functional diversity.

**Preliminary results of inundative release of beneficial insects in apple orchard**

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**Abstract**
In recent years, the availability of chemical-synthetic plant protection products for use in Swiss fruit production has been increasingly restricted. In the future, the use of the remaining plant protection products will be further reduced in favor of minimizing environmental inputs, potential health risks and other negative effects on non-target organisms. However, it is necessary to ensure the successful control of economically important pests in order to guarantee high quality fruit production. One approach, which has been widely used in greenhouse crops is the targeted use of natural antagonists or beneficial organisms. Changes in production technology of outdoor crops (anti-insect nets, rain covers) in recent years now also could improve conditions for the inundative use of beneficial insects. The aim of the following trials was to determine the efficacy of a targeted release of beneficial insects to control aphids in apple cultivation. In addition, the influence of insect nets and implementation of flower strips on the effectiveness of the beneficial insects was investigated. The number of aphids and their antagonists was visually monitored on a by-weekly basis on selected trees at different distances from the flower strips. Preliminary data shows variable effects of insect netting on the number of aphids and their antagonists and no significant effect of the additional release of beneficials. However, it was shown that the presence of antagonists supported the control of aphid populations and that the beneficials selectively chose the shoots with the largest aphid colonies.
This project is partly funded by the Interreg program "Alpenrhein-Bodensee-Hochrhein".

**Keywords**: biological control, aphids, *Dysaphis plantaginea*, *Aphis pomi*, aphid predators, pome fruits, anti-insect netting, flower strips.

## Effects of woody and herbaceous habitat on aphids and natural enemies during aphid population buildup, peak, and decline in cotton

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**Abstract**
Semi-natural habitats (SNH) have reported to have variable and inconsistent effects on both pests and their natural enemies in crop fields. There is a need for a mechanistic understanding of the processes underlying the effects of different SNH on pest control in specific landscape contexts. Here we studied the effects of land use type in the landscape matrix on cotton aphid (*Aphis gossypii*) and predatory ladybeetles (Coleoptera: Coccinellidae) in cotton during buildup, peak and decline phases of the aphid population dynamics. Aphid and ladybeetle population dynamics in cotton were monitored across 61 cotton fields in 3 years. We measured the proportion of different land use types in a 2-km radius around each field. Data were analysed using linear regression. We also monitored the abundance of herbivorous insects and ladybeetles in different land use types (wheat, maize, cotton, herbaceous and woody SNH) from May to August. Effects of surrounding landscape on aphids and ladybeetles in cotton were mainly found during the buildup and peak period of cotton aphid. Cotton crops in landscapes with more herbaceous SNH had lower aphid density during the buildup and peak stages and lower ladybeetle density during the aphid peak stage than landscapes with less herbaceous SNH. In contrast, cotton crops in landscapes with more woody SNH had higher aphid density but lower ladybeetle density during the buildup phase. Results show that landscape composition effects on cotton aphids and ladybeetles vary temporally while herbaceous and woody SNH had contrasting effects. Woody SNH have winter hosts for cotton aphid while the higher aphid populations in woody compared to herbaceous SNH could draw ladybeetle adults away from field crops. The results suggest that herbaceous SNH, but not woody SNH, are valuable habitats for supporting cotton pest control in the Xinjiang landscape context.

**Keywords**: Biological Control; Pests; Predator; Agricultural Landscapes; temporal.

## Intercropping cotton with wheat or maize enhances biological pest control in cotton

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**Abstract**

Cotton is a major cash crop which heavily depends on insecticides for pest control. Intercropping can help to suppress pests in cotton when companion plants provide early resources for natural enemies and support an early colonization of cotton by natural enemies due to spillover from companion crop species. However, this mechanism critically depends on the planting time and resources provided by the companion crop. Here we assessed the effects of intercropping with spring wheat or maize on the biocontrol of cotton aphid (*Aphis gossypii*) in cotton. Spring wheat is sown one-week before cotton while maize is sown at the same time as cotton planting. We visually assessed pest and predator densities as well as predation activity using cotton bollworm egg cards on cotton plants in a two-year replicated field experiment. Aphid densities on cotton in cotton-spring wheat and cotton-maize intercrops were 55% and 58% lower than in sole cotton, and not significantly different between the two intercropping systems. The ladybeetle : aphid ratio during the cotton aphid peak was 1.9 and 2-fold higher in cotton-spring wheat and cotton-maize intercrops than in sole cotton, and predation rate on cotton bollworm eggs was 1.9 and 1.6-fold higher in spring wheat and maize intercrops. We conclude that intercropping cotton with spring wheat and maize have a similar suppressive effect on cotton aphids despite the one-week earlier sowing time of spring wheat than maize. This indicates that both wheat and maize can attract natural enemies which subsequently spill over to cotton, and that intercropping is a robust strategy to suppress cotton aphid with a reduced reliance on insecticides.

**Keywords**: Aphids; Predator; Integrated Pest Management; Crop Diversification.

**The role of lateralization in the successful copulation of *Praon volucre***

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**Abstract**
The ability of invertebrates, including insects, and vertebrates to use one side of the brain for specific tasks is defined as lateralization. There are documented cases of lateralized traits observed in the courtship and mating behaviors of various insect species. In the current study, we investigated the mating behavior of the aphid parasitoid *Praon volucre* (Haliday) (Hymenoptera: Braconidae: Aphidiinae), emerged from different hosts, i.e., *Macrosiphum euphorbiae* (Thomas) (Hemiptera: Aphididae) feeding on *Citrus aurantium* and *Aulacorthum solani* (Kaltenbach) (Hemiptera: Aphididae) feeding on *Malva neglecta*. We recorded the main traits during the courtship and copulation, emphasizing the influence of lateralization at the population level. Virgin individuals (2–4 days old) were used in the experiments that were conducted in an arena with ø 6 cm (22°C and 55% RH). The observations were performed visually under a stereomicroscope from 10:00 to 16:30 and carried out for 30 min or until the termination of sexual interaction. Our results revealed that *P. volucre* males showed a left-biased tendency when mounted females, which led to a greater number of successful copulations compared to right-biased males, regardless of the host species. The duration of each mating phase (i.e., mate detection, wing fanning by males, chasing females by males, antennal tapping of females by males, copulation attempts by males, and copulation) did not differ significantly between *P. volucre* emerging from *M. euphorbiae* or *A. solani*. Furthermore, the duration of each mating phase was lower in left-biased male parasitoids emerging from both aphid hosts, except for the time when males emerged from *A. solani* chased females. This duration was longer in left-biased compared to right-biased males. This study sheds light on new insights into the reproductive activity of *P. volucre*, highlighting the influence of lateralization on the duration of mating behavior features and mating success, regardless of the host aphid species.

**Keywords**: mating behavior, host aphid, parasitic wasp, lateralization.

## Sequestration of prey chemicals for defence by ladybird beetles (Coleoptera: Coccinellidae)

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**Abstract**
Most ladybird beetles chemically defend themselves against natural enemies using autogenously produced alkaloids. In a few cases, it has been suggested that predatory ladybirds may sequester additional chemicals for defence from prey. However, open questions remain about the balance of benefits (i.e., whether such compounds confer additional defensive benefit over pre-existing defence) and costs (e.g., toxicity of such compounds to the ladybird). In this presentation, this trade-off is discussed and new data on sequestration by ladybird beetles from prey is presented. Is defensive sequestration a valuable part of the ladybird chemical defensive armory or a side effect of eating marginally suitable, chemically defended prey?

**Keywords**: cost-benefit analysis, defensive chemicals, sequestration.

**Landscape complexity modulates the effects of local management on two aphid pest and their natural enemies**

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**Abstract**
The effects of landscape complexity on natural pest control have been widely studied but remain difficult to predict, probably because they can interact with local management practices and other environmental factors. We present the results for two different systems where we tested whether and to what extent landscape complexity (compositional and configurational heterogeneity) interacts with local management. In a first study the effect of the presence of a non-crop host plant and the intensity of pesticide use in 18 apple orchards on *Eriosoma lanigerum* (the woolly apple aphid) biological control was measured across a landscape complexity gradient in central Chile. In the second study, the influence of flower strips next to cabbage plots on the biological control of *Brevicoryne brassicae* (the cabbage aphid) was measured in 20 small brassica farms in the same landscape gradient. In both studies we assessed landscape characteristics within a 1 km buffer around study sites. Our results highlight the significant role of configurational heterogeneity on aphid incidence and aphid parasitism rates. Management (intensive insecticide use or the use of flower strips) had a strong impact on aphid populations, aphid parasitism and the abundance of predators, regardless of landscape characteristics. However, in apple orchards the presence of a non-crop host plant for the pest and its parasitoid modulated these effects, partially offsetting the negative effect of insecticides. In the annual system, the intensity of the management effect varied depending on the proportion of semi-natural habitat in the landscape. For brassica crops, faba bean strips increased aphid parasitism by *Diaeretiella rapae* regardless of landscape composition at the beginning of the season, but a stronger effect of the landscape became apparent at the end of the season when flower strips may be less dependable. These findings emphasize the importance of integrating landscape structure, local management, and key features of non-crop habitats when designing biological control strategies.

**Keywords**: landscape complexity, biological control, management, *Eriosoma lanigerum*, *Brevicoryne brassicae.*

**Essential oils: a lucky double-edged sword for aphids and hoverflies**

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**Abstract**
*Myzus persicae* (Hemiptera: Aphididae) is a major pest in greenhouse horticulture. Control options are increasingly limited due to the scarcity of authorized insecticides and stricter EU regulations on synthetic pesticides. This highlights the urgent need for natural, eco-friendly, and IPM-compatible alternatives.
Essential oils (EOs) are a promising tool for aphid control. Our previous research demonstrated the efficacy of several EOs against aphids and their compatibility with some predator, such as *Sphaerophoria rueppellii* (Diptera: Syrphidae). This study expands that work by evaluating EO compatibility with two additional aphid predators: *Episyrphus balteatus* (Diptera: Syrphidae) and *Adalia bipunctata* (Coleoptera: Coccinellidae), both widely used in commercial biocontrol. We extracted EOs from cypress (*Cupressus sempervirens*), laurel (*Laurus nobilis*) and Aleppo pine (*Pinus halepensis*) leaves. A novel feature of our approach was the formulation of these oils into nanoemulsions, tested for both toxicity and repellency to the three predators. Plant material was collected from the Estación Biológica-Jardín Botánico de la Universidad de Alicante (Ibi, Alicante, Spain), dried, and processed by hydrodistillation using a Clevenger-type apparatus. Nanoemulsions were prepared by mixing EO and Tween 80 (1:1 v/v), diluted in water, and homogenized via ultrasonication.
EO effects varied among species. *S. rueppellii* was the most tolerant, showing low mortality and no significant repellency. *E. balteatus* exhibited sensitivity to laurel oil, with 40% mortality and reduced repellency. *A. bipunctata* was the most affected, showing high mortality in response to pine (37%), laurel (47%), and cypress (50%) oils, though repellency was observed only with laurel.
These findings highlight the importance of evaluating EO compatibility with natural enemies to support their safe integration into sustainable aphid management strategies.

**Keywords**: essential oils, biological control, aphid predators, integrated pest management.

## Modelling the evolution of cannibalism in Coccinellidae with life tables

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**Abstract**
We used life tables to model rates of population growth when egg cannibalism by specific life stages increases developmental rate and/or fecundity, using aphidophagous coccinellids as a model system. Sibling egg cannibalism was beneficial for population growth; a modest (10%) increase in developmental rate or fecundity was sufficient to favor cannibal over non-cannibal populations, provided the rate of cannibalism remained low. The highest rates of population growth occurred when cannibals received both developmental and fecundity benefits, the former being more beneficial than the latter. As cannibals increased in number, the costs to population growth rate eventually out-weighed the individual life history benefits, such that the proportion of cannibal individuals (or cannibalism rate) was limited in a frequency-dependent manner. Simulations of cannibalism by later stages (fourth instar larva or adults) often led to cannibals comprising more than 50% of the population, depending on the magnitude of individual benefits, as the costs of cannibalism (mortality) were shared by both cannibals and non-cannibals, in contrast to sibling egg cannibalism, in which cannibals alone bore the costs. We conclude that cannibalism can evolve in the absence of resource-limitation, as cannibals can easily invade non-cannibal populations when they gain life history benefits, although higher levels of cannibalism become self-limiting by the constraints they impose on population growth rate.

**Keywords:** Developmental rate, fecundity, *Hippodamia convergens*, intrinsic rate of increase, stage-specific cannibalism.

## Combining macrobial and microbial biological agents to control aphids in Integrated Pest Management strategies

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**Abstract**

Globally, around 25–40 % of yields are annually lost due to insect herbivory, and aphids are among the top most damaging pests. Because of the development of insect resistance and of the increasing ban of chemical pesticides, controlling aphids chemically is no longer possible and robust biological solutions are needed to face this threat. Yet, controlling aphids in a biological manner has been challenging due to the large diversity of species and ecologies of aphids, and often single-solution approach led to poor or failed control of the aphid population. In this presentation, we will present our proposed approach in combining different biological control agents, both macrobials (such as predators and parasitoids) and microbials (entomopathogenic fungi), to work together in a complementary or synergistic way to sustainably control aphid population. We will provide specific examples of successful integrated pest management strategies in protected greenhouse cultivations but also highlight the main challenges of implementing such strategies. Ultimately, we believe that the future of agriculture lays in the integration of different biological control agents in a systemic approach, and that more emphasis should be placed on combining fundamental knowledge of the biology of the different biological control agents and practical aspects of the grower's practices.

**Keywords**: biological control, complementary, entomopathogenic fungi, integration, predators, parasitoids.

**Specialist versus generalist predators – a review**

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**Abstract**
Predators, including aphidophagous, can be classified as monophagous, oligophagous, polyphagous, and omnivorous according to the width of the feeding niche. Predators can specialize to specific taxa of prey, but also to host plant of the prey, to habitat or to a functional trait of prey. We can distinguish essential food that enables the development and reproduction of the predator, and alternative, factitious, and artificial foods that contribute to the survival of predator and should not be included to the natural food niche. E.g., we reproduce both the generalist *Harmonia axyridis* and a conifer specialist *Harmonia quadripunctata* using frozen *Ephestia* eggs. Simple field observations of the presence of predators with prey, and laboratory choice experiments are not reliable marks of prey suitability / essentiality / specialization. E.g., we reproduce conifer specialist *Harmonia quadripunctata* on the pea aphid *Acyrthosiphon pisum* raised on faba beans (*Vicia faba*). Assessment of physiological suitability of prey can use diverse criteria such as larval developmental time (the better the food the shorter DT) and fresh adult body mass (the better the food the bigger BM). These two measures are combined in a suitability parameter SL=BM/DT for better resolution. Specialization can also include life history adaptations specific to a group of prey. In aphidophagous ladybirds, it includes large egg clusters and fast development. Food mixing need not be a mark of wide generalist, but it can be explained as the nutritional complementarity of several foods, by toxin dilution effect, and by avoidance of environmental risks connected with one prey type. Both specialists and generalists are effective as biocontrol agents, sometimes in synergy. Generalist predators are often combined with specialist parasitoids, parasites, and pathogens. Risk evaluation needed for release of a biocontrol agent favours specialists for their low non-target effects. Generalists more easily become an invasive species.

**Keywords**: Food ecology, Niche breadth, Predation, Food mixing, Prey choice, Euryphagous, Stenophagous, Searching.

**Quantification of toxicity of *Harmonia axyridis***

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**Abstract**
Like other ladybirds, *Harmonia axyridis* is protected by alkaloids against predators. Its alkaloid harmonine is also toxic to other non-target animals, and surprisingly also to many microorganisms. It is also a polymorphic species with many different color forms. In our study, we quantified the amount of harmonine using gas chromatography (GC) in adult ladybirds of nine color forms and for comparison in our original congeneric species *Harmonia quadripunctata*. In addition, we attempted to quantify the toxicity of the extract from different developmental stages and adults of different forms using a simple and inexpensive procedure using the reduction of germination of white mustard seeds. The harmonine content converted to mg fresh weight did not differ between the color forms of *H. axyridis*, nor in the species *H. quadripunctata*. Females have a higher concentration of the alkaloid than males. Concentration increases with the age of adults, with an increase especially between one and three months of age. The bioassay shows that the toxicity of the aqueous extract increases with the developmental stage and the age of the ladybirds and does not differ between the color forms. The agreement of the toxicity for seeds with the concentration measured by GC allows for a simple and inexpensive study of other factors affecting the toxicity of ladybirds, such as the influence of diapause, reproduction, and nutrition.

**Keywords**: poison, warning colouration, chemical defenee, polymorphism, sex.

**Bet-hedging and context-dependent maternal resource allocation via unhatched smaller eggs in the ladybird beetle *Harmonia axyridis***

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**Abstract**
Many aphidophagous ladybird beetles lay eggs in clusters, where sibling cannibalism occurs at hatching. Early hatchlings tend to cannibalize undeveloped eggs and developing eggs with delayed hatching. These cannibalized eggs—especially the undeveloped ones—represent a maternal investment for the cannibal and are regarded as 'functional trophic' eggs. Such eggs increase the survivorship of the cannibal hatchlings. However, the characteristics of the cannibalized eggs have been poorly investigated to date.
In this study, I examined egg size and the occurrence patterns of developing and undeveloped eggs in *Harmonia axyridis*. Developing eggs were significantly larger than undeveloped ones, and unhatched eggs were biased toward smaller sizes. Furthermore, egg hatchability was significantly affected by egg size, indicating maternal effects. These results suggest that relatively small undeveloped eggs function as a circumstance-dependent form of maternal investment, enhancing survival only for the early-hatched larvae within an egg cluster.

**Keywords**: egg size, sibling cannibalism, maternal investment, trophic eggs, *Harmonia axyridis.*

**Resource availability in apple orchards: Key for understanding parasitoid-pest interactions**

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**Abstract**
Parasitoid effectiveness in biological control depends not only on host availability, but also on access to essential nutritional resources. However, while agroecosystems often provide abundant hosts within the field plots, they typically lack complementary (e.g., plant-derived food sources: nectar, pollen, guttation or honeydew) and supplementary resources (e.g., alternative insect hosts) limiting the survival and efficacy of parasitoids. Therefore, increasing plant diversity using companion plants in and around fruit orchards is currently recommended to provide resources for parasitoids and to promote biological control of pests. Furthermore, companion plants can also serve as a bait for ants, attracting ants away from aphid colonies which allows parasitoids to control aphid populations more freely. We conducted two studies to evaluate resource availability on parasitoid-pest interactions. First, we evaluated the available food resources in apple orchards during the season and inferred the recent feeding patterns of *Aphelinus mali*, the main parasitoid of the aphid *Eriosoma lanigerum*, under field conditions based on body carbohydrate profiles and protein, lipid and glycogen content. Biochemical profiles from laboratory-reared parasitoids exposed to a controlled diet were used to train a machine learning algorithm that classified the individuals collected in the field into the different diet categories defined in the laboratory. Secondly, we assessed the effects of ant exclusion and of providing faba bean companion plants in apple orchards on the biological control of the aphid *Dysaphis plantaginea.* Together, these studies demonstrate the importance of food resource availability in the performance of parasitoids as biological control agents in apple orchards.

**Keywords**: *Aphelinus mali*, *Eriosoma lanigerum*, *Dysaphis plantaginea*, ants, faba beans, haemolymph.

**Biocontrol or bio-oops: lethal and sublethal effects of surfactin on crop pest and crop auxiliaries.**

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**Abstract**
Stakeholders from the France-Wallonia-Flanders cross-border region, a major production area for field crops, market gardening and orchards, needs to respond to the growing demand for food production while reducing the use of chemical pesticides in favour of biological control. However, climate change is altering the tritrophic interactions between plants, crop pests and their natural enemies, as well as the effectiveness of biomolecules, thereby limiting the success of more sustainable pest management strategies. Lipopeptides, extracted from the Bacillus genus, are promising biomolecules for controlling crop pests because one of their families, the surfactins, has insecticidal properties. However, very little information is available on the lethal and sublethal non-target effects of these lipopeptides on the pests' natural enemies and therefore on their ability to be used simultaneously as biological control agents. This study therefore aims to investigate the lethal and sublethal effects of surfactin on pests and their natural enemies. We chose to work with the cereal aphid *Sitobion avenae* and two of its natural enemies: the seven-spotted ladybird *Coccinella septempunctata*, an aphid predator, and the parasitic wasp *Aphidius ervi*. The effects of surfactin on mortality were investigated by topically exposing the different developmental instars of the three species to different concentrations of surfactin under two climate change scenarios based on IPCC predictions. Next, the sublethal effects of surfactin on fecundity and offspring were assessed for all three species. It is expected that surfactin is not specific to pests and that it will have the same impact on crop auxiliaries, and that these lethal and sublethal effects will be accentuated at higher temperatures.

**Keywords**: natural enemies, aphids, biological control, global changes, ladybug, parasitic wasp.

**Influence of local and landscape characteristics on the alfalfa aphids and their main natural enemies: the spring season**

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**Abstract**
Aphids are among the most common herbivores feeding on alfalfa, with *Acyrthosiphon pisum* Harris being the dominant species in the spring. This aphid plays a key role in alfalfa food webs due to its high abundances and extended presence in the crop. To gain a broader understanding of pest-natural enemy dynamics, we investigated how local factors, and the composition and configuration of the surrounding landscape influence the abundance of *A. pisum*, its primary natural enemies, and parasitism rates during the first two alfalfa intercuts, covering the period from March to June. We sampled 42 commercial alfalfa fields across the Ebro Basin, Spain, over a 3-year period, recording field characteristics and landscape structure at buffer distances of 250, 500, and 1000 m from the center of each field. The role of alfalfa as a reservoir for natural enemies was confirmed, with spiders, aphid parasitoids, lady beetles, and hoverflies being the most prevalent species in the spring. Overall, aphid natural enemy populations were higher in the second intercut compared to the first. Our findings revealed that field characteristics and landscape composition, rather than configuration, significantly affected natural enemy abundances and *A. pisum* parasitism rates. Among the local variables, prey abundance within the field was the primary driver of natural enemy populations, while parasitism rates were positively influenced by the abundance of the parasitoid *Aphidius ervi* Haliday. In terms of landscape variables, winter cereals and natural/seminatural habitats were the key cover types influencing natural enemy populations and parasitism rates. These results enhance our understanding of aphid-natural enemy dynamics in agroecosystems.

**Keywords:** Landscape composition, landscape configuration, *Acyrthosiphon pisum*, Coccinellidae, Syrphidae, Araneae, Aphidiinae, parasitism rate.

**Trophic transfer of fipronil and its effects on *Cucurbita pepo* L., *Aphis gossypii*, and the parasitoid *Aphidius colemani***

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**Abstract**
The increasing reuse of treated wastewater in agriculture has raised concerns about the environmental fate and trophic transfer of contaminants such as persistent insecticides. This study investigated the effects of environmentally relevant doses of fipronil applied via irrigation, on zucchini plants (*Cucurbita pepo L.),* their primary herbivore *Aphis gossypii,* and the parasitoid *Aphidius colemani*. We applied fipronil via irrigation (10μg/L) under controlled conditions and its accumulation in plant tissues. The aphids were then placed on fipronil-contaminated planys and allowed to grow and reproduce. The second generation of aphids, which were reared on contaminated plants, were then exposed to the parasitoids. The survival, development and reproductive performance of aphids reared on fipronil-contaminated plants were then compared to those of the control group. At the third trophic level, *A. colemani* was introduced to fipronil-exposed aphid populations to investigate the potential effects on parasitoid fitness and reproductive traits. Traces of fipronil were found in the zucchini leaves after cumulative exposure. A decrease in nymph-to-adult survival and reduction in the fecundity of *A. gossypii* feeding on contaminated host plants was observed. The altered physiological condition of contaminated hosts also affected parasitoids life history traits. The results of the present study highlight concerns about the indirect effects of residual insecticide contamination on multitrophic interactions at environmental concentrations. By analyzing potential shifts in the performance of beneficial insects, the study will contribute to more informed and ecologically sound risk assessments for the use of non conventional water in sustainable agricultural systems.

**Keywords**: Indirect pesticide exposure, Tri-trophic interactions, Parasitoid performance, Aphididae, Braconidae.

**Sexual communication in coccinellids: mechanisms, triggers, and evolutionary conservation**

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**Abstract**
The first sex pheromone ever identified in a lady beetle was recently discovered in the Asian lady beetle *Harmonia axyridis* (Coleoptera: Coccinellidae). Females display a stereotyped calling behavior that results in the release of a volatile blend -mainly composed of five terpenoid compounds- which attracts males and triggers copulation, but only in the presence of aphid prey. Although similar behaviors have been observed in other coccinellid species, pheromonal communication in closely related taxa remains poorly studied. Moreover, the precise olfactory cues triggering pheromone production in *H. axyridis*, as well as the potential influence of larval diet quantity and quality, remain unknown.
This study, which is an integral part of Anaïs Sion's PhD thesis, aims to (1) identify the olfactory cues that trigger sex pheromone production; (2) evaluate the impact of larval diet on adult pheromone output; (3) explore the conservation of sex pheromones across phylogenetically related species.
Using dynamic sampling of volatile organic compounds (VOCs) further analyzed by gas chromatography (TD-GC-MS-FID), we first demonstrate that exposure to aphid-emitted VOCs alone is sufficient to trigger sex pheromone production in *H. axyridis*. To identify specific cues that trigger pheromone emission, we exposed ladybeetles to aphid alarm pheromone or aphid honeydew, but no significant difference in pheromone production was found between the two, due to large variations within each modality. Additionally, larval diet quality and quantity had no significant effect on adult pheromone production, highlighting the pivotal role of some aphid-derived cues during adulthood.
In *H. quadripunctata*, we identified three female-specific compounds—β-caryophyllene, β-elemene, and α-humulene—also present in *H. axyridis*, suggesting a conserved communication mechanism. Further behavioral assays and analyses are needed to confirm their functional role. This study contributes to our understanding of sexual communication in coccinellids, specifically in *H. axyridis* and may inform future phylogenetic analyses within this family.

**Keywords:** Semiochemicals, mate recognition, prey-induced signaling, olfactory plasticity, insect chemical ecology, comparative pheromone analysis.

**Habitat preference and intraguild predation of the 5-spot ladybird, *Coccinella quinquepunctata***

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**Abstract**
The 5-spot ladybird, *Coccinella quinquepunctata*, is a relatively scarce Palaearctic species. In western Europe it appears to occupy river shingle, but to broaden its preferences to other pioneer habitats when the climate is cooler and damper. It typically co-occurs with two other ladybirds, the native *Coccinella septempunctata* (7-spot) and the invasive *Harmonia axyridis* (Asian ladybeetle), and has been observed in the field to be the intraguild prey of both. This community represents an ideal opportunity to examine how intraguild predation may operate in a three-way intraguild interaction. Laboratory tests suggest that intraguild predation of *C. quinquepunctata* by both species combined is not simply the sum of their individual effects, because *H. axyridis* suppresses intraguild predation by *C. septempunctata*.

**Keywords**: community ecology, conservation, habitat specialization, intraguild predation, invasive species.

**Abundance of aphid natural enemies on flowering service plants is associated with aphid prey and floral resources**

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**Abstract**
Natural enemies of agricultural pests are dependent on alternative prey and floral food resources that may be scarce in intensively managed agricultural landscapes. Introduction of flowering service plants may provide food resources, but context-specific information on plant species and associated plant traits attractive and supportive to natural enemies is often lacking. Here, we assessed aphid natural enemies on 39 native and non-native service plant species in a replicated field experiment in Korla, Xinjiang, China, in 2020 and 2021. The natural enemy communities and aphid abundance on these plants were assessed using visual counts and sweepnetting. Flowering period, corolla type, and presence of extrafloral nectar on the plants were assessed as possible predictors for attractiveness to natural enemies. *Gossypium hirsutum*, *Melilotus officinalis*, *Medicago sativa*, *Anethum graveolens*, and *Foeniculum vulgare* were associated with relatively high natural enemy abundances, but *G. hirsutum*, *M. officinalis* and *M. sativa* also hosted cotton or cowpea aphids. Parasitoids, predatory bugs and ladybeetles showed positive responses to aphid densities on plants. Ladybeetle adults showed consistent positive responses to extrafloral nectar, open corollas and flowering across two years, while for other natural enemies this was only found in one out of two years. Our findings indicate that besides the provision of floral resources, aphid prey on service plants is an important characteristic that influences the attractivity of service plants to natural enemies. Service plants that host aphids that do not infest crops can be useful for habitat management programs aiming to conserve and augment natural enemies.

**Keywords**: functional plants, alternative prey, nectar accessibility, flowering period.

**A historical consideration of the aphid parasitoid work of Maud Doria Haviland**

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**Abstract**
Our science today rests on a foundation of what came before us, though these contributions sometimes go unrecognized. The accomplishments of female scientists, in particular, have a tendency to fade from memory. Aphid parasitoids were, as far as we know, first recorded in 1679 by Maria Sibylla Merian in her book, *Der Raupen wunderbare Verwandelung und sonderbare Blumen-Nahrung*, 16 years before Anton van Leeuwenhoek published his aphid dissections, equally amazing for the time. 250 years after Merian's pioneering entomological work, Maud Doria Haviland conducted equally groundbreaking accounts of hymenopteran parasitoid biology. This talk is a historical consideration of the life and science of Maud Haviland, an early 20th century British entomologist and ornithologist at the University of Cambridge. It is based on original biographical research and literature review by the authors. Haviland's accomplishments include a body of work on aphid parasitoids, featuring highly detailed and extremely accurate figures of many aspects of parasitoid development and anatomy, which bring to mind the painstaking anatomical studies of the great German invertebrate anatomists of the 19th and early 20th centuries. Haviland's descriptions and illustrations have stood the test of time and the rigors of scientific assessment, and are prime for new recognition. Haviland was also an adventurer who participated in biological expeditions to Siberia and British Guiana, and served as a French Red Cross ambulance driver in World War I. In an era when barriers for women in science were high, Haviland's accomplishments stand out on their own merit, but also as an example of the contributions of women to the early development of modern entomology.

**Keywords**: history of science, parasitoid biology.

**Ladybeetle dispersal from adjacent wheat or maize fields into cotton enhances biological control of cotton aphid**

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**Abstract**
*Context* Cotton is a key crop in Xinjiang, where pest control heavily relies on pesticides. Enhancing biological control through natural enemies offers potential to reduce the use of pesticides, but little is known about the seasonal sink-source dynamics of natural enemies.
*Objectives* Over two years, we studied the movement of adult ladybeetles between cotton and adjacent wheat or maize fields using transparent sticky cards, with movement from adjacent cotton fields serving as a reference. We monitored aphid and ladybeetle densities and assessed predation activity using cotton bollworm egg cards in cotton fields bordered by cotton, wheat, or maize fields.
*Results* More ladybeetles moved from wheat (37%) and maize (23%) into cotton than the reverse, indicating a net spillover from cereal crops. Adjacent wheat or maize crops enabled earlier ladybeetle migration into cotton, resulting in higher early-season ladybeetle densities, enhanced aphid control, and slower population growth of cotton aphid. Adjacent wheat or maize crops altered the ladybeetle species composition in cotton.
*Conclusions* Wheat and maize fields functioned as early-season sources of ladybeetles for adjacent cotton fields under realistic farming conditions. This increased natural enemy abundance, improved biological control, and reduced aphid densities in cotton. The findings suggest that interspersing wheat and maize fields among cotton fields would enhance natural regulation of cotton pests in Xinjiang.

**Keywords**: sink-source dynamics, landscape, *Gossypium hirsutum*, *Aphis gossypii, Hippodamia variegata, Propylea quatuordecimpunctata.*

**Further development of sampling plans for aphid natural enemies in grain sorghum**

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**Abstract**
Traditional IPM sampling plans are primarily based on the spatial distributions of pests alone. However, relatively few sampling plans integrate natural enemy and pest density estimates for management decisions. Based on published studies, at critical densities/ratios, a combination of parasitoids and predators reliably prevents Sorghum Aphid (*Melanaphis sorghi*) from reaching economic injury levels in sorghum fields. Yet, no such integrated sampling plans exist for this crop. Even though sampling techniques have been evaluated for their accuracy and precision in estimating natural enemy densities, sampling plans with appropriate sample size requirements have not been developed. Seasonal sampling data from three states (Kansas, Oklahoma, and Texas) over six years (2017-2019 and 2021-2023 with 900+ individual sampling events) was used to create enumerative sequential sampling plans for natural enemy groups (parasitoids, predators, and all natural enemies) at fixed precision levels of 0.1 and 0.25. Nested ANOVA were utilized to determine variation in natural enemy counts among strata, and Taylors Power Law regressions were used to calculate aggregation indices. Approximately 80% of the variance in counts for all NEs occurred at the same spatial scale as aphid pests in sorghum; therefore, sampling schemes can overlap. According to TPL regression analyses, each calculated aggregation index was lower than that of SCA. Average sample size requirements for all NE groupings are lower or relatively similar to those of SCA at low densities, which are common in most fields, as sample size requirements become prohibitive for IPM decision making. Additional analyses indicate that presence-absence and/or ratio-based (natural enemies to pests) sampling procedures for NE and SCA look promising.

**Keywords**: predator, parasitoid, biological control, *Melanaphis sorghi*, IPM, sampling protocol.

**Ecologically Based Management of Cotton Aphid in China**

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**Abstract**
The cotton aphid, *Aphis gossypii*, also known as the melon aphid, is a highly polyphagous pest worldwide. In China, it is a major cotton pest with two biotypes: the seedling aphid, active in May and June, and the summer aphid, which causes severe damage during summer. Historically, Chinese cotton growers relied heavily on broad-spectrum insecticides for aphid control, however, the rapid development of insecticide resistance and the detrimental effects on natural enemies led to aphid resurgence. To address this issue, extensive ecologically based work has been conducted in China, including agronomic practices to enhance plant resistance, intercropping, habitat management and precision pesticide application to conserve natural enemies. These approaches have also continually evolved alongside agricultural mechanization and changes in cropping systems. Initial ecological strategies, including wheat-cotton intercropping and alfalfa field margins, effectively suppressed seedling aphid populations. However, broad-spectrum insecticide applications against lepidopteran pests (e.g., *Helicoverpa armigera*) during summer disrupted this biological control by eliminating natural enemies migrating from these habitats, ultimately triggering summer aphid outbreaks. The widespread adoption of Bt cotton has effectively controlled target lepidopteran pests and reduced (broad-spectrum) insecticide usage in cotton fields, conserving natural enemies and mitigating summer aphid infestations. Recent landscape-level studies revealed that both field management and regional landscape characteristics influence aphid dynamics. Modern strategies were developed to preserve inter-field non-crop habitats for natural enemy colonization, satellite and drone remote sensing enabled precise aphid monitoring and spraying within cotton fields to minimize negative effects on natural enemies. China's evolving cotton aphid management provides valuable insights into the experiences and lessons of ecologically based pest management worldwide, illustrating how systems thinking can effectively control pests and promote ecological agricultural intensification.

**Keywords**: *Aphis gossypii*, agroecological crop protection, habitat management, landscape, precision management, systems thinking.

# POSTERS

**Climate change triggers parasitoid summer diapause directly and indirectly via trophic cascades**

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**Abstract**
The increase in thermal fluctuations and extreme events related to climate change can induce modifications in life history strategies in ectotherms. Summer diapause is known to allow ectotherms to survive hot and dry periods and is triggered by a combination of biotic (resource depletion, increased competition) and abiotic (rising temperatures and photoperiod) factors. However, it is unknown if this strategy could be promoted by climate change and how biotic and climatic factors interact to affect it, especially in natural conditions. We examined this, first through a laboratory experiment and second by a two-year field survey using cereal aphid parasitoids, Aphidius spp., as model system. We tested whether the exposure to host competition during female oviposition under simulated warming and heat stress can increase diapause incidence in parasitoid progeny. We found that rising mean temperatures increased diapause incidence, while greater heat stress reduced it. We further monitored aphids, parasitoids and hyperparasitoids in cereal fields along an unprecedent longitudinal gradient from western France to the Czech Republic (1200km), during the springs of 2022 and 2023. We found that diapause rates directly increased with the duration of heat waves and with lower precipitation. In addition, we highlighted that the frequency of heat waves indirectly increased parasitoid diapause by increasing aphid resource scarcity. Our study provides the first evidence in nature that summer diapause is induced by both current climate change indicators and trophic cascades. While this suggests that ectotherms could, at least temporarily, resist to warming and heat waves by using such strategy, this response may still become insufficient to cope with increasingly frequent and more stressful climatic events, and could have consequences for biocontrol in a more volatile and extreme future climate.

**Keywords**: aestivation, geographic gradient, global warming, parasitic wasps, thermal fluctuations, trophic interactions.

# Temperature-dependent performance of mirid predators for aphid biocontrol in sweet peppers

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**Abstract**
Biological control is a cornerstone of integrated pest management in horticultural crops, particularly under greenhouse conditions. In this context, zoophytophagous mirids such as *Nesidiocoris tenuis*, *Macrolophus pygmaeus*, and *Dicyphus bolivari* have proven effective against key pests like *Tuta absoluta* and *Bemisia tabaci*. However, their use against aphids, specifically *Myzus persicae* nicotianae, remains limited, despite increasing evidence pointing to their potential as effective biological control agents for this group. Temperature is one of the main abiotic factors influencing the performance of natural enemies, affecting key biological processes such as development, fecundity, prey consumption, and survival. Understanding how different mirid species respond to varying thermal regimes is therefore essential to determine their suitability under specific climate conditions, especially in protected cropping systems where temperature can be managed or predicted. This study investigates how three constant temperatures (18 °C, 24 °C, and 30 °C) influence the performance of *N. tenuis*, *M. pygmaeus*, and *D. bolivari* as predators of *M. persicae* nicotianae on sweet pepper. Our results reveal temperature-dependent responses: *N. tenuis* doubled its prey consumption rate and achieved the highest intrinsic rate of increase ($r_m$) at 30 °C compared to lower temperatures, while *M. pygmaeus* and *D. bolivari* failed to complete development at 30 °C and showed decreased $r_m$ values as temperature increased. Conversely, at moderate temperatures (18–24 °C), *M. pygmaeus* and *D. bolivari* displayed higher reproductive rates and survival than *N. tenuis*. These findings offer clear guidance for the temperature-based selection of mirid species: *N. tenuis* is better suited for warm climates or summer cropping, while *M. pygmaeus* and *D. bolivari* are more effective under cooler conditions.

**Keywords**: *Myzus persicae* nicotianae; *Nesidiocoris tenuis*; *Macrolophus pygmaeus*; *Dicyphus bolivari*; biological control.

**Role of *Coccinella septempunctata* as a predator of the alfalfa weevil, *Hypera postica*, by molecular gut content analysis**

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**Abstract**
This study evaluates, using molecular detection, whether *Coccinella septempunctata* L. consumes *Hypera postica* Gyllenhal, in laboratory and field conditions. Species-specific primers to the COI gene of *H. postica* were established and validated for high specificity and sensitivity. To estimate the detectability window of *H. postica* DNA within predators' guts, adults and fourth instar larvae of *C. septempunctata* were fed with alfalfa weevil larvae under laboratory conditions. Gut content samples were taken at several time points over a 24-hour period. Gut analysis revealed mean detectability of DNA by 15.37 hours in larvae and 19.05 hours in adults of *C. septempunctata*. Field-collected *C. septempunctata* larvae and adult individuals from eight alfalfa plots in the Ebro area were also positive for *H. postica* DNA, confirming natural predation. Fields differed in aphid density, potentially impacting predator foraging behaviour. In low aphid density fields, there were high proportion of positive detections for both adults (82–100%) and larvae (86–100%). On the other hand, the fields with medium infestation of aphids were characterized by lower detection, particularly on larvae (13–45%). Remarkably, in the fields where aphid pressure was the highest (>80%), only 33% of the adults and 13% of larvae tested were positive for *H. postica*. These results confirm a prey-switching behaviour with increased *H. postica* predation under low availability of aphids, confirming the ecological role of *C. septempunctata* as a facultative predator of the alfalfa weevil.

**Keywords:** Seven spot lady beetle; alfalfa weevil; alfalfa; predation; molecular detection.

**Development of strategies for early season promotion of aphidophagous natural enemies to increase biocontrol in field vegetables**

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**Abstract**
Natural enemies of aphids often appear too late in the season due to lower temperatures and delayed migration from aphid winter hosts, so that aphid pests may have already caused considerable damage to the crops by this time. In order to attract and permanently establish natural enemies in the crop, an alternative host or prey together with a specific beneficial insect established on a non-crop plant in the so-called banker plant system (open rearing system) is a possibility to increase the biocontrol potential in the field. However, this system is also strongly subject to climatic conditions, so that population build-up of aphids and subsequent natural enemies can be negatively affected, especially in spring. Therefore, our study investigated the influence of crop protection nets as a cover for *Rumex* spp. banker plants on temperature and population development of the aphid species *Aphis fabae* Scopoli and *A. rumicis* Linnaeus (Hemiptera: Aphididae). *Rumex sanguineus* banker plants and aphids were established in April (*A. fabae*) and May (*A. rumicis*) 2025 on plots without (control) and with two different crop protection covers, i.e. 19 g/m$^2$ and 23 g/m$^2$. Temperature and aphid population development was monitored over a period of two weeks in each case. After removal of the crop protection cover colonisation of banker plants by natural enemies was recorded for additional two weeks. Moreover aphid parasitism was investigated on both banker plant systems in the lab to get a first idea about the potential reproduction rates of the parasitoid species *Lysiphlebus fabarum* and *L. testaceipes* (Hymenoptera: Aphidiinae). Our study will contribute to a targeted establishment of parasitoids and attraction of aphidophagous beneficials early in the season and thus most likely enables an early and more effective aphid control in the field. The project 'Nützlingszelte' is funded by the European Agricultural Fund for Rural Development (EAFRD) as part of the European Innovation Partnership (EIP Agri) Schleswig-Holstein.

**Keywords:** alternative host, open rearing system, *Aphis rumicis*, *Aphis fabae, Lysiphlebus* spp., crop protection net.

**Influence of refuge availability on the oviposition strategy of anachroetic and non-anachroetic aphidophagous ladybirds**

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**Abstract**

*Scymnus nubilus* Mulsant and *Coccinella undecimpunctata* L. (Coleoptera: Coccinellidae) are two generalist aphidophagous predators abundant in herbaceous habitats. *Coccinella undecimpuctata*, a larger species, lays its eggs in uncovered clusters, whereas *S. nubilus*, a tiny species, lays its eggs singly and, possibly, in concealed sites. Reproductive strategies in ladybirds seem to be adaptive, allowing the co-occurrence of both predators, apparently without interfering with each other. The aim of this study was to characterize the following oviposition strategies in *S. nubilus* and *C. undecimpunctata*: daily fecundity, effect of available sites on females' fecundity, and circadian rhythmicity of oviposition. We hypothesize that the single-egg-laying strategist (i) is more dependent on the availability of concealed sites to oviposit and (ii) lays eggs closer to aphid colonies. We found that different levels of site concealability allows *S. nubilus* to increase fecundity. Contrary to *C. undecimpunctata*, in the absence of a suitable substrate to conceal its eggs, *S. nubilus* females refrain oviposition. *Scymnus nubilus* prefers to hide their eggs beneath prey carcasses while *C. undecimpunctata* is less selective concerning the oviposition sites. *Scymnus nubilus* dilutes its fecundity effort through more oviposition sites and events, while *C. undecimpunctata* requires one event to lay its clusters. Our results showed that the smaller ladybird is more dependent than the larger one on habitat structural complexity to maximize its fitness and that laying a single hidden egg mainly during the scotophase confers a potential adaptive advantage to increase fitness.

**Keywords:** Oviposition strategy, single egg-laying, cluster egg-laying, circadian rhythmicity of oviposition, Coleoptera, Coccinellidae.

**Development and reproductive investment of anachoretic and non-anachoretic aphidophagous ladybirds**

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**Abstract**
Insect eggs are exposed to many threats before eclosion and thus, egg-laying oviposition strategies are key to protecting the development of new-born larvae. Oviposition strategy of the anachoretic (concealed - single egg laying) *Scymnus nubilus* (Mulsant) differs non-anachoretic (exposed - cluster egg laying) *Coccinella undecimpunctata* (L.) (Coleoptera: Coccinellidae). *Scymnus nubilus* prefers to conceal its eggs in individual hidden places. *Scymnus nubilus* conceal its eggs beneath aphid carcasses, while *C. undecimpunctata* was less selective regarding oviposition sites. *Scymnus nubilus* diluted oviposition efforts through more oviposition sites and events, especially during scotophase, while *C. undecimpunctata* required one single event to lay its clusters. Therefore, the investment allocated to reproduction, induced by different reproductive strategies, may have implications for other life history parameters, including larval development. This study aims to contrast the development and reproductive investments of both Coccinellidae. What was found was that all stages were shorter in the anachoretic *S. nubilus* except the pupal stage, which didn't show differences, and the embryogenesis, which was longer. The reproductive investment was proportionally higher in *S. nubilus*, laying nearly three times heavier eggs and two and a half times more eggs daily than the number of ovarioles contained. This could suggest that laying proportionally larger and numerous eggs, individually hidden and with longer embryogenesis, could increase the probability of survival of neonatal larvae of *S. nubilus* that are more vulnerable to adversities. This may be an evolutionary strategy to enhance the offspring survival by providing a suitable number of eggs in the best conditions.

**Keywords**: Oviposition strategies, *Coccinella undecimpunctata*, *Scymnus nubilus*, Life-cycle traits, Reproductive investment.

**Contrasting structure of insular and continental prey-predator trophic networks from the Azores and mainland Portugal**

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**Abstract**
The colonization of oceanic islands and the evolution of species interactions remains a widely studied and debated topic within the scientific community. The study of ecological networks has partly allowed to understand how evolution may have unfolded in certain areas, depending on the organisms present. Nevertheless, significant knowledge gaps remain concerning coastal grassland ecosystems. In this study, a comparative analysis of bipartite trophic networks was conducted in coastal grassland systems belonging to distinct regions: the Azores and mainland Portugal. The main aim was to assess and characterize potential differences in network structure and composition between these locations, thereby contributing to a deeper understanding of the ecological dynamics and evolutionary implications associated with island versus mainland grassland communities. Over the course of four months, trophic interactions between plants, aphids, ladybeetles and ants were observed in the Azores (São Miguel Island) and mainland Portugal (Setúbal Peninsula and Sines region). For each network (plants-aphids, aphids-ladybeetles and aphids-ants), the following metrics were calculated: Degree, Normalized degree, Species strength, and Specialization (*d*'). Additionally, a correlation analysis was carried out between the number of interaction types and environmental variables (temperature, humidity, and altitude) for each region. We found a higher number of interactions in the Azores compared to the mainland. However, no significant differences were found in the calculated metrics between the two regions, except for *specialization* in the plants-aphids bipartite network, which was higher on the mainland than in the Azores. At the same time, no strong correlations were found between humidity, temperature, or elevation values and the number of interactions.

**Keywords:** Aphids, Aphidoidea, coastal grasslands, Coccinellidae, community assembly rules, ladybeetles, specialization, trophic networks.