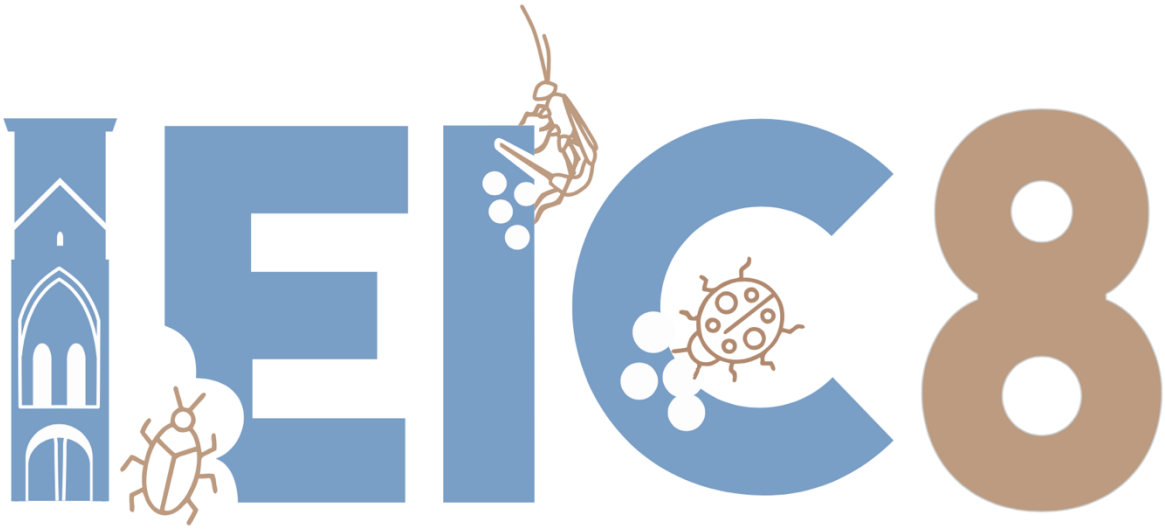
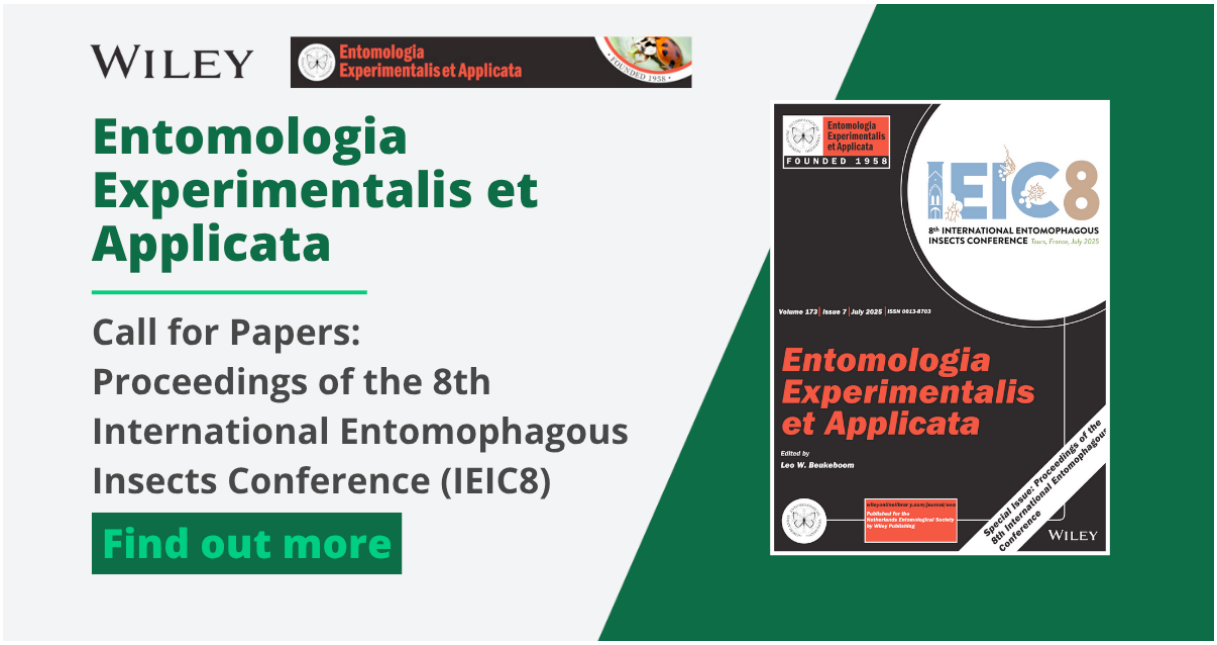


8th INTERNATIONAL ENTOMOPHAGOUS INSECTS CONFERENCE *Tours, France, July 2025*

Abstract Book



Entomologia Experimentalis et Applicata will publish the **proceedings of IEIC8 as a special issue of the journal**, as has been the case for previous IEIC meetings.

The submitted manuscripts will be subjected to the journal's standard reviewing procedures. The organizers of IEIC will act as guest editors for this special issue. All contributions accepted for publication will become freely available on the EEA website for a limited time. Invited keynote speakers and presenters of oral communications and posters are invited to submit their review-type, full research papers or technical notes. Preparation of manuscripts should follow the guidelines of *Entomologia Experimentalis et Applicata* as set out in the Author Guidelines.

Authors may submit the manuscript before or shortly after the symposium, but please note the deadline: manuscripts must be submitted at the latest by **31 August 2025.**

For any questions you can contact the Editor-in-Chief Leo Beukeboom at l.w.beukeboom@rug.nl or at the meeting

Tuesday, July 1st

8:30 am	Registration (Doubinsky amphitheater, Tanneurs building, University of Tours)
9:00 am	Welcome & Introduction (Organizers)
	Keynote speaker
9:15 am	Honeydew as food source for parasitoids in agroecosystems [*Alejandro Tena Barreda, p. 8*]
	Session « Behavioural ecology »
10:00 am	Comparison of life-history traits in six egg parasitoid species of the genus *Trichogramma* [*Véronique Martel, p. 9*]
10:15 am	Host location by hyperparasitoids [*Erik Poelman, p. 10*]
10:30 am	**Coffee break (Hall)**
11:15 am	Optimal host plant selection by caterpillars may not be optimal: Performance of *Chelonus insularis* is enhanced by fall armyworm's preference for caterpillar-susceptible maize [*Julio S. Bernal, p . 11*]
11:30 am	Influence of thermal history on contest outcome and aggressiveness of competing parasitoids [*Mathieu Bussy, p. 12*]
11:45 am	The slaughter of the innocents: male killing in quasi-social parasitoids with unusually female biased sex ratios [*Ian Hardy, p. 13*]
12:00 am	Kin recognition and inbreeding avoidance in *Venturia canescens*: behavioral and transcriptomic insights [*Maxime Verdier, p. 14*]
12:15 pm	**Lunch (Hall)**
	Session « Chemical Ecology »
2:00 pm	The dose makes the poison: hormesis and herbivore immunity against parasitoids [*Paul Ode, p. 15*]
2:15 pm	Sublethal effects of insecticides on pheromone communication and host finding in parasitoids [*Joachim Ruther, p. 16*]
2:30 pm	Host-recognition response of the parasitoid *Cotesia typhae* to oral secretion enzymes of its host, the Mediterranean corn borer [*Taiadjana Fortuna, p. 17*]
2:45 pm	Below and above-ground infestation effects on the olfactory responses of Trichogramma achaeae to Tuta absoluta-infested tomato plants [*Savvina Toufexi, p. 18*]
3:00 pm	Effects of microbe-induced tomato volatiles on the behaviour of natural enemies of greenhouse pests [*Michele Ricupero, p. 19*]
3:15 pm	Which companion plant intercropped in a young apple orchard could affect aphid population and/or natural enemies? [*Louna Rizzi, p. 20*]
3:30 pm	**Coffee break (Hall)**
4:00 pm	*Trichoderma harzianum* modulates indirect defenses on tomato against herbivore stink bugs [*Stefano Colazza, p. 21*]
4:15 pm	Flower strips and synthetic volatiles and its effect on aphid natural enemies' populations in Mediterranean apple orchards [*Judith Arno, p. 22*]
	Session « Systematics & Biodiversity »
4:30 pm	Untangling a cryptic species complex of *Cephalonomia* spp. (Hymenoptera: Bethylidae) associated with coffee berry borer and other Scolytinae (Coleoptera: Curculionidae) in Hawaii [*Tara Gariepy, p. 23*]
4:45 pm	Concealed world of tiny forest spirits: biology, taxonomic issues and Afrotropical diversity of the genus *Omphale* (Hymenoptera: Chalcidoidea, Eulophidae) [*Alex Gumovsky, p. 24*]
5:00 pm	What do we know about Darwin wasps (Ichneumonidae, Hymenoptera) distribution in Ecuador through entomological collections? [*Marina Mazon, p. 25*]
	Sponsor
5:15 pm	**Biological control in livestock: underused tools for emerging needs** [*Damien Morel -Bestico*]
5:45 pm	**Poster session & Cocktail**

Wednesday, July 2

Keynote speaker	
9:00 am	Biological control in large-scale open-field systems [*Lessandro Gontijo, p. 26*]
Session « Biological control & IPM »	
9:45 am	Parasitoids that are cryptically effective and ineffective biological control agents: distinguishing between 'dark horses' and 'paper tigers' [*Paul K. Abram, p. 27*]
10:00 am	Host selection behaviour and specificity of *Anagyrus fusciventris* (Hymenoptera: Encyrtidae) on three mealybugs present in Spanish persimmon orchards [*Emanuele Porcu, p. 29*]
10:15 am	A theoretical framework 3MP to improve the adoption of "green" IPM tactics while considering broad environmental benefits [*Peng Han, p. 30*]
10:30 am	**Coffee break (Hall)**
11:00 am	Getting a visa for an exotic biological control agent [*Laure Kaiser, p. 31*]
11:15 am	Dipteran parasitoids as biocontrol agents [*Maria Luisa Dindo, p. 32*]
11:30 am	Ant-mediated pest control with cover crops in citrus agroecosystems [*Maite Fernandez de Bobadilla, p. 33*]
11:45 am	Insights on the evolution of endogenous viruses involved in parasitism success provided by *Toxoneuron nigriceps* (Braconidae, Cardiochilinae) genome [*Eugène Maurey, p. 34*]
12:00 pm	How overwintering affects the reproduction of two egg parasitoids of *Halyomorpha halys* in France and Italy [*Guillaume Martel, p. 35*]
12:15 pm	Potential of Nabis provencalis Remane (Hemiptera: Nabidae) as a predator of the alfalfa weevil, Hypera postica Gyllenhal (Coleoptera: Curculionidae) [*Roberto Meseguer Rosagro, p. 36*]
12:30 pm	**Lunch (Hall)**
Session « Behavioural ecology »	
2:00 pm	Does the natal fly host species affect host preference and parasitization efficiency of pupal filth fly parasitoids? [*Leo Beukeboom, p. 37*]
2:15 pm	Getting to the heart of the matter: How does lettuce plant architecture affect aphid predator foraging behaviour? [*Jessica Fraser, p. 38*]
2:30 pm	Olfactory responses of *Ganaspis kimorum* and *Leptopilina japonica* (Hymenoptera: Figitidae) to host-associated chemical cues [*Francesco Tortorici, p. 39*]
2:45 pm	Fruit domestication impacts oviposition preference and performance of a parasitoid wasp [*Cesar Rodriguez-Saona, p. 40*]
3:00 pm	Complex interactions in host-selection: decoding behaviour in *Sclerodermus cereicollis* for effective pest control [*Serena Malabusini, p. 41*]
3:15 pm	Modulating trophic interactions among natural enemies of Tuta absoluta in tomato crops using artificial sugary diets [*Pablo Urbaneja, p. 42*]
3:30 pm	**Coffee break (Hall)**
4:15 pm	Foraging at night under artificial light: impacts on senescence and lifetime reproductive success for a diurnal insect [*Emmanuel Desouhant, p. 43*]
4:30 pm	Convergence in symbiont-induced plant-mediated responses to herbivory: cascading effects for foraging parasitoids [*Antonino Cusumano, p. 44*]
4:45 pm	Experimental evaluation of the voracity and predation behavior of a set of natural enemies of pests in Clementine orchards [*Judith Le Nan, p. 45*]
5:00 pm	Effects of defensive symbionts on aphid natural enemies: Mechanisms and Behaviour [*Maximilien Adam, p. 46*]
5:15 pm	The plant-mediated effect of *Cotesia glomerata* parasitism and symbionts on parasitoid recruitment [*Sarah Kalisvaart, p. 47*]
	Public conference (town hall, in french)
6:30 pm	Friends and enemies associated for sustainable control of pests [*Laure Kaiser*]

Thrusday, July 3

Keynote speaker	
9:00 am	Effect of global warming on Drosophila-parasitoid communities [*Mélanie Thierry, p. 48*]
Session « Global Changes »	
9:45 am	Global warming and copper pollution: a deadly trap for pest natural enemies in vineyards [*William Nusillard, p. 49*]
10:00 am	Sublethal pesticide exposure in non-target terrestrial ecosystems: disruptions in trophic interactions and consequences for natural enemies [*Axel Beringue, p. 50*]
10:15 am	Climate change triggers parasitoid summer diapause directly and indirectly via trophic cascades [*Cécile Le Lann, p. 51*]
10:30 am	Extreme thermal events have more effects on aphid-parasitoid-hyperparasitoid trophic networks than long-term climatic conditions and landscape [*Léna Jego, p. 52*]
10:45 am	**Coffee break (Hall)**
Session « Biological control & IPM »	
11:15 am	Conservation biological control in winter reduces vector-borne virus incidence in cereal crops [*Joan Van Baaren, p. 53*]
11:30 am	Enhancing the biological control of two mirids with banker plants in tomato greenhouses [*Juliette Poidatz, p. 54*]
11:45 am	Exploring the competitive interactions between two parasitoids of *Tuta absoluta*: the native *Necremnus tutae* and the exotic *Dolichogenidea gelechiidivoris* [*Angeliki Syropoulou, p. 55*]
12:00 pm	The making of - a parasitoid product to control the Spotted Wing Drosophila in Germany [*Annette Herz, p. 56*]
12:15 pm	A comparison of natural pest control measurement methods: which indicators do we need to quantify predation? [*Yann Tricault, p. 57*]
12:30 pm	**Lunch (Hall)**
Session « Biological control & IPM »	
2:00 pm	Biological Control of Stable Flies: An Effective Alternative to Insecticides [*Gérard Duvallet, p. 58*]
2:15 pm	Assessment of tachinid flies and egg parasitoids as biological control agents of stink bugs (Hemiptera: Pentatomidae) [*Fernanda Cingolani, p. 59*]
2:30 pm	Classical biological control of orange spiny whitefly, *Aleurocanthus spiniferus* (Quintance) (Hemiptera: Aleyrodidae) in Greece [*Maria Vasiliki Giakoumaki, p. 60*]
2:45 pm	Nectar-inhabiting bacteria affect the longevity of adult parasitoids [*Evgenia Sarakatsani, p. 61*]
Session « Population, Community and Landscape »	
3:00 pm	Floral enrichment effect on the biodiversity and ecosystem services in European agricultural landscapes along a European Gradient with Climate and landscape variations [*Hanna Chole, p. 62*]
3:15 pm	Floral nectar provision improves parasitoid wasp biological control efficiency [*Gail Jackson, p. 63*]
3:30 pm	**Coffee break (Hall)**
4:00 pm	Attraction response of *Mastrus ridens* (Hymenoptera: Ichneumonidae) to flowers of seven plant species and response relationship with different floral traits [*Tania Zaviezo, p. 64*]
4:15 pm	A summer-flowering desert tree supports local parasitoids: prospects for conservation biological control [*Tamar Keasar, p. 65*]
4:30 pm	Resolving whitefly-natural enemy trophic connections in vegetable-cotton landscapes [*Jason Schmidt, p. 66*]
4:45 pm	Do food webs studies in apple orchards reveal buffering ability of key natural enemies against plant pests? [*Shameer KS, p. 67*]
5:00 pm	Balancing Complementarity and Intraguild Predation to Enhance Long-Term Biocontrol Services [*Francisco Martínez-Martínez, p. 68*]
5:15 pm	Intra-annual dynamics of the carabids' diet in oilseed rape field [*Yohann Graux, p. 69*]
5:30 pm	Assessing the Determinants of the Distribution of Carabid Communities in Agricultural Landscapes Using Joint Species Distribution Models [*Abel Masson, p. 70*]
6:00 pm	**Visit of Renaissance gardens and gala dinner at "Château de Villandry"**

Friday, July 4

Keynote speaker	
9:00 am	Characterization of Domesticated Endogenous Viruses gene function in parasitoid wasps [*Ange Lorenzi, p. 71*]
Session « Genetics, Evolution & Physiology »	
9:45 am	Unravelling the amplification of domesticated endogenous viruses in ichneumonid wasps [*Anne-Nathalie Volkoff, p. 72*]
10:00 am	Search for key regulators of endogenous viruses replication in ichneumonid wasps through differential gene expression analysis [*Fabrice Legeai, p. 73*]
10:15 am	Insights on the evolution of endogenous viruses involved in parasitism success provided by *Toxoneuron nigriceps* (Braconidae, Cardiochilinae) genome [*Jean-Michel Drezen, p. 75*]
10:30 am	**Coffee break (Hall)**
11:00 am	Discovery of endogenous viral elements in Campopleginae wasps suggest widespread nudivirus domestication [*Elisabeth Huguet, p. 76*]
11:15 am	Improving parasitism success of a weakly virulent parasitoid strain [*Florence Mougel, p. 77*]
11:30 am	Viral flow among citrus mealybugs and their parasitoid complex [*Jesica Pérez-Rodríguez, p. 78*]
11:45 am	Host regulation by insect parasitoids: The induction of diapause [*Thomas Zankl, p. 79*]
12:00 pm	Integrative Framework for Sustainable Insect Management [*David Giron, p. 80*]
12:15 pm	Closing ceremony & Future IEIC
1:00 pm	**Sandwiches (Hall)**
2:00 pm	**Excursion "Château de Chenonceau" (optional)**

Oral communications

Honeydew as food source for parasitoids in agroecosystems

Alejandro Tena Barreda * [1]

[1] Instituto Valenciano de Investigaciones Agrarias - Institut Valencià d'Investigacions Agraries - Valencian Institute for agricultural Research – Spain

Honeydew is the sugar-excretion product of plant-feeding hemipterans, such as aphids, coccids, whiteflies, and psyllids. Compared to other sugar sources present in agroecosystems, honeydew is highly accessible and abundant in nearly all crops and seasons. This sugar source is exploited by many biological control agents, including parasitoids of numerous pests. However, honeydew is not only consumed by parasitoids, but also by pests, hyperparasitoids and ants. Besides arthropods, many fungi and bacteria grow on honeydew in agroecosystems, changing its composition. Therefore, honeydew mediates the interaction between parasitoids and other organism in agricultural crops. These interactions may affect directly or indirectly the honeydew producer and the parasitoid in positive and negative ways. I will first explain the content of honeydew as food source for parasitoids. Then, I will review the main ecological interactions driven by honeydew as a food source and as a semiochemical. Finally, I will propose several strategies to exploit this knowledge and improve the fitness and abundance of parasitoids used in biological control of pests in agriculture.

Keywords: hemipterans, parasitoids, predators, ants, mutualism

*Speaker

Comparison of life-history traits in six egg parasitoid species of the genus *Trichogramma*

Véronique Martel * [1], Marlène Goubault *

[2], Guy Boivin [3]

[1] Natural Resources Canada – Canada

[2] Institut de recherche sur la biologie de l'insecte UMR7261 – Université de Tours, Centre National de la Recherche Scientifique, Centre National de la Recherche Scientifique : UMR7261 – France

[3] Agriculture and Agri-Food Canada – Canada

Energy is a finite resource that can be used by insects on different life-history traits, but with trade-offs. One of those trade-offs is between reproduction and maintenance (or longevity). Energy can be provided through different sources, mainly sugar, lipids and amino acids/proteins. In parasitoids, the sources can include hosts or non-hosts. In this study, we investigated the impact of different food sources on life-history traits, such as longevity and fecundity, of females from six Trichogramma species: *T. cacoeciae*, *T. chilonis*, *T. minutum*, *T. leptoparameron*, *T. pintoi* and *T. sibericum* (Hymenoptera: Trichogrammatidae). Although the impact of food differs among species, there is a general tendency of increased life expectancy with access to sugar and to hosts. Similarly, the potential maximal fecundity differed among species, access to hosts increased the number of eggs matured during their life, and this increase was greater with access to sugar. The ovigeny index was calculated for each species, but it did not significantly vary with the longevity of the species.

Keywords: Life, history, Longevity, Fecundity, Ovigeny Index, Nutrition, Oosorption, Hymenoptera

*Speaker

Host location by hyperparasitoids

Erik Poelman * [1]

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Hyperparasitoids are parasitic wasps that lay their eggs in or on the larvae or pupae of primary parasitoids. Any parasitic wasp associated with caterpillars or aphids is attacked by multiple species of hyperparasitoids. The hosts for hyperparasitoids are concealed within the bodies of herbivores and do not provide the hyperparasitoids with direct cues in host location. Hyperparasitoids typically use a cues that are derived from an indirect interaction network of the parasitoid larvae with its herbivore host and the food plant on which this parasitized herbivore is feeding. Aphid and caterpillar associated hyperparasitoids may use plant volatiles induced by parasitized herbivores to locate the larvae of parasitic wasps inside the herbivores. When arriving to plants with parasitized hosts the hyperparasitoids use cues associated with the herbivores to identify which herbivore is actually parasitized. In these interactions there is a role for microorganisms, parasitoid associated components such as venoms and polydnavirusses that they inject into the host, and herbivore saliva.

Keywords: hyperparasitoids, host location

*Speaker

Optimal host plant selection by caterpillars may not be optimal: Performance of *Chelonus insularis* is enhanced by fall armyworm's preference for caterpillar-susceptible maize

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[3] Department of Entomology, Texas AM University, College Station – United States

The egg-larval parasitoid *Chelonus insularis* (Braconidae) is among the most important natural enemies of fall armyworm (*Spodoptera frugiperda*) (FAW) in Mexico. Parasitism by *C. insularis* is initiated in its host's egg stage though parasitoid hatching and larval development occur during the host's larval stage. FAW is a Neotropical species that is pestiferous on numerous crops but is especially injurious to maize and has become an invasive pest in many areas of the world. In this study, we addressed the preference for and performance of *C. insularis* on maize accessions with varying degrees of resistance to FAW. Specifically, w e u sed three accessions shown previously to be variably resistant to FAW: (i) Tuxpeño landrace, shown to be most resistant; (ii) B73 inbred line, shown to be intermediately resistant; and (iii) B73-lox10 isoline, shown to be least resistant. B73-lox10 is a B73 mutant isoline deficient i n g reen leaf volatile (GLV) emission and jasmonic acid (JA) production. Per the preference-performance hypothesis we expected that *C. insularis* females would prefer FAW eggs laid on B73-lox10 maize where FAW larvae grow largest, and avoid eggs laid on Tuxpeño maize where FAW larvae grow smallest; indeed, our results showed that the size (dry weight) of *C. insularis* adults, a positive correlate of performance, increased with the size of FAW larvae. Contrary to our expectation we found that *C. insularis* females preferred FAW eggs laid on Tuxpeño maize though their offspring's p erformance w as l ower c ompared t o B 73-lox10 m aize. H owever, we found that dispersing, parasitized FAW larvae preferred B73-lox10 maize over Tuxpeño maize, thus correcting their mother's suboptimal host choice; the preference of parasitized larvae was consistent with the previously shown preference of unparasitized larvae. Our results suggest that optimal host selection by FAW larvae, whether parasitized or unparasitized, compensates for suboptimal host selection by *C. insularis* females.

Keywords: Preference, performance hypothesis, host selection, Spodoptera frugiperda

*Speaker

Influence of thermal history on contest outcome and aggressiveness of competing parasitoids

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When exploiting patches of resources heterogenous in quality, an organism makes a series of decisions based on the potential pay-off it can obtain by exploiting these resources. Selection should favor individuals maximizing their pay-off, i.e. making the best decisions. However, in the presence of competitors (i.e. under direct competition), individuals may have to fight to access and defend the resource, thereby modulating this pay-off for all competitors. Temperature is among the most influential abiotic factors for the quality of a resource for insects, as it influences both the quality of the resource directly and the physiology of the individual exploiting it. Individuals fighting to access a favorable thermal patch, however, may value it differently (motivation) depending on their past experiences, or short-term acclimation. Individuals that have previously exploited a series of patches of low thermal quality, may place a greater value into patches where temperature is optimal for their physiology and/or maximizing resource quality and invest more into fighting for its exploitation that an individual having already exploited a series of patches close to their thermal optimum. These interactions between motivation, aggressiveness, patch exploitation and temperature have only rarely been studied. We studied two species of parasitoids, *Eupelmus vuilleti* and *Dinarmus basalis*, exploiting the same host, *Callosobruchus maculatus.* Previous work indicate that those two species can exploit their host in a range of 20 to 40∘C, with an optimum around 35∘C. We investigated how their previous experience of temperature (25, 34 or 40∘C) for host exploitation affects the intensity and outcome of contest for hosts. Previous experiment showed that *D. basalis* dominates direct interspecific contests, but we hypothesized that contest outcome should be modulated by their recent experience of temperature regime, allowing *E. vuilleti* females to win contest as they are over-motivated when they exploited previously low-quality patches.

Keywords: Competition, aggressiveness, parasitoids, temperature

*Speaker

The slaughter of the innocents: male killing in quasi-social parasitoids with unusually female biased sex ratios

Ian Hardy * [1], Xiaomeng Guo [2], Guiling Zhuang [3], Baoping Li [3]

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[2] Zhenjiang Institute of Agricultural Science in Hilly Area of Jiangsu – China
[3] College of Plant Protection, Nanjing Agricultural University – China

Extremely female-biased sex ratios of parasitoid wasps in multiple-foundress groups challenges evolutionary theory which predicts diminishing bias as foundress numbers increase. Theory based on foundress cooperation (Local Resource Enhancement, LRE) achieved qualitative rather than quantitative success in explaining bias among parasitoids in the bethylid genus *Sclerodermus*, in which groups of females produce, and then care for, communal broods on a single large host. Recent theory, expanding the theory of Local Mate Competition (LMC) to consider post-oviposition sex ratio adjustments, was based on the observation that male production is dominated by some foundresses within groups. These new LMC models matched observed sex ratios far better than prior explanations but evidence for the mechanism of skew in male production was indirect. Here we recap the recent theoretical developments and present new evidence for male-biased infanticide, via filial cannibalism, by adult female *Sclerodermus* females that are presented with broods laid by (absent) conspecifics. We show that cannibalism is common. We also show that developing broods exposed to adult females with prior reproductive experience have, for a given degree of overall mortality, more greatly female biased sex ratios on maturity than do broods exposed to naïve females or to no further females. These results contribute a new twist to the panoply of competitive interactions that are being discovered within the, broadly cooperative, reproductive system of *Sclerodermus*.

Keywords: Quasisocial, Infanticide, Conflicts, Sex ratios, Local Mate Competition

*Speaker

Kin recognition and inbreeding avoidance in *Venturia canescens*: behavioral and transcriptomic insights

Maxime Verdier * [1], Zainab Belgaidi [2], Adil El-Filali [2], Patricia Gibert [2], Marie Fablet [1], Christina Vieira [1], Isabelle Amat [1], Emmanuel Desouhant [1], Aurore Gallot Le Grand [1]

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Kin recognition plays a pivotal role in animal mating behavior, preventing inbreeding and preserving genetic diversity. Inbreeding is known to drive genetic erosion across species and can ultimately lead to population extinction. In this study, we investigated inbreeding avoidance in the parasitoid wasp Venturia canescens. In this species, the decision to mate or not is assigned to the female. Behavioral assays revealed that sibling mating occurred at a lower frequency compared to unrelated pairings. Males exhibited delayed, less frequent, and shorter courtship interactions when exposed to sibling females. These results suggest that both male and female mate choice contributes to inbreeding avoidance. To elucidate the molecular basis of this selective mating behavior, we performed RNA sequencing on the heads of both males and females. Our transcriptomic analysis demonstrated that the presence of a related mate triggers a specific gene expression response. Among the differentially expressed genes, we identified those involved in the production of neuropeptides, which can influence decision-making. These findings provide novel insights into the mechanisms underlying kin discrimination and mate selection. In addition, we draw parallels with findings from another species exhibiting an opposite mate choice strategy: Drosophila melanogaster, which preferentially engages in inbred matings. This comparison offers a broader perspective on the conserved mechanisms of kin recognition and highlights the diversity of mating responses across taxa.

Keywords: Kin recognition, Mate choice, Venturia canescens, Transcriptomic analysis

*Speaker

The dose makes the poison: hormesis and herbivore immunity against parasitoids.

Paul Ode * [1], Enakshi Ghosh

[1] Colorado State University [Fort Collins] – United States

Hormesis, the phenomenon in which low doses of toxins promote beneficial biological responses and higher doses compromise these responses, offers an unexplored framework for understanding herbivore eco-immunology. Here we explore how insect herbivores might exploit plant secondary metabolites within the framework of hormesis to enhance immune function. We propose that herbivores experience an "immunocompetence window," where toxins confer immune benefits at low concentrations, but suppress immune responses at higher concentrations. This concept bridges the interplay between bottom-up (plant defense) and top-down (natural enemy) pressures, providing insights into how herbivores balance toxin exposure and natural enemy pressure. We discuss how both generalist and specialist herbivores navigate this balance, highlighting the evolutionary adaptations that influence their strategies. This perspective underscores the significance of hormesis in eco-immunology and its potential applications in pest management and conservation biology.
Our data from studies of three common herbivores (two specialists: *Pieris rapae*, *Plutella xylostella*, and one generalist: *Trichoplusia ni*) of *Brassica* spp. and their *Cotesia* parasitoids suggest that the immune systems of specialist caterpillars appear to respond differently than generalists to changes in plant toxin concentrations. We present three scenarios that potentially explain the differences in the relationship between plant secondary metabolite concentration and herbivore immunocompetence for specialists and generalists. Our experimental results revealed a biphasic immune response to a range of toxin concentrations, with low toxin exposure enhancing immune function and higher concentrations suppressing it. Our findings highlight the role of plant toxin variability in shaping herbivore immunity and provide insights into how environmental heterogeneity can affect trophic interactions in natural systems.

Keywords: immunity, plant defense chemistry, trophic interactions

*Speaker

Sublethal effects of insecticides on pheromone communication and host finding in parasitoids

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Insecticides are widely used across the globe for plant protection but can also harm beneficial non-target organisms. Beyond their lethal effects, they may cause less apparent sublethal impacts. Parasitoid wasps can be exposed to sublethal doses of insecticides through, for instance, direct contact with treated plants or by consuming contaminated nectar, honeydew, or guttation water. This study examined the sublethal effects of four insecticides that target cholinergic neurons in insects: acetamiprid (neonicotinoid), dimethoate (organophosphate), flupyradifurone (butenolide), and sulfoxaflor (sulfoximine). The research focused on the three parasitoid wasp species *Nasonia vitripennis* (Pteromalidae) (*1*), *Lariophagus distinguendus* (Pteromalidae) (*2*), and *Leptopilina heterotoma* (Figitidae) (*3*). The wasps were treated with sublethal doses of the insecticides by topical application and assessed through bioassays evaluating pheromone-mediated mating behavior and olfactory host-finding abilities. All four insecticides disrupted pheromone communication and/or olfactory host finding in at least one of the studied species. In *N. vitripennis* and *L. distinguendus*, treated wasps exhibited significantly reduced mating frequencies. Additionally, experiments with *L. heterotoma* demonstrated that bioactive levels of dimethoate can reach parasitoid wasps through the food chain (host breeding medium → host larvae → parasitoid). The intensity of sublethal effects varied depending on the insecticide and wasp species, with *L. distinguendus* showing the highest sensitivity. These findings suggest that insecticides targeting cholinergic neurons impair the olfactory capabilities of parasitoid wasps. Since their sense of smell is essential for their ecological role, sublethal insecticide exposure is likely to hamper their effectiveness as natural enemies.

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Keywords: host finding, insecticides, sex pheromone, sublethal effects

*Speaker

Host-recognition response of the parasitoid *Cotesia typhae* to oral secretion enzymes of its host, the Mediterranean corn borer

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The performance of insect parasitoids, used successfully in the biological control of crop pests worldwide, depends on their ability to locate and recognize their hosts effectively in the field. *Cotesia typhae* (Hymenptera: Braconidae) is a larval parasitoid specialized on the Mediterranean corn borer *Sesamia nonagrioides* (Lepidoptera: Noctuidae) in sub-Saharan Africa. As *S. nonagrioides* is an important maize pest in southern Europe, the use of *C. typhae* as a biological control agent against *S. nonagrioides* is currently under study. Here, we focus on the host recognition and acceptance mechanisms underlying parasitoid adaptation to a new host population, by investigating the role of α-amylase enzymes, present in caterpillar oral secretions, on these processes. We developed a protocol to synthetize *S. nonagrioides* α-amylases, and tested its influence on parasitoid behaviour in the laboratory. *C. typhae* response to a non-host amylase (*e.g. Drosophila*) was also tested. The frequency of parasitoid antennation and oviposition (proxy of host recognition and acceptance) in the presence of these α-amylases (isolated or in synergy) at different concentrations was measured. All α-amylases triggered host recognition and acceptance behaviour by *C. typhae* independently of the concentration. However, the "recognition" response of *C. typhae* to α-amylases was not host-specific, revealing that other molecules may act synergistically in host-specific acceptance by the parasitoid. Other metabolites, present in caterpillar oral secretions, have been identified by GC-MS, and their potential involvement in *C. typhae* host selection is under investigation. The recognition of proteins of this size by the sensory system of an insect has rarely been observed, and the mechanism of perception of these α-amylases by the wasp sensory system remains to be elucidated. These results open up new prospects for the use of these molecules as oviposition stimulants to enhance the parasitic performance of *C. typhae* for effective biological control of *S. nonagrioides.*

Keywords: kairomone, amylase, stemborer, Sesamia nonagrioides, larval parasitoid

*Speaker

Below and above-ground infestation effects on the olfactory responses of *Trichogramma achaeae* to *Tuta absoluta*-infested tomato plants

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Natural enemies utilize Volatile Organic Compounds (VOCs) emitted by plants to locate their hosts and prey.. However, information is limited about what occurs in natural conditions, particularly when plants are attacked by multiple herbivores, either simultaneously or successively. Depending on the attack, different defense pathways are activated, which play a significant role in the communication between herbivores, pathogens, and beneficial insects. The tomato leafminer *Tuta absoluta* Meyrick (Lepidoptera: Gelechiidae) and the brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Pentatomidae) are two herbivores with different feeding mode that are frequently encountered in tomato cultivation. In addition, below-ground pests attack plants such as nematodes. Egg parasitoids have been shown to be attracted to Oviposition Induced Plant Volatiles (OIPVs) emitted by tomato plants that were oviposited by *T. absoluta.* However, previous infestation by another herbivore with different modes of feeding or another pathogen may modify the volatile profile of the plants under attack and interfere with the foraging behavior of the parasitoids. In this study, we examined the behavioral response of the egg parasitoid *Trichogramma achaeae*, in the volatiles of tomato plants following sequential infestation by different pest species i) two herbivores, ii) a plantpathogenic nematode and a herbivore), using Y-tube olfactometer. We tested *T. achaeae* females' responses to *T. absoluta* oviposited tomato plants previously infested by *H. halys*. We also investigated the below-ground infestation by nematode *Meloidogyne javanica*, on the parasitoid response towards *T. absoluta* oviposited tomato plants. The results so far indicate that dual infestation from either upper-ground or below-ground pests does not affect the parasitoid's preference. The above results contribute to elucidating the chemical ecology that underpins multitrophic interactions at higher trophic levels and enhancing a comprehensive integrated pest management strategy approach.

Keywords: Trichogramma achaeae, parasitoids, Tuta absoluta, Halyomorpha halys, Y tube olfactometer, tomato

*Speaker

Effects of microbe-induced tomato volatiles on the behaviour of natural enemies of greenhouse pests

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Tomato is one of the most widely consumed crop worldwide, but its production is constantly threatened by numerous pests. In the Integrated Pest Management (IPM), the induction of natural plant defense mechanisms mediated by soil microorganisms is considered a sustainable solution for pest control, but the effects of microbial-induced tomato volatiles on plant-herbivore-natural enemies interactions remain largely unknown. The current study evaluated in the laboratory the effects of volatiles emitted by tomato plants inoculated with three fungal commercial strains (*Trichoderma asperellum* T34, *T. harzianum* T22 and *Beauveria bassiana* ATCC 7404), six bacterial species (commercial strains of *Bacillus subtilis* QST 713 and *B. amyloliquefaciens* D747, and laboratory isolates of *B. spizizenii* PFE9, *Pseudomonas fluorescens* POE44, *P. veronii* POE73 and *P. gessardii* POE79) on the olfactory response of three natural enemies (*Cryptolaemus montrouzieri*, *Eretmocerus eremicus* and *Nesidiocoris tenuis*) used against greenhouse key pests. The olfactory choices of beneficial insects to plant volatiles were assessed in a two-way olfactometer after 3 and 7 days of microbial inoculation (doi) in comparison to untreated plants. Expression level of plant defense-related genes and emitted volatiles were assessed through qRT-PCR and TD-GC/MS, respectively. In dual choice tests, *C. montrouzieri* showed significant attraction towards tomato plants inoculated with *B. spizizenii* and *T. asperellum* after 3 and 7 doi, respectively. Conversely, *C. montrouzieri* females were generally repelled by tomato emitted volatiles when inoculated with other microbials. A similar trend was observed with *E. eremicus*. Tomato plants inoculated with *B. bassiana* and *B. subtilis* significantly repelled *N. tenuis* both after 3 and 7 doi. Plant defense-associated pathways in microbial-induced tomatoes were overexpressed and tomato-emitted volatile profile showed different features. These results suggest further research into microbe-natural enemy interactions is crucial for effective IPM in greenhouse tomato systems.

Keywords: biocontrol, induced defenses, microorganisms, natural enemies, Solanum lycopersicum, volatiles

*Speaker

Which companion plant intercropped in a young apple orchard could affect aphid population and/or natural enemies?

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In a global context of pesticide reduction, the sustainable management of aphids is a major challenge in order to maintain an economically viable fruit and vegetable production. Intercropping with companion plants (CPs) is one possible strategy, still little studied in orchards. Indeed, some CPs are known to emit volatile organic compounds (VOCs) with repellent or attractive properties in the laboratory but their effects in the orchard to disrupt aphid behaviour or attract natural enemies of pests (NE) are not widely documented. Here we tested the hypotheses that the intercropping of CPs around apple trees could decrease the populations of the rosy apple aphid (RAA) (*Dysaphis plantaginea* Passerini) directly or indirectly by increasing the abundance of its NE. Four CP species (Basil, French marigold, wild fennel, peppermint) and ryegrass as a control were introduced in a young apple orchard (*Malus domestica* Borkhausen, cv Ariane) in the south of France in April 2024. The development dynamics of aphid colonies and the abundance of NE were studied every week on the trees surrounded by CPs or ryegrass from April till the end of June. Every fortnight, the VOCs emitted by CPs were sampled and analyzed. These measurements were aimed to identify the VOC profiles associated with CPs and their potential effect to reduce aphid colony development.

Keywords: companion plant, apple orchard, repulsion, attraction, Dysaphis plantaginea, Volatile organic compounds

*Speaker

T*richoderma harzianum* modulates indirect defenses on tomato against herbivore stink bugs

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Beneficial soil-borne fungi from the genus *Trichoderma* can establish symbiotic relationships with plant roots. These microorganisms provide several benefits to plants by promoting growth, enhancing nutrient uptake or suppressing plant pathogens. Recently, several studies have also shown that *Trichoderma* species can affect the indirect defenses of plants against insect herbivore attack, through the emission of volatile organic compounds (VOCs) which can attract the natural enemies of pest insects. Nevertheless, current information on the effect of *Trichoderma* species on tri-trophic systems involving plants, stink bugs, and their egg parasitoids remains limited. To fill this gap, we conducted olfactometer experiments to investigate how the presence of beneficial soil microbes affects plant responses to stink bug feeding and oviposition. We tested whether root inoculation with *Trichoderma harzianum* strain T22 enhances attraction of the egg parasitoids *Trissolcus basalis* and *Trissolcus japonicus* towards plants induced by feeding and oviposition activities of their respective hosts, i.e. *Nezara viridula* and *Halyomorpha halys*. We also explored the possible priming effect that *T. harzianum* T22 could have on tomato plants induced only by stink bug feeding and the consequences for the olfactory responses of the egg parasitoid. The importance of these findings will be discussed in the context of plant-insect-microbe interactions and their potential role in biological pest control.

Keywords: microbial volatile organic compounds (MVOCs), Conservation Biological Control, Insect Parasitoid

*Speaker

Flower strips and synthetic volatiles and its effect on aphid natural enemies' populations in Mediterranean apple orchards

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Different natural enemies, predators and parasitoids, contribute to the biological control of aphids in apple orchards. Often, these natural enemies rely on plant derived food sources such as aphid honeydew, nectar, and/or pollen. Recent attempts to improve the efficacy of floral resources have focused on the 'Attract and Reward' (A&R) strategy. This method combines floral resource provision with the use of synthetically produced volatiles aiming to attract biological control agents into the crop. Our study evaluated the effect of floral strips and commercial synthetic volatiles on the abundance of two main groups of aphid natural enemies: hoverflies and parasitoids. The experiment was conducted in an organic commercial apple orchard in Catalonia (Spain) that was divided into four plots. The combined effect of the floral resources and the volatiles on natural enemies' abundance was tested in a nested split-plot design. Two groundcover treatments were established: one in which the resident vegetation was dominated by monocots, and the second in which eight dicot species were sown in the center of the alleyway to modify the composition of the resident cover. As far as volatiles are concerned, Csalomon® dispensers containing a blend of phenylacetaldehyde, methyl salicylate, and acetic acid were used. Aphid parasitoid populations were recorded on yellow sticky traps and adult hoverflies abundance by visual counting. Our results suggested that, in Mediterranean apple orchards, the presence of dicot plants in the groundcover may be useful to increase the abundance of hoverflies, but not parasitoids. Moreover, the beneficial effect of synthetic attractants was not demonstrated. This research was supported by the grants PID2019-107030RB-C21 and PID2022-139988OB-I00 funded by MICIU/AEI/ 10.13039/501100011033 and by ERDF/EU. LGMB is a beneficiary of the grant PRE2020-092229 funded by MICIU/AEI/10.13039/501100011033 and by "ESF Investing in your future".

Keywords: conservation biological control, hoverfles, Dysaphis, Aphelinus, Ephedrus, floral resources, synthetic volatiles

*Speaker

Untangling a cryptic species complex of *Cephalonomia spp.* (Hymenoptera: Bethylidae) associated with coffee berry borer and other Scolytinae (Coleoptera: Curculionidae) in Hawai'i

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Cephalonomia hyalinipennis (Hymenoptera: Bethylidae) is a generalist parasitoid known to attack the coffee berry borer, *Hypothenemus hampei* (Coleoptera: Curculionidae: Scolytinae). However, despite its recorded presence, *C. hyalinipennis* has never been found associated with this pest in infested coffee berries in Hawai'i. Interestingly, *C. hyalinipennis* has been reared from other wood boring beetles in Hawai'i, and may in fact represent a complex of host-specific cryptic species. Here we use morphometrics and non-destructive DNA barcoding on freshly-collected specimens from Hawai'i, 30-year old preserved specimens from Mexico, and 10 – 25 year old pinned specimens from museum collections to explore the potential for cryptic diversity, and where possible, to associate this diversity with biological information. A nested DNA barcoding approach was successfully developed here, which provided sequences for older and unpreserved specimens for comparison, which would otherwise not have been achievable. This approach may also have future applications in foodweb analysis in this system to further understand *Cephalonomia*-Scolytinae host-parasitoid associations.

Keywords: Bethylidae, Coffee Berry Borer, DNA Barcoding, Cryptic Species, Host Specificity

*Speaker

Concealed world of tiny forest spirits: biology, taxonomic issues and Afrotropical diversity of the genus *Omphale* (Hymenoptera: Chalcidoidea, Eulophidae)

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The genus *Omphale* Haliday primarily consists of the so-called 'soft-bodied' represenatives within the subfamily Entedoninae, meaning that its species require more delicate handling compared to many other chalcidoids, which complicates progress in their taxonomy. This genus is quite diverse, with nearly 270 described species, and has been relatively well studied in temperate regions such as North America and Europe (Hansson, 1996, 1997; Hansson & Shevtsova, 2012), as well as in the Neotropics (Hansson, 2004). However, only two species have been recorded from the Afrotropical region so far (UCD Community, 2023). Species of *Omphale* for which biological data is available are known to parasitize gall midges (Diptera: Cecidomyiidae), although biological surveys are limited. We were able to observe the ovipositing behavior and the morphology of the egg and larva of *O. theana* (Walker), and compare these traits with those of other entedonines. Our studies revealed a significant diversity of *Omphale* species across various regions of continental Africa, both in terms of morphospecies and the number of specimens collected per habitat. Most Afrotropical *Omphale* species seem to be new to science, with the two previously recorded species belonging to different genera. It is noteworthy that many of these species have Palearctic 'counterparts' that are morphologically similar, yet differ in several subtle details. The distribution pattern of Afrotropical *Omphale* species suggests their potential role as indicators of climax communities in Afrotropical forests. This may correlate with their associations with midge galls, which are widely represented on various plants in rainforest habitats across Africa.

Keywords: Hymenoptera, Eulophidae, parasitoids, Africa, ovipositing, immature and adult morphology, galls, Cecidomyiidae

*Speaker

What do we know about Darwin wasps (Ichneumonidae, Hymenoptera) distribution in Ecuador through entomological collections?

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Ecuador is a hyperdiverse country, and yet the number of Darwin wasp species reported there is surprisingly low. These low counts are probably due to a subsampling and the restricted access to local entomological collections. This work was aimed to dilucidate where the known species have been reported to occur, and if the access to entomological collections might be a limitation to the study of Ecuadorian Ichneumonidae diversity. We looked for all the reports of Ichneumonidae species in the scientific literature up to 2022, and we build up a heatmap to identify over and subsampled areas in the country. We also used the collection localities to categorize the ecology of Ecuadorian species, based on ecosystem, temperature, precipitation, elevation, and distances to roads and rivers, but considering the collection year, based on three temporary datasets (before 1990, 1990-2000 and 2000-2020). We found 1058 records belonging to 336 Ichneumonidae species, most of them located at Yasuní National Park (Napo province) and at the surroundings of Quito (Pichincha province). Coast and Southern Amazonas were underrepresented, as well as paramo and shrubland ecosystems. There seems to be a shift in the sampling areas: whilst until 1990 a great amount of Ichneumonidae records were done in agricultural areas, from 1990 to 2022 sampling has clearly focused on native forests, and researchers are exploring more remote and unexplored areas far away from roads and rivers. Most species reported and described after 1990 are clearly associated to Terry Erwin's 20-years monitoring in Yasuní National Park, whose collection is mainly deposited in the Smithsonian National Museum of Natural History (USA). Only 0,2% of the specimens found in the scientific literature were placed in Latin American collections. The lack of specialists, curators and a proper management of local entomological collections are contributing to an unbalanced knowledge of Ecuadorian diversity.

Keywords: Biogeography, parasitoids, biodiversity, hyperdiverse country

*Speaker

Augmenting parasitoids in large crop fields in Brazil: A proven success with room for improvement

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Augmentative biological control has significantly reduced insecticide use in 'closed-system' agriculture (i.e. greenhouses). In this perspective, the commercial success of biocontrol agents in greenhouses has long driven efforts to expand their use in open agricultural systems. While this approach is intuitively appealing, it presents far greater challenges compared to augmenting natural enemies in greenhouses. Some of these challenges include need of cost-effective mass production, unfavorable field climatic conditions, a tendency to disperse, intraguild predation, excessive use of insecticides, release technology, among others. Nevertheless, with the advancement of cost-effective mass production protocols and drone technology for field releases, Brazil has taken the lead in augmenting parasitoids across vast crop fields. This has worked particularly well in the use of *Cotesia*, *Trichogramma, Telenomus* parasitoids to control pests in soybean, maize, cotton and sugarcane crops. Despite the progress made in augmenting parasitoids in large fields, several factors still need to be addressed in order to maximize their effectiveness. In this regard, researchers in Brazil and around the world are exploring ways to further automate mass production, enhance decision-making regarding the timing, location, and quantity of parasitoid releases, provide supplementary resources in the field, and minimize the non-target effects of insecticides. Taken altogether, augmenting natural enemies in large fields presents a challenge that can be addressed through science, with results that could be of broad interest to regions worldwide where crops are primarily grown in open fields.

Keywords: Biological control, Egg parasitoids, Open field agriculture, Cotesia, Trichogramma, Telenomus

*Speaker

Parasitoids that are cryptically effective and ineffective biological control agents: distinguishing between 'dark horses' and 'paper tigers'

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Several empirical and analytical approaches exist to assess how effective parasitoids are as agents of biological pest control. Percent parasitism is by far the most commonly measured and reported metric, yet has well-known limitations. In practice, when evaluating the biological control potential (or historical impact) of a parasitoid based on published data, percent parasitism is often the only available information. However, relying on this metric could result in the importance of potentially effective biological control agents being downplayed, or ineffective biological control agents being promoted. This is because percent parasitism may range from vastly under- or over-estimating true suppressive impact on pest populations. We introduce the terms "dark horses" and "paper tigers" to describe cryptically effective and ineffective agents, respectively. Thus, dark horses are parasitoids that would appear ineffective as biological control agents based on percent parasitism but in fact have strong population-level effects. On the other hand, paper tigers would show high percent parasitism but contribute little to host population suppression. We discuss the various ways that percent parasitism measurements can theoretically over- or under-estimate biological control impact and attempt to identify general characteristics of host-parasitoid systems that could tend to lead to these outcomes. Considerations include methodological and ecological factors such as sampling timing, host mortality rates, parasitoid behavior, host reproductive rates, the timing of density dependence in host life-cycles, and spatial refuges. We explore how these factors influence the relationship between true host population suppression and percent parasitism. A case study of larval parasitoids of the pest *Drosophila suzukii* serves as an illustrative example. Considering these issues could

*Speaker

help provide a roadmap for more often 'going beyond' percent parasitism when evaluating the efficacy of biological control agents.

Keywords: Biological control, impact, population dynamics

Host selection behaviour and specificity of *Anagyrus fusciventris* (Hymenoptera: Encyrtidae) on three mealybugs present in Spanish persimmon orchards

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The host selection behaviour of *Anagyrus fusciventris* Girault (Hymenoptera: Encyrtidae) was evaluated in choice tests comparing four mealybug species of applied importance: *Pseudococcus longispinus* Targioni Tozzetti, *Planococcus citri* Risso, *Delottococcus aberiae* De Lotto and *Paracoccus burnerare* Brain (Hemiptera: Pseudococcidae). Albeit *P. longispinus* reached the Mediterranean basin at the end of the 19th century it became a key pest of persimmon in Spain in 2020. In Australia, *P. longispinus* is mainly controlled by *Tetracnemoidea* spp., *Anagyrus fusciventris*. Particularly, *A. fusciventris* has been reported in 2020 firstly in Canary Islands and Spain as the most abundant primary parasitoid of *P. longispinus*. The inoculative releases of this parasitoid has been suggested as potential strategy to manage *P. longispinus* in persimmon orchards. However, its release is not allowed because it is not considered a naturalized parasitoid and it is necessary to determine its specificity. For this aim, one mated female of *A. fusciventris* was exposed to *P. longispinus* and the three mealybug species. The mealybugs were observed under stereomicroscope one week after the exposure and the number of alive, dead or mummified hosts as well as host encapsulation were recorded. Moreover, the behaviour of *A. fusciventris* was observed, recording the time spent antenning and probing, time before acceptance and, if enacted, the defensive behaviour by the mealybug. The majority of *P. longispinus* individuals were successfully parasitised, while *P. citri* and *D. aberiae* encapsulated the parasitoid eggs and a few individuals of the *D. aberiae* and *P. burnerae* were successfully parasitised. This study provides insights into the host selection mechanism of *A. fusciventris* suggesting that it can accept other mealybug species, but they tend to encapsulate its eggs. Therefore, inoculative releases of *A. fusciventris* to control *P. longispinus* in persimmon should not affect other mealybug species, offering an environmentally-friendly alternative than the current chemical control.

Keywords: Biological control, host selection, long, tailed mealybug, parasitism behaviour, persimmon

*Speaker

A theoretical framework 3MP to improve the adoption of "green" IPM tactics while considering broad environmental benefits

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Sustainable agriculture relies on implementing effective, eco-friendly crop protection strategies. However, the adoption of these green tactics by growers is limited by their high costs resulting from the insufficient integration of various components of Integrated PestManagement (IPM). In response, we propose a framework within IPM termed Multi-Dimensional Management of Multiple Pests (3MP). Within this framework, a spatial dimension considers the interactive effects of soil-crop-pest-natural enemy networks on pest prevalence, while a time dimension addresses pest interactions over the crop season. The 3MP framework aims to bolster the adoption of green IPM tactics, thereby extending environmental benefits beyond crop protection. Following our previous findings from laboratory and semi-field conditions, we are now conducting field trials to compare the outcomes of the 3 strategies: 3MP strategy, famer's practices strategy (FP) and untreated as control on open-field and/or greenhouse tomato in Vietnam, Thailand, Malysia, Pakistan, Italy, France, Spain and China.

Keywords: Multidimentional Management of Multiple Pests (3MP), fertilization, multi, service plants, natural enemies, bottom, up effects, top, down effects, tomato, Tuta absoluta, Bemisia tabaci, Liriomyza spp., Macrosiphum euphorbiae

*Speaker

Getting a visa for an exotic biological control agent

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The Mediterranean corn borer, *Sesamia nonagrioides* (Lepidoptera: Noctuidae), is a major pest of maize in this area. In its native range, sub-Saharan Africa, *S. nonagrioides* caterpillars are parasitized by a newly identified parasitoid insect, *Cotesia typhae* (Hymenoptera: Braconidae), specialized on this host on wild plants. The strict specificity of *C. typhae* and the identification of a Kenyan population having a high reproductive success on the French *Sesamia* population makes it a potential candidate for biological control (BCA) of this pest, which is mainly treated with insecticides in France. The EU regulates the introduction of BCA exotic species. The decision depends on the balance between estimated environmental risks and benefits. Knowledge of ecology and biology of *C. typhae* allowed to circumvent such risks to effects on non-target species. Out of eight species tested, representative of the 14 at risk, the probability that their caterpillars would be attacked and die varied between 3.3 and 5.4%, and only 0.9 to 1.2% of the caterpillars of four species allowed the parasitoid development. Its probability of establishment in the environment should be further compromised by its sensitivity to winter temperatures, the mortality threshold of immature stages being between 10 and 15∘C and adults living only a few days. Finally, in a greenhouse, we introduced *C. typhae* and quantified its action on *S. nonagrioides* on maize during four trials. An improved protocol during the last trial made it possible to obtain a 98% reduction in the *Sesamia* population, with a single release of *C. typhae*, while significantly preserving the maize plants. A market analysis helped delineating economically sustainable uses in France. We submitted our request for introducing the parasitoid and it is in the final step of a long procedure. The auditors might be invited to vote pro or against the visa for *C. typhae*!

*Speaker

Dipteran parasitoids as biocontrol agents

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Parasitoid flies (Diptera) are often overlooked or considered secondary to parasitoid wasps (Hymenoptera) in biological control programs. This disparity is partly due to the relatively lower number of dipteran parasitoids, as they represent about 20% of all parasitoids, the majority of which are hymenopterans. However, numerous studies conducted across various temporal and spatial scales worldwide show that dipteran parasitoids can effectively control certain insect pests. We provide an overview of major examples of successful classical and augmentative biological control initiatives, organized by major dipteran families which include parasitoid species (i.e., Tachinidae, Phoridae and Sarcophagidae) and according to different global regions. In addition, examples of unsuccessful attempts are discussed, along with potential reasons for these failures. These include insufficient number of parasitoids released, unfavorable host transfer, and the absence of alternative hosts, which could sustain parasitoid populations when regular hosts are unavailable in certain seasons. A notable drawback found in our literature review is the frequent misidentification of both parasitoid and host species, along with a general scarcity of laboratory and field studies. Further research is needed to better understand the reproductive strategies of dipteran parasitoids and their host-parasitoid interactions. Challenges associated with the production of dipteran parasitoids have also limited their exploitation as biocontrol agents. Expanding the knowledge of these parasitoids is crucial for improving biocontrol strategies, particularly against pests for which dipterans play a key role as natural enemies.

Keywords: natural enemies, Tachinidae, Phoridae, Sarcophagidae

*Speaker

Ant-mediated pest control with cover crops in citrus agroecosystems

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Up to 40% of global agricultural harvests are lost to pests, costing over €240 billion annually. Traditional chemical pest control methods have significant environmental impacts, prompting interest in sustainable alternatives. One such strategy is establishing flower strips and herbaceous plants in field alleyways to promote biodiversity-based ecosystem services, including natural pest control. Ants are essential in sustainable agriculture as they are among the most abundant arthropods in agroecosystems and significantly influence biological control. They provide various ecosystem services, including pest reduction and yield improvement. However, ants can also reduce the abundance of other biological control agents and increase certain pest populations, particularly honeydew-excreting hemipterans like aphids, whiteflies, and mealybugs. Although cover crops have been shown to enhance pest suppression and promote ecosystem services, their potential for ant management in citrus orchards remains unexplored. This study aimed to compare the effects of two cover crops-standard grass cover (Poaceae) and a mix of eight wildflower species with varied flowering times-on ant communities and pest management. We evaluated the impact of each cover crop on i) ant community composition; ii) ant activity in the tree canopy; iii) ant tending behaviour on hemipteran pests; iv) pest predation services by ants; and v) hemipteran pest density. Our results revealed that trees surrounded by the floral mix exhibited increased ant activity, higher ant tending behaviour on hemipteran pests, and greater mealybug pressure, while mealybug parasitism was lower. In contrast, ant predation on pests was higher around trees with the floral mix. These findings demonstrate that cover crop selection influences ant-mediated pest control and suggest that careful crop design could enhance functional biodiversity, contributing to sustainable agriculture.

Keywords: Functional biodiversity, biological pest control, ant management

*Speaker

Accuracy or accessibility: comparing methods estimating pest control based on trophic energy fluxes and on functional diversity.

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Provide tools to understand the pest control services is crucial for sustainable agriculture management. Although a wide range of approaches exists, we focus on two methodological approaches to infer levels of pest control from arthropod communities' structures: a predator metrics-based approach and the Quantitative Trophic Flux Web (QTFW). We compared these two methods by examining their connections and how they complement each other. We realized two Principal Component Analysis (PCA) using variables related to each methodology. Linear models based showed that the predator metrics were related to level of carnivory, as expected, but did not explain the level of pest control. This is in line with what we imagined because carnivore flows are built with the description of predator communities. However, these finding challenges classical top-down trophic regulation paradigms and highlights the role of bottom-up processes in pest control. The low redundancy between the two methods suggests that QTFW captures additional ecological interactions not reflected in predator metrics alone making the two methods complementary. This discrepancy underscores the complexity of trophic networks, where processes such as intraguild predation and omnivory can modulate the effectiveness of the top down control exercised by predator on herbivore in the pest control service. While predator metrics provide an accessible and cost-effective method for estimating predation potential, QTFW offers a more comprehensive view of realized predation and trophic interactions. These findings have important implications for optimizing biological control strategies in agroecosystems.

Keywords: soil macroinvertebrates predator, predation, functional trait, biological regulation

*Speaker

How overwintering affects the reproduction of two egg parasitoids of *Halyomorpha halys* in France and Italy

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In their native range, *Trissolcus mitsukurii* and *T. japonicus* (Hymenoptera, Scelionidae) are major egg parasitoids of *Halyomorpha halys* (Hemiptera, Pentatomidae); therefore, they have been selected for biological control programs in France and Italy. Annual collections of these parasitoids in southwestern France and northwestern Italy since 2020 and 2018, respectively, demonstrate their successful acclimatization, and most recent investigations reveal that populations in the two regions are genetically close. However, knowledge about the survival and reproductive patterns of overwintered individuals is scarce or missing. Beyond survivorship, the ability of *Trissolcus* spp. females to reproduce after overwintering period depends on their ability to maintain viable oocytes throughout winter or to produce new ones. In addition, the parasitism pressure on *H. halys* should also depend on the sex ratio of parasitoid progeny. In this study, we assessed how winter stress could affect survival, fecundity, ovarian load and progeny sex ratio of *Trissolcus* spp., by comparing the responses of *T. mitsukurii* and *T. japonicus* in France and Italy. In France, the average ovarian load of overwintered *T. mitsukurii* and *T. japonicus* was 32.4±5.6 and 28.2±4.8 oocytes, respectively, while in Italy *T. japonicus* ovaries contained 42.6±1.5 oocytes. Interestingly, French *T. mitsukurii* produced on average 22.7±8.9 offspring on its first day of oviposition, while *T. japonicus* produced only 5.3±8.5 offspring, the opposite of Italy where *T. japonicus* produced 40.7±3.0 offspring. Moreover, the presence of males throughout the winter did not increase egg fertilization, leading to the same progeny sex ratio compared to the absence of males for both species in France (75-80% of females) and for *T. japonicus* in Italy (88% of females). These results provide a better understanding of *T. mitsukurii* and *T. japonicus* establishment capacity in France and Italy, as well as their short-term efficiency as biological control agents.

Keywords: brown marmorated stink bug, Trissolcus japonicus, Trissolcus mitsukurii, overwintering survival, oocyte, sex ratio

*Speaker

Potential of *Nabis provencalis* Remane (Hemiptera: Nabidae) as a predator of the alfalfa weevil, *Hypera postica* Gyllenhal (Coleoptera: Curculionidae).

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The alfalfa weevil, *Hypera postica* Gyllenhal (Coleoptera: Curculionidae), is a significant pest worldwide and one of the most important pests of Spanish alfalfa fields. The larvae attack alfalfa during March and April, before the first commercial cutting, causing considerable damage. Given the increasingly early appearance of the polyphagous predator *Nabis provencalis* Remane (Hemiptera: Nabidae) in alfalfa fields, this study evaluated its potential as a predator of *H. postica*, compared to a previously documented predator, *Coccinella septempunctata* L. (Coleoptera: Coccinellidae). Additionally, the nutritional suitability of *H. postica* for both predators was assessed by comparing a range of feeding parameters with those obtained when the predators were fed *Aphis craccivora* Koch (Hemiptera: Aphididae), a common prey for both species. Finally, the preference for either of the two prey species was analyzed. *Nabis provencalis* preyed on a greater number of *H. postica* larvae than *C. septempunctata*, although the ingested biomass of *H. postica* did not differ between the two predators. When comparing both diets, the ingested biomass and relative growth of *N. provencalis* were significantly higher when fed on alfalfa weevil, although it exhibited greater conversion efficiency when fed on aphids. A preference of *N. provencalis* for *H. postica* was observed. On the other hand, *C. septempunctata* showed greater relative growth and conversion efficiency when fed on *A. craccivora*, also displaying a strong preference for this prey. This study highlights the greater potential of *N. provencalis* as a predator of *H. postica*, as well as the higher suitability of *A. craccivora* for both predators.

Keywords: Medicago sativa, Coccinella septempunctata, Aphis craccivora, voracity, nutritional suitability, prey preference

*Speaker

Does the natal fly host species affect host preference and parasitization efficiency of pupal filth fly parasitoids?

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Filth flies are a common problem in the livestock industry, having negative effects on the health and wellbeing of livestock and their caretakers, leading to economic losses. With an increasing need for integrative pest management that relies less on pesticides, focus is shifting more to biological control such as the use of parasitoids. To determine whether rearing methods can improve parasitoid efficacy, we investigated the effect of natal fly host species on host preference and parasitization behaviour of three pupal parasitoids, Muscidifurax *raptorellus* (Kogan and Legner), *Nasonia vitripennis* (Walker) and *Urolepis rufipes* (Ashmead). Wasps were raised for either 1 or multiple generations on *Musca domestica* L. or *Calliphora vomitoria* L. (both Diptera) pupae. Overall, the natal host had either minimal or no effects on host preference, and raising the wasps for multiple generations on a host species did not alter this. *N. vitripennis* and *U. rufipes* consistently parasitized more pupae of both host types when raised on the larger *C. vomitoria* host. We will report on additional experiments that control for wasp size and that use Y-tube choice assays with chemical signals emitted by the fly hosts. We conclude that host size is more important than host species for improving efficiency of filth fly parasitoids as biological control agents.

Keywords: Filth fly, pupal parasitoid, host preference, natal host, behavioural assays, biological control

*Speaker

Getting to the heart of the matter: How does lettuce plant architecture affect aphid predator foraging behaviour?

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Host plant architecture can influence predator foraging behaviour and biocontrol agent efficacy. The pest aphid *Nasonovia ribisnigri* feeds throughout the lettuce plant, including in the closed heart, where it is protected from contact insecticides and some natural enemies. To optimize conservation biocontrol, it is important to identify which natural enemies can exploit aphids within the lettuce heart. Syrphid larvae are known to reach the heart, but it remains unclear for coccinellids.
We compared where on lettuce plants three larval predators exploited aphids. We expected the large spiny coccinellid *Harmonia axyridis* to feed less in the heart than the similar-sized but narrower-bodied syrphid *Eupeodes americanus* and the smaller coccinellid *Coleomegilla maculata.*

Under greenhouse conditions, lettuce plants were inoculated throughout with *N. ribisnigri.* One predator larva, or no predator, was introduced per plant for 24 hours, after which each predator's position and the number of aphids per leaf was recorded. Among the larvae recovered on the plant, the syrphid was found significantly deeper in the plant than either coccinellid ($p < 0.01$). On average, *E. americanus* was found on the 4th leaf inside the heart, *H. axyridis* on the leaf marking the start of the heart, and *C. maculata* on the second leaf outside the heart. Aphid densities throughout the plant did not differ among the treatments.
These findings indicate that all three predators can access the lettuce heart to some extent. Contrary to predictions, the size and spininess of *H. axyridis* do not prevent its access. Further research is needed to understand how the predators impact aphid populations. If the predators tend to occupy different parts of the plant, this may contribute to diet differentiation between them since different aphid species occupy different parts of lettuce. It may also help reduce encounter rates among predators, thereby reducing intraguild predation.

Keywords: Syrphidae, Coccinellidae, conservation biocontrol

*Speaker

Olfactory responses of *Ganaspis kimorum* and L*eptopilina japonica* (Hymenoptera: Figitidae) to host-associated chemical cues

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Ganaspis kimorum and *Leptopilina japonica* (Hymenoptera, Figitidae) are promising candidates for the biological control of *Drosophila suzukii* (Diptera, Drosophilidae), a invasive pest affecting soft fruits, strawberries and c herries. *Ganaspis kimorum* is specialized in attacking host larvae in ripening fruits, whereas *L. japonica* exhibits broader ecological plasticity, parasitizing larvae in both ripening and decaying fruits. Olfactory cues play a crucial role in host location, but their interaction with rearing conditions and host development remains poorly understood. Two-choice olfactometer assays were performed to study the behavioral responses of *G. kimorum* and *L. japonica* to chemical cues associated with *D. suzukii*-infested fruits. Female parasitoids were individually tested for their response to infested *vs* healthy fruit, infested fruit *vs* air, and healthy fruit *vs* air. The effect o f r earing s ubstrate w as e valuated b y t esting p arasitoids reared on blueberries, raspberries, or artificial d iet. P arasitoid r esponses w ere a nalyzed f rom e arly *D. suzukii* infestation for seven days (T0–T6). Volatile organic compounds released by the tested targets were collected and analyzed.

The results revealed species-specific responses t o host-associated chemical c ues. *Ganaspis kimorum*, reared on blueberries, was attracted to fruits at early infestation stages but repelled by degraded fruits with mature host larvae. When tested on raspberries after being reared on blueberries, it showed no significant p reference b etween i nfested a nd h ealthy f ruits b ut significantly avoided both when tested against air. *Leptopilina japonica* reared on fruit-based substrates preferred infested fruits over air, particularly at early infestation stages (T0–T2), but did not show a significant preference between infested and healthy f ruits. In comparison, females reared on an artificial d iet e xhibited a l ower responsiveness.
These findings emphasize t he role of chemical cues in host location, t he impact of early olfactory conditioning, and the effects o f r earing s ubstrates, o ffering in sights fo r op timizing parasitoid rearing and enhancing the *D. suzukii* control.

Keywords: Drosophila suzukii, biological control, parasitoids, olfactory conditioning, volatile organic compounds, host location, rearing effects

*Speaker

Fruit domestication impacts oviposition preference and performance of a parasitoid wasp

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Domestication syndrome involves the suite of phenotypic changes that distinguish wild from domesticated organisms. These changes can significantly influence not only plant interactions with insect herbivores but also associations with their natural enemies. Previous studies have shown that domesticated highbush blueberries (*Vaccinium corymbosum*) produce larger berries with lower phenolic content compared to their wild counterparts, which enhances the performance of the invasive spotted-wing drosophila (*Drosophila suzukii*). Conversely, wild blueberries are more attractive due to their higher volatile emissions. This study examined how blueberry domestication affects the oviposition preference and performance of *Ganaspis kimorum*, a larval koinobiont endoparasitoid of *D. suzukii*. To evaluate oviposition preference, gravid *G. kimorum* were subjected to 10-minute, no-choice behavioral assays on infested wild and cultivated blueberries, during which behaviors on- and off-berry were recorded. Wasp performance was assessed by measuring adult emergence rates from infested wild and cultivated blueberries and documenting emergence timing, adult size, and sex ratio. Physical and chemical traits of blueberries across domestication levels were also analyzed, including berry size, sugar content (Brix), and total phenolic content. The results revealed significant differences in *G. kimorum* behavior and performance between wild and cultivated blueberries, correlating with variations in berry chemical and physical traits. These findings highlight the impact of domestication on tri-trophic interactions and offer valuable insights for optimizing biological control strategies against *D. suzukii*.

Keywords: Ganaspis kimorum, spotted wing drosophila, tritrophic interactions, blueberries

*Speaker

Complex interactions in host-selection: decoding behaviour in *Sclerodermus cereicollis* for effective pest control

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Sclerodermus cereicollis Kieffer (Hymenoptera, Bethylidae) is a potential biological control agent for wood-boring beetles. Initially recorded in Italy in association to the exotic *Psacothea hilaris hilaris* (Pascoe) (Coleoptera, Cerambycidae), this native parasitoid could also be used against other invasive longhorn beetles. To enhance its efficacy in biocontrol programs, experimental trials were conducted to investigate *S. cereicollis* bioethology, focusing on developmental cycle, reproductive behaviour, and the feasibility of mass rearing this species on factitious hosts. Laboratory trials enhanced knowledge of quasi-social reproduction observed in *Sclerodermus*, where several female parasitoids paralyse a host and take care for their communally-produced offspring together. Kinship among female foundresses and host quality both influence host selection. Controlled choice tests, progressively increasingly complexity in terms of host-parasitoid interactions (e.g. parasitoid-host ratios, offspring origin and kinship), showed that foundress kinship, host quality and availability all influence host selection. Further, when multiple females emerge from the same brood, they tend to segregate, possible in order to parasitise as many hosts as possible. These findings improve our understanding of the behavioural-ecological interactions among *S. cereicollis* and have implications for optimizing its application as a biological control agent.

Keywords: Scaling, up, Parasitoid, Bioethology, Kinship, Wood, boring beetles

*Speaker

Modulating trophic interactions among natural enemies of *Tuta absoluta* in tomato crops using artificial sugary diets

Pablo Urbaneja Bernat * [1], Syropoulou Angeliki [1], Vila Sala Marc [1], Riudavets Jordi [1], Arnó Judit [1]

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Tuta absoluta is a major pest threatening tomato crops worldwide, and its introduction into the Mediterranean basin has driven extensive research into management strategies. Current biological control approaches rely on polyphagous predators such as *Macrolophus pygmaeus* and *Nesidiocoris tenuis*, which effectively target *T. absoluta* eggs but offer limited control over larvae. In northeastern Spain (Catalonia), surveys have identified the eulophid *Necremnus tutae* and, more recently, the braconid *Dolichogenidea gelechiidivoris* as the predominant larval parasitoids, suggesting that preserving these natural enemies is a promising strategy for controlling *T. absoluta*. Although previous studies indicated no competitive interactions between *N. tutae* and mirids and between *D. gelechiidivoris* and *N. tenuis*, interspecific competition between *D. gelechiidivoris* and *M. pygmaeus* remains poorly understood. The present study focuses on two key aspects: first, investigating how artificial sugary food sources modulate competitive interactions between *D. gelechiidivoris* and *M. pygmaeus*; second, evaluating how sugary diet contributes to reducing *N. tenuis*-induced damage in tomato crops and influences the behavior of both co-existing mirids. Our experiments show that *M. pygmaeus* exhibits significant intraguild predation on *T. absoluta* larvae parasitized for 72 hours by *D. gelechiidivoris*. Notably, artificial sugar provision significantly reduced this predatory behavior, increasing the emergence of *D. gelechiidivoris*. Moreover, we found that high concentrations of artificial sugars effectively reduce *N. tenuis* populations without adversely affecting *M. pygmaeus*, thereby decreasing plant damage. These findings demonstrated that artificial sugary food sources modulate trophic interactions and potentially enhance biological control. This research was supported by the ADOPT-IPM project funded by Horizon Europe (101060430). Angeliki Syropoulou holds a predoctoral fellowship (AGAUR-FI -2023 FI-1 00749). The CERCA Programme of the Generalitat de Catalunya also funded IRTA researchers.

Keywords: Dolichogenidea gelechiidivoris, Macrolophus pygmaeus, Nesidiocoris tenuis, Intraguild predation

*Speaker

Foraging at night under artificial light: impacts on senescence and lifetime reproductive success for a diurnal insect

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Artificial light at night (ALAN) is an anthropogenic disturbance with ecoevolutionary consequences for both nocturnal and diurnal organisms. It has been hypothesized that light pollution could create a 'night-light' niche providing new opportunities for diurnal organisms to forage and reproduce at night, with fitness consequences still scarcely explored. We exposed diurnal parasitoid wasps (Venturia canescens) to control, low or high intensity of light at night throughout their lives and monitored changes in behavioural and life history traits. Light pollution influenced the night-time activity of wasps, with increased feeding and egg laying at night and a tendency for higher night-time reproductive success under a high intensity of light pollution. Surprisingly, high light pollution also increased the wasps' life span. Light pollution did not significantly affect lifetime reproductive success but did affect the distribution of ovipositions between day and night. Additionally, we showed that reproductive senescence occurred in V. canescens and that offspring development time was influenced by light pollution, in interaction with maternal age.

Keywords: fitness, behaviours, environmental pollution

*Speaker

Convergence in symbiont-induced plant-mediated responses to herbivory: cascading effects for foraging parasitoids

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Convergent evolution arises when unrelated species develop similar traits without a shared ancestral origin possessing those characteristics. While typically observed at the organismal level, it can also occur at higher levels of biological organization. Polydnaviruses represent a striking example of convergent evolution. These viruses, divided into bracoviruses and ichnoviruses, were independently acquired by braconid and ichneumonid parasitoid wasps respectively, to deliver pathogenic genes to caterpillar hosts. Here we show convergent patterns across trophic levels, demonstrating that both bracoviruses and ichnoviruses induce changes in plant-phenotypic traits that specifically benefit their parasitoid partners, facilitating plant-mediated host discrimination. This is achieved through an interaction network triggered by changes in the polydnavirus-infected herbivore (via alteration in regurgitant composition) which eventually affected parasitoids' foraging decisions. Our findings unveil a novel ecological benefit that polydnaviruses offer to their parasitoid partners through intricate, plant-mediated effects, providing evidence of convergence in symbiont-induced responses in terrestrial trophic systems.

Keywords: PDVs, Parasitoids, tri, trophic interactions

*Speaker

Experimental evaluation of the voracity and predation behavior of a set of natural enemies of pests in Clementine orchards.

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Corsican clementine trees are the target of numerous pests and pathogens. To face these attacks, pesticide products are used intensively by farmers, degrading orchard ecosystems and biodiversity. To reduce pesticide use, fostering natural biological control is a key. This requires quantifying the service provided by natural enemies in terms of natural regulation provided by these insects. In our study, we aimed to assess the predatory behaviors of the most abundant natural enemies in corsican clementine orchards on the main pests observed in the orchards. We accordingly implemented laboratory experiments with 4 specialist predators, the coccinellid species *Coccinella septempunctata, Adalia bipunctata, Propylea quatuordecimpunctata* and *Cryptolaemus montrouzieri* and one generalist, an earwig species, *Forficula auricularia* and 3 prey species, an aphid, *Aphis fabae*, a mealybug, *Pseudoccocus sp.* and a whitefly, *Trialeurodes vaporariorum*. First, the actual prey range of each predatory species was assessed. Then, a feeding experiment was carried out with each predator and their prey range to assess their voracity. Several experiments were conducted by modulating parameters which have an impact on their voracity: (i) the sex and (ii) the developmental stage of the predator. These experiments allowed us to estimate a global predatory rate of the entire community of predators on each prey depending on the composition and abundance of the community in the orchard. The aim of this indicator is to be used to modulate pesticide use to control pest infestations depending on the abundance and composition of the community of natural enemies.

Keywords: voracity, biological control, natural enemies, Clementine orchards, pests, Coccinella septempunctata, Adalia bipunctata, Propylea quatuordecimpunctata, Cryptolaemus montrouzieri, Forficula auricularia, Aphis fabae, Trialeurodes vaporariorum, Pseudoccocus sp.

*Speaker

Effects of defensive symbionts on aphid natural enemies: Mechanisms and Behaviour

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Symbiotic interactions between animals and microorganisms are widespread. In herbivorous insects, microbial symbionts play a key role in shaping insect biology and their interactions with plants and natural enemies. A well-documented example is the defensive bacterium Hamiltonella defensa, which protects aphids from parasitoids. While its role in aphid resistance to parasitoids is well established, two crucial gaps remain: (1) the mechanism by which some parasitoid geno-types overcome H. defensa-mediated defence, and (2) the effect of H. defensa on the attraction of aphid predators to volatiles emitted by infested plants.

In the first part of this study, we investigated the role of parasitoid venom in overcoming aphid resistance conferred by *H. defensa*. Using genetically identical lines of *Aphis fabae* that varied in their *H. defensa* infection status, we assessed the impact of venom on parasitism success. We extracted venom glands from *Lysiphlebus fabarum* parasitoids and injected parasitoid eggs, with or without venom, into aphids. By measuring parasitism success across different aphid lines, we aimed to determine whether venom facilitate parasitoid development in resistant hosts.

In the second part, we explored how *H. defensa* influences the attraction of multiple natural enemies to volatiles emitted by aphid-infested plants. Using an olfactometer, we tested the preference of four natural enemy species for plants colonized by aphids with or without *H. defensa*. The time spent near each plant was recorded to assess attraction, and additional analyses of volatile organic compounds (VOCs) provided insights into the underlying chemical mechanisms.
By combining these approaches, our results provide novel insights into the effects of *H. defensa* on parasitoid success and natural enemy behaviour. These findings contribute to a better understanding of aphid resistance mechanisms and inform the development of more effective biological control strategies.

Keywords: parasitoid, venom, symbiosis, performance, tritrophic interaction, plant volatiles, choice

*Speaker

The plant-mediated effect of C*otesia glomerata* parasitism and symbionts on parasitoid recruitment

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Plants are in a constant battle with insect herbivores. When plants perceive insect-derived cues like feeding damage, they often enhance their defences to the specific herbivore. This induced defence can directly affect the herbivore, or can be indirect by recruiting natural enemies of herbivores. One of those indirect defences is the production of herbivore-induced plant volatiles. These volatiles can be attractive to a wide array of other insects in the third trophic level, like parasitoid wasps. These are wasps that lay their eggs inside herbivores, which makes them effective biocontrol agents. We have a lot of knowledge about how herbivores influence their food plant and the insect-plant community. However, little is known about what happens with these interactions once parasitoid wasps have parasitized these herbivores. Recent studies have identified that parasitoids can have a great, top-down plant-mediated effect on the community through both behavioural- as well as physiological changes in their host.
Cotesia glomerata is a parasitoid wasp that carries a polydnavirus (CgPDV). Along with injection of eggs, the parasitoid infects its caterpillar host *Pieris brassicae* with CgPDV, resulting in physiological changes in the caterpillar that benefit the offspring of parasitoids that develop inside the caterpillars. At the same time changes in the physiology of the parasitized caterpillar influence the defensive response of its food-plant and thereby interactions with other community members.
In my research, I investigate whether this altered plant response results in differential attractiveness to both conspecific parasitoid wasps as well as parasitoids of different herbivore species. My findings in the lab and field demonstrate how parasitoid wasps and their symbionts can have a significant, plant-mediated ecological effect on the rest of the insect-plant community, e. g. by affecting colonisation of plants by other herbivores and influencing the attraction of parasitoids associated with these herbivores.

Keywords: plant, mediated interactions, attraction, volatiles, symbiotic agents, community ecology, behavioural ecology, colonisation, polydnavirus, venom, physiological changes

*Speaker

Host-parasitoid communities under global warming: insights from microcosm experiments

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Current warming trends are expected to have direct effects on species through their sensitivity to temperatures, but also on their biotic interactions, ultimately impacting individuals, populations, communities, and ecosystems. In response to global warming, many species have already shifted their ranges and phenology, leading to novel communities of species that did not co-occur or interact before. To forecast ecological consequences of further changes in the environment, it is thus important to investigate the effects of both the abiotic and the biotic contexts that organisms experience, and the interplay between these factors. Using a series of microcosm experiments on a set of Drosophila species and their parasitic wasps naturally co-occurring in Australian tropical rainforest, we probed the joint effects of abiotic and biotic environmental changes due to global warming on species interactions and communities. Our experimental approach allowed us to control both the abiotic and biotic contexts in which species interacted. We were therefore able to test if those abiotic and biotic drivers had independent effects, worked in combination, or had antagonistic effects on species interactions and community structure. Consistently throughout our microcosm experiments and across parasitoid species and assemblages, we found a general trend of a decrease in parasitism rates with warming. We also found the effects of multiple parasitoids on host suppression to be affected by thermal change. Further, we highlighted the need to consider the timing of thermal change relative to host-parasitoid interaction and the differences between interacting species in their phenological response to temperature to accurately predict effects of global warming on communities. Our work emphasizes the importance of considering environmental factors and different interaction types to better predict community dynamics in a rapidly changing world.

Keywords: host, parasitoid interaction, Drosophila, global changes, temperature

*Speaker

Global warming and copper pollution: a deadly trap for pest natural enemies in vineyards

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Global change is affecting plant-insect interactions in agroecosystems and may favor the outbreak of non-target pests by affecting natural enemies. In vineyards, the high use of copper-based fungicides has led to an environmental contamination that can affect natural enemies through their host or through direct exposure to pesticide residues. The problems posed by this contamination are all the more critical as global warming may exacerbate some of the effects of copper pesticide on natural enemies. We have tried to consider the possible combined effects of the use of the Bordeaux mixture and global warming on biocontrol methods in vineyards. On the one hand, we investigated the effects of temperature increase and copper-based fungicide contamination on the major vineyard moth pest *Lobesia botrana* as a host for the oophagous parasitoid *Trichogramma oleae*. We exposed *L. botrana* larvae to three concentrations of copper under two fluctuating thermal regimes and then exposed their eggs to *T. oleae*. Our results showed that although the development and survival of *L. botrana* were negatively affected by our treatments, the negative effects on its natural enemy *T. oleae* were even more deleterious. The F1 emergence rate of *T. oleae* was reduced and its development time increased by the combined effects of the warmer regime and increasing copper concentrations. Size, longevity and fecundity of *T. oleae* F1 decreased at high copper concentrations. On the other hand, we focused on the effects of Bordeaux mixture surface contamination on the survival and behavior of *T. cordubensis*. Although this contamination reduced the longevity of *T. cordubensis*, we found no repellent effect of this pesticide. Our studies suggest that the lack of physiological or behavioral responses to Bordeaux mixture toxicity may explain the reduced pest control efficiency of *Trichogramma* species in contaminated environments.

Sublethal pesticide exposure in non-target terrestrial ecosystems: disruptions in trophic interactions and consequences for natural enemies

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The intensification of agriculture has led to increased pesticide use, resulting in widespread contamination of agricultural landscapes, including non-target ecosystems. Plants and arthropods inhabiting these environments are chronically exposed to residual pesticide levels through direct drift and contamination of their nutrient sources (e.g., soil, water, or host/prey tissues). Pesticides-herbicides, insecticides/acaricides, and fungicides-are designed to disrupt specific physiological mechanisms and induce mortality in target organisms (weeds, pest insects, and pathogenic fungi, respectively). However, even at sublethal doses, they can affect biological processes such as metabolism, development, reproduction, and interspecific interactions, including in organisms lacking the pesticide's molecular target.
Among non-target organisms, natural enemies such as parasitoids and predators are known to be particularly sensitive to chemical stress. While extensive research has documented the sublethal effects of pesticides on these organisms, their impact on trophic interactions remains less explored, especially in terrestrial food webs. Such disruptions may trigger cascading effects within trophic chains, potentially harming insect natural enemies through altered interactions with their phytophagous hosts/prey and associated plants.

Through a literature review, we synthesize current knowledge on the target and non-target effects of sublethal pesticide exposure on plants, herbivorous insects, and their natural enemies, with a focus on traits relevant to trophic interactions. This approach highlights the potential consequences of pesticide exposure on plant–herbivore–natural enemy trophic chains in semi-natural habitats adjacent to crops. We also discuss implications for ecosystem functioning and outline key challenges and research directions for understanding pesticide effects on trophic interactions and networks in non-target terrestrial ecosystems.

Keywords: Agrosystems, non, target organisms, phytosanitary products, Plant, Phytophage, Natural enemy interactions, residual doses, trophic web

*Speaker

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

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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 competition for resources between females, followed by a rise in mean temperature (24 ± 2∘C vs 26 ± 2∘C) and more extreme thermal events (26 ± 2∘C with a heat stress at 32∘C) during female oviposition, increase diapause incidence in their 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.

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

*Speaker

Extreme thermal events have more effects on aphid-parasitoid-hyperparasitoid trophic networks than long-term climatic conditions and landscape

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In agrosystems, climate, landscape and biotic interactions constitute filters structuring insect guilds of phytophagous pests and their natural enemies. In the context of global change (homogeneization of landscapes and climate change) characterized by a substantial increase of the frequency and intensity of extreme events, the relative importance of these filters evolves quickly as the selection pressures act differently on each species, with a strong impact on their relative abundances and ecosystem functioning. Among, Human Induced Rapid Environmental Changes (HIREC), the *Climate Extreme Hypothesis*, predicts that extreme thermal events, even if rare, are a key selective agent in the evolution of thermal tolerance. This study focused on three main species of cereal aphids and their associated community of parasitoids and hyperparasitoids, which, due to their worldwide distribution, constitute a model of choice for analysing changes in filters. Conducted on unprecedented geographic (European gradient of 1200km) and temporal (2 years of data, in both fall and spring) scales, our study highlighted two important points. First, climatic effects better explained the population dynamics of the cereal aphids than abiotic (landscape) and biotic (interactions with natural enemies) factors. Second, among climatic factors, the short-term extreme events, both heat waves and cold spells are more important drivers than the average long-term climatic conditions. This study provides a first large scale field evidence of the Climate Extreme Hypothesis. Our results also underlined the necessity to develop new models to predict the population dynamics of cereal aphids at the guild level, for both the fall and winter climatic data. This will be particularly important for agricultural risk assessment in the context of climate change where pest outbreaks and disease expansion are increasing in some agrosystems, like the studied one.

Keywords: Climate change, Climatic extreme events, Geographic gradient, Biotic intercations, Population dynamic

*Speaker

Conservation biological control in winter reduces vector-borne virus incidence in cereal crops

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Most studies that have explored the effect of biological control in maintaining pest populations at acceptable levels have focused on the ability of natural enemies to reduce pest abundances. The reduction in pest populations induced by natural enemies, however, is rarely studied in association with the incidence of viruses transmitted by pests, as well as its impact on crop damage and yield. Here, we performed large-scale winter field monitoring to assess the direct and indirect effects (via arthropod natural enemies) of flower strips along cereal crop margins, on (i) cereal aphid abundance, (ii) the incidence of barley yellow dwarf viruses (BYDVs) transmitted by aphids in autumn and winter, (iii) crop damage, and (iv) crop yield. In 28 cereal fields (over 2 years), we used a paired experimental design to compare a cereal field edge directly adjacent to a flower strip with an opposite (at least 50 m apart) cereal field edge adjacent to a grassy margin. Our results highlight that winter flower strips favoured the activity of ground arthropod predators in the adjacent cereal field but not aphid parasitism rate in winter. Parasitism rate only increased with the complexity of the surrounding landscape. Our results also showed that flower strips reduced both vector abundance and virus incidence in the adjacent cereal field in winter but did not affect virus symptom levels or yields. Damages were low and yield remained high in our study, which may encourage farmers to stop insecticides during the autumn-winter. This study provides a first example of how flower strips along field edges can decrease the incidence of a vector-borne virus in winter and could be used as a strategy to promote more sustainable agriculture.

Keywords: BYDV, cereal aphids, flower strips, natural enemies, yields, winter

*Speaker

Enhancing the biological control of two mirids with banker plants in tomato greenhouses.

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In the tomato greenhouses of the tropical island of la Réunion, the populations of the exotic mirid *Nesidiocoris tenuis* outcompete the indigenous mirid *N. volucer*. Both species are zoophytophagous insects capable of regulating the main pests of tomatoes, but *N. tenuis* under the tropical conditions is deeply damaging the tomato crops (necrotic rings on stems, leaves, flowers and fruits, floral abortion), the problematic is therefore to find ways to maintain and enhance *N. volucer* populations while decreasing *N. tenuis* ones. In two trials, we explored for those species alone or in combination 1) the interest of 4 different potential banker plants (BP) and 2) the transfer performances, from selected BP to the tomato crop. For doing so, we recorded mirids numbers and localisation in the plants, predation capacities through the use of sentinel prey's consumption, and damages on tomatoes. In the first trial, only *Cleome viscosa* and *Calendula officinalis* were of interest as BP, *N. volucer* outcompeted *N. tenuis* in those plants, *N. tenuis* colonised the tomatoes earlier and in mass, while *N. volucer* transferred in the crops in small number after an artificial feeding. Moreover, the mirids localisation, damages and predation levels were not dependant of the distance with the different BP. In the second trial, we confirmed that *N. volucer* needed to be fed with artificial food to spread in the crop, but this spreading was slower and in smaller quantities than for *N. tenuis*. Sentinel prey consumption was higher when located at the top part of the plant for *N. volucer*, decreasing for both species when no banker plant was use or no feeding made. To conclude, BP are promising tools to maintain and enhance *N. volucer* populations, nonetheless, beside artificial feeding, more tools need to be developed to improve their transfer to the crop.

Keywords: banker plant, IPM, zoophytophagous predators, miridae, Calendula officinalis

*Speaker

Exploring the competitive interactions between two parasitoids of *Tuta absoluta*: the native *Necremnus tutae* and the exotic *Dolichogenidea gelechiidivoris*

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Tuta absoluta is a major pest threatening tomato crops worldwide. Biological control remains the main approach in Integrated Pest Management (IPM) strategies for controlling this pest. In the Mediterranean basin, biological control mainly relies on zoophytophagous predators, such as *Nesidiocoris tenuis* and *Macrolophus pygmaeus*, which primarily feed on *T. absoluta* eggs, but have low larval predation rates. In northeastern Spain these predators coexist with larval parasitoids, such as *Necremnus tutae*, native to the Mediterranean region. Another naturally occurring larval parasitoid native to South America, *Dolichogenidea gelechiidivoris*, has also been reported as an effective biological control agent against *T. absoluta* in this area. However, there is a knowledge gap regarding its interactions with other natural enemies outside its native range. Then, the coexistence of these natural enemies targeting the same pest can result in diverse outcomes, including synergistic, additive, or antagonistic effects on *T. absoluta* populations. While previous studies demonstrated that *D. gelechiidivoris* does not compete with *N. tenuis*, its interaction with *N. tutae* remains unexplored. Our ongoing research aims to elucidate these dynamics, exploring the potential competitive interactions between *D. gelechiidivoris* and *N. tutae,* under laboratory conditions. Our results indicate that there is clear interspecific competition between these two parasitoids. Specifically, *D. gelechiidivoris* parasitism rates are significantly reduced in the presence of *N. tutae*, and the progeny emergence of both parasitic wasps decreases when combined. Interestingly, we also demonstrated that *N. tutae* exhibits a preference for host-feeding or host-killing on larvae that were previously in contact with *D. gelechiidivoris* compared to those with no prior contact. These findings provide valuable insights into the interactions between these two larval parasitoids, highlighting the importance of understanding such dynamics to design effective IPM strategies to control *T. absoluta*. This work was funded by ADOPT-IPM (Horizon Europe 101060430), AGAUR-FI (2023 FI-1 00749), and CERCA.

Keywords: ectoparasitoid, endoparasitoid, biological control, competition interactions

*Speaker

The making of - a parasitoid product to control the Spotted Wing Drosophila in Germany

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The spotted-wing drosophila, *Drosopila suzukii*, a globally invasive pest, arrived in Germany in 2011 and caused massive damage, especially to stone and berry fruit, from 2014 onwards. For more than 10 years, we have been working on research into potential biological control agents, including hymenopteran parasitoids. After extraction of suitable antagonists from infested fruit samples collected in different parts of Germany in 2014-2016 and their successful transfer into stable rearing lines, we tested these parasitoids for acceptance, preference and suitability of *D. suzukii* as a new host resource. We identified the two pupal parasitoids *Trichopria drosophilae* and *Pachycrepoideus vindemmiae* as the most promising candidates and investigated their life history in subsequent laboratory and field studies. In 2021, we began our collaboration to develop a parasitoid-based augmentation release strategy to be used in protected berry production. After developing an efficient methodology for quality-assuring mass rearing and testing suitable release devices and application methods, we were able to apply this system in field trials and under practical conditions. In addition, we examined the necessary conditions for integrating parasitoid releases into fruit growing, taking into account both the potential side effects of pesticides, of different temperature scenarios and the possibility of promoting parasitoids with floral resources in the system. Finally, we have succeeded in providing a "parasitoid product" that can be used in net-covered berry crops to sustainably control *D. suzukii*. However, further multi-year monitoring of the effectiveness of these parasitoids is needed to evaluate practical success, especially in close collaboration with farmers.

Keywords: Spotted Wing Drosophila, augmentative biological control, parasitoid

*Speaker

A comparison of natural pest control measurement methods: which indicators do we need to quantify predation?

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Understanding the conditions favourable to the natural regulation of pest insects and adapting management strategies based on this ecosystem service depend entirely on reliable and effective methods of measuring the intensity of predation (the number of preys killed by a predator per unit of time). However, it remains difficult to quantify predation in the field while estimating the specific contributions of a diversity of coexisting predators.
We reviewed the available methods for estimating pest predation, distinguishing between direct or indirect measures (e.g., video recording or DNA-based testing) and inference methods (e.g., estimating predation rates from pest population dynamics) and more general proxies (e.g., predator diversity). We analysed the quantitative, qualitative and semi-quantitative information provided by these methods, from the individual hunter to the predator community, and discussed their field of application, merits and biases. A particular development based on the techniques of molecular detection of prey consumed by predators consists of converting the qualitative information obtained into a quantitative estimate of the predation rate. This also comes with a set of limitations.
None of the methods considered on its own allows for a reliable estimate of the intensity of pest predation by a community of predators while estimating the contribution of each predator species. Fortunately, combining molecular detection data (PCR like) from field-caught predators with estimated abundances of predator species in the field, the most frequently measured variable but which has a noisy correlation with pest predation, offers a promising and elegant way of meeting the challenge. We show how an indicator that aggregates the predation intensities estimated simultaneously for a set of predatory species can be constructed using this approach and provide a new tool for quantifying biological pest control.

Keywords: biological control, quantitative methods, indicator, natural enemy community, pest predation, molecular detection

*Speaker

Biological Control of Stable Flies: An Effective Alternative to Insecticides

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Stable flies (*Stomoxys* spp.; Diptera: Muscidae) are major pests in livestock farming, negatively impacting both productivity and animal welfare. In metropolitan France, economic losses attributed to *Stomoxys* and *Haematobia* infestations are estimated to exceed €400 million per year (Blanc-Debrunne, 2019). In dairy farming, these flies can cause a reduction of 42 to 299 kg of milk per cow per year (Taylor, 2012). For calves raised outdoors, even light infestations can lead to a 16.8 kg decrease in growth compared to protected animals (Campbell, 2001). The repeated use of insecticides has led to the emergence of resistant populations and negatively impacts biodiversity by affecting non-target insects. Furthermore, residual insecticides present in manure used as organic amendments may be dispersed into the environment and persist over time.

To address these challenges, we initially developed an integrated approach combining trapping and biological control. This strategy relied on an optimized trapping system, inspired by Vavoua traps, alongside biological regulation of immature stages using arthropod natural enemies. These include hymenopteran parasitoids (Pteromalidae), which target fly pupae, and predatory mites (Macrochelidae), which attack *Stomoxys* eggs and larvae.

However, due to the unintended impact of trapping on non-target fauna and the highly promising results achieved with biological control, we have since opted to focus exclusively on the latter. The implementation of a biological control program, involving regular releases of parasitoids and predatory mites, has demonstrated very satisfactory results, particularly in Spain and the Netherlands. These findings are supported by a significant improvement in animal welfare and an increase in parasitized pupae on livestock sites, confirming the effectiveness of *Stomoxys* biological control.

Keywords: Keywords: Stomoxys, biological control, parasitoids, predators, livestock, animal welfare, Spain, Netherlands.

*Speaker

Assessment of tachinid flies and egg parasitoids as biological control agents of stink bugs (Hemiptera: Pentatomidae)

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Phytophagous stink bugs are major pests of several crops. Among them, *Edessa meditabunda* (Hemiptera: Pentatomidae) has gained greater importance in the Neotropics in the last two decades. This pest causes damage to lettuce, tomatoes, eggplant, strawberries, quinoa, sunflowers, corn, wheat, cotton, among other crops, resulting in significant production losses. Broad-spectrum insecticides are used in high doses and with repeated applications to control this pest, with significant negative environmental, sociocultural, and economic impacts. In this context, biological control is explored as an alternative tool to control *E. meditabunda*. We evaluated the performance of two parasitoids of different guilds, as potential candidates for the biocontrol of *E. meditabunda*: the tachinid fly *Neobrachelia edessae* which exploits adults as hosts, and the egg parasitoid *Trissolcus urichi* (Hymenoptera: Platygastroidea). In the first case, biological information of *N. edessae* is practically lacking while *T. urichi* is an important parasitoid of various pentatomids but little is known about its ability to attack the eggs of this particular host. Regarding *N. edessae*, we found that on average, it parasitized 70% of offered hosts, equally distributed between host sexes (n=102; c2=0.023; p=0.88; df=1). Moreover, the tachinid significantly reduced the longevity (F=20.25; df=1; p> 0.001), fecundity (F=11.23; df=1; p=0.001) and fertility (c2=7.32; df=1; p=0.007) of parasitized *E. meditabunda*. On its turn, *T. urichi* parasitized 87% of offered egg masses and 84% of total eggs, and the progeny's female proportion per parasitized egg mass was 0.738. Our findings are promissory for the design of biocontrol programs to manage *E. meditabunda*, based on the use of *N. edessae* and *T. urichi* parasitoids, both alone or in combination.

Keywords: PARASITOIDS, BIOLOGICAL CONTROL, GUILDS OF NATURAL ENEMIES

*Speaker

Classical biological control of orange spiny whitefly, *Aleurocanthus spiniferus* (Quintance) (Hemiptera: Aleyrodidae) in Greece

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Aleurocanthus spiniferus (Quintance) (Hemiptera: Aleyrodidae), orange spiny whitefly, is an invasive species from Southeast Asia. Its invasion in Europe commenced in 2008. In Greece, it was first reported in 2016 on the island of Corfu, and soon, it was spread in Western Greece causing devastating damages to citrus crops. Successful classical biological control (CBC) programs with the introduction of natural enemies of the pest have been implemented in several countries that the orange spiny whitefly had invaded. The implementation of a CBC program initiated in 2022 against *A. spiniferus.* For that reason, exploratory investigations were conducted in specific countries to retrieve potential natural enemies of *A. spiniferus.* Samples from the investigations were imported to Greece and directly placed in the quarantine facilities at Benaki Phytopathological Institute in Athens. The emerged parasitoids were isolated by species, identified and placed in cages with nymphs of *A. spiniferus.* A colony of the only parasitoid species that had recovered, *Encarsia smithi* Sylvestri (Hymenoptera: Aphelinidae) was successfully established within a month. Thereafter, an evaluation of the biological characteristics of *E. smithi* took place including host specificity tests, longevity, and overwintering capacity. Before the initial releases, host specificity was tested on three whitefly species *Aleurothrixus floccosus* Maskell (Hemiptera: Aleyrodidae), *Dialeurodes citri* (Ashmead) (Hemiptera: Aleyrodidae), and *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae). No parasitism was observed on any of the above species. Initial field releases took place from April until October 2024 in 6 regions of Western Greece. Approximately 4.000 adults were released. Surveys conducted in the releasing spots a few months after the initial releases demonstrate that *E. smithi* has successfully established in almost all the releasing points. The percentage of parasitism reached up to 5% in these locations. New releases of *E. smithi* are ongoing in 2025, and we continue monitoring its dispersal and efficacy.

Keywords: parasitoid, hymenoptera, Aphelinidae

*Speaker

Nectar-inhabiting bacteria affect the longevity of adult parasitoids

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Habitat management with the aim to support resident populations of natural enemies is often used in Conservation Biological Control (CBC). The establishment of flowering plants is one common strategy of CBC, since wild flora provide food resources such as floral and extrafloral nectar to a wide range of predators and parasitoids. It is well-documented that nectar is inhabited by microbial communities which have the capacity to modify its chemical profile; however, the effect of nectar fermentation by bacteria on parasitoids remains to be thoroughly explored. In this study, we examined how synthetic nectar may affect the longevity of parasitoids after nectar fermentation by different bacterial isolates belonging to the phyla Bacillota, Pseudomonadota, and Actinomycetota. These bacteria had previously been isolated from the floral nectar of *Fagopyrum esculentum* (Polygonales: Polygonaceae), which has been shown to enhance parasitoid longevity. Synthetic nectar was prepared by filter-sterilizing sucrose solution mixed with casamino acids. The nectar was subsequently inoculated with different bacterial strains at an optical density of 1 (OD=1). The synthetic nectar types, following bacterial fermentation, constituted the treatments, while the non-fermented synthetic nectar served as the control. The longevity bioassays revealed either positive, neutral or negative effects on parasitoid longevity, suggesting a species-specific effect of the different bacteria on parasitoid performance. These results, when considered in conjunction with a chemical analysis of the fermented nectar, demonstrate the manner in which the induced alterations by the bacteria in the chemistry of nectar can affect the performance of parasitoids.

Keywords: nectar, parasitoids, Conservation Biological Control, Bacillota, Pseudomonadota, Actinomycetota

*Speaker

Floral enrichment effect on the biodiversity and ecosystem services in European agricultural landscapes along a European Gradient with Climate and landscape variations.

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Biodiversity loss is one of the most pressing issues that humanity has to face. In conventional farmland it can lead to a loss of beneficial organisms, such as parasitoids and predators of pests which are essentials for an integrated pest management through biological control. This biodiversity can be preserved through the improvement of plant biodiversity through the establishment of hedges and flowering strips.
As part of a project using the approach of living labs, that promote the involvement of citizens in science, 10 farmers are participating in the collective implementation of flowering strips and the monitoring of the farmland biodiversity at 5 locations in Europe: Brittany and Picardie in France, Belgium, Germany and Czech Republic. This study is done on 8 taxa (Aphids, parasitoids, hyperparasitoids, spiders, carabids, pollinators (syrphids and bees), slugs, and a vegetation survey), in both winter and spring seasons, and along a climatic gradient from the mild Atlantic climate to the more continental climate of central Europe. We determined the effect of floral enrichment, and analyzed the separated and complementary role of hedges and flower strips by comparing 4 modalities: presence of Hedge alone (HC), Hedge with Floral strip (HF), Floral strip along a Grass margin (GF) and Grass margin alone (GC). We monitored the abundance of rove beetles, ground beetles, spiders, as well as the interaction between each species of aphids of cereals, their parasitoids and their hyperparasitoids in order to analyze the abundances, diversity and community networks and infer the improvements of the ecosystem services of pest regulation brought by the presence of the enrichments.
This study will thus help to provide European-wide solutions relevant in each location according to land-use and climate change and help to effectively design plant enrichment that supports pest and weed control as well as pollination at the European scale.

Keywords: pest management, biological control, aphids, parasitoids, hyperparasitoids, spiders, carabids, syrphids, bees, slugs, rove beetles, ground beetles, ecosystem, services

*Speaker

Floral nectar provision improves parasitoid wasp biological control efficiency

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Biological control strategies often aim to improve the abundance of natural enemies through introduction, augmentation, and habitat conservation. As such, increasing the populations of parasitoid wasps, can offer an effective strategy for managing pest populations. However, in the absence of their host species (frequently aphids) parasitoid wasps often require nectar from flowering plants to maintain their longevity, fecundity, and overall fitness. Supplying floral resources in agricultural landscapes can improve the survival and effectiveness of parasitoid wasps, thus potentially enhancing pest control management. There is therefore the need to identify suitable plant species to provide accessible nectar and/or extra floral nectar for parasitoid species.
This paper presents findings from controlled experiments assessing the ability of nectar-bearing flower species to sustain the parasitoid *Aphidius ervi* in the absence of aphids. The selection of plants was based on flower morphology, presence of floral nectaries/extrafloral nectaries (EFNs) and whether species are found in Scottish agroecosystems. This study assessed four flowering plants: buckwheat (*Fagopyrum esculentum*), phacelia (*Phacelia tanacetifolia*), hairy vetch (*Vicia villosa*) and faba bean (*Vicia faba*). The plants were evaluated for their impact on *A. ervi* longevity and parasitation efficiency, in the presence and absence of flowers and EFNs.
Wasp survival was significantly enhanced by all four plants species when bearing flowers, in comparison with plants which had been stripped of their flowers. Additionally, wasp survival was significantly enhanced by the presence of faba bean EFNs in comparison with bean plants devoid of flowers and EFNs. Parasitisation efficiency, measured by the population mummification rate of the aphid *Sitobion avenae,* was also significantly enhanced by all four plant species, in the presence of flowers, compared with plants devoid of flowers. Fieldwork this summer will test the efficacy of flower species to support parasitoid longevity and parasitisation efficiency; specifically faba beans in a barley/bean intercrop trial.

Keywords: Parasitoid wasps: Biological control, Aphidius ervi: aphid, Sitobion avenae, nectar, flowers

*Speaker

Attraction response of *Mastrus ridens* (Hymenoptera: Ichneumonidae) to flowers of seven plant species and response relationship with different floral traits

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Most parasitoids in their adult lives benefit from sugary diets, significantly extending their longevity and fecundity. The nectar provision hypothesis for parasitoids indicates that since modern intensive agroecosystems do not provide natural sugar sources, if nectar is provided near crops, the biological control exerted by parasitoids can be improved. However, the nectar of these flowers must be available, accessible, and nutritious, and the flowers must also be attractive to parasitoids. The main objective of this work was to evaluate the attraction of flowers of five native species of Chile (*Cistanthe grandiflora*, *Encelia canesencs*, *Lycium chilense*, *Spharealcea obtusiloba* and *Teucrium bicolor*) and two exotic species (*Lobularia maritima* and *Fagopyrum esculentum*) for *M. ridens* (Hymenoptera: Ichneumonidae), a specialist parasitoid of the codling moth. In addition, different floral traits were measured to explore whether they are associated with the parasitoid response. The most attractive species were the native *Teucrium bicolor* and the introduced *Lobularia maritima* (Allysum) which had several similar floral traits. The number of flowers/inflorescences per cluster also positively influenced the visits of the parasitoid. This study emphasizes that proper selection of flowering plants is essential for the success of biological conservation control.

Keywords: Parasitoid, Insect, plant interaction, floral resources, conservation Biological control.

*Speaker

A summer-flowering desert tree supports local parasitoids: prospects for conservation biological control

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Abstract

Conservation biological control often relies on adding herbaceous vegetation within and around crop fields to support native natural enemies. Dryland ecosystems cover 41% of the world's land and support over 38% of the global population, making their conservation and sustainable management crucial. Many arid ecosystems contain abundant and diverse parasitoid assemblages. Nevertheless, these parasitoids are rarely managed for conservation biocontrol because of the challenges of growing non-crop herbs under water shortage. *Ziziphus spina-christi* L. (Rhamnaceae), a common wild tree in Middle Eastern drylands, thrives under hot and dry conditions and flowers for several months in summer. To explore *Z. spina-christi*'s potential to provide resources for local biocontrol agents, we characterized its parasitoid community in different seasons and in four sites along a climate gradient (200-600 mm annual rainfall) in Israel. A leafminer parasitoid (*Zagrammosoma ramotensis*, Eulophidae) dominated the samples, followed by two braconids (*Glyptapanteles sp.* and *Gnamptodon sp.*) that parasitize various lepidopterans. The abundance of sampled parasitoids did not show a geographical trend across the four study sites. Total parasitoid abundance peaked in summer, and correlated with the wasps' frequency of sugar feeding and with the trees' flower numbers. These findings suggest that adult parasitoids feed on nectar from *Z. spina-christi* flowers during the hot summer, when other nectar sources in the desert are limited. Growing dryland summer crops next to *Z. spina-christi* stands may increase parasitoid densities in the fields, improving natural pest control with no need for additional irrigation. In future research, we will test this hypothesis by placing tomato plants, infested by the leafminer pest *Tuta absoluta*, at increasing distances from flowering *Z. spina-christi* trees. We will test whether parasitism rates by the dominant parasitoid *Zagrammosoma ramotensis*, as well as pest damage to the crop plants, vary with distance from the *Z. spina-christi* trees.

Keywords: desert, conservation biological control, nectar feeding, leafminer parasitoid

*Speaker

Resolving whitefly-natural enemy trophic connections in vegetable-cotton landscapes

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Generalist predators have the potential to provide biological control services for the whitefly, *Bemisia tabaci*, but their feeding on alternative prey may reduce efficacy. Review of generalist predators commonly observed feeding on or suppressing whitefly populations suggests at least 30 species feed on whiteflies. In addition, review of biodiversity ecosystem service delivery promotes diverse communities as important for contributing to regulation of *pests* in agricultural landscapes. For whitefly regulation specifically, however, challenges remain as vegetable-cotton landscapes contain risky areas of highly intensive management and frequent application of insecticides. Here we provide an overview of studies at the field level for unraveling food webs of generalists within whitefly systems, and zoom out to the landscape level to reveal patterns of landscape dependence on whitefly regulation and generalist predator use of alternative prey.

*Speaker

Do food webs studies in apple orchards reveal buffering ability of key natural enemies against plant pests?

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Maintenance of ecosystem services can depend on understanding the structure of community webs and the consequent promotion and conservation of pest suppression interactions. Research on beneficial insect species that are naturally present in cultivated apple in Finland and their roles in community food webs will contribute to pest management, e.g. through crop and agri-environment diversification, which can provide beneficial insects with alternative food sources when pests are seasonally scarce. The common flowerbug, *Anthocoris nemorum,* is a predatory insect found in apple trees. Coccinellids are known to be influenced by crop management practices. Insects were collected in a 10-year-old orchard in Finland. Predator, prey and plant species were identified by multiprimer metabarcoding sequencing. In the preliminary analyses to study the prey range of *A. nemorum,* DNA fragments from taxonomic families among arthropod orders Diptera, Hemiptera, Lepidoptera, Coleoptera, Arachnida, Collembola and Psocoptera were identified. We will present estimates of community structure based on literature records and on direct empirical assessments of feeding relationships. Trophic interactions identified from empirical and literature study will be visualized and analyzed using metrics that describe and analyze the structure (topology) of trophic webs, including 'Connectance' (a proportional measure of community complexity), 'herbivore overlap' and the 'potential for apparent competition' (a form of indirect ecological interaction).

Keywords: Anthocoris nemorum, Coccinellids, feeding relationships, community ecology, DNA, NGS

*Speaker

Balancing Complementarity and Intraguild Predation to Enhance Long-Term Biocontrol Services

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Biodiversity plays a crucial role in maintaining ecosystem functions, including biological control. The biodiversity-biocontrol relationship suggests that diverse predator assemblages enhance pest suppression through functional complementarity through species trait differentiation (e.g., hunting strategy, resource use, or temporal activity). Complementarity promotes predator coexistence, reduces competition, and may sustain pest control. However, the benefits of natural enemy diversity on biocontrol can be undermined by antagonistic interactions, particularly intraguild predation, where predators consume each other while sharing a common prey. This antagonistic interaction among natural enemies can reduce suppression of the shared prey, but in some cases, it can facilitate enemy persistence and support long-term biocontrol services. The relative contributions of complementarity and intraguild predation on long-term biocontrol services thus remain unclear, and experimentally untested. To address this gap, we conducted a long-term multigenerational experiment using population cages in which we evaluated eight predator combinations that shared a common prey, the aphid *Myzus persicae*. Predators included predatory bugs, hoverflies, lacewings, midge flies, and parasitic wasps, all of them provided by our industrial collaborator Biobest. Enemies were paired based on two main conditions: (i) their functional complementarity (based on predatory traits like hunting strategies, and morphology), and their functional guild (hoverfly, parasitoid, predatory bug, etc), (ii) and their intraguild potential. We assessed the potential of these predator communities to persist over time and maintain stable biocontrol services. We hypothesize that enemy communities with larger complementarity and lower intraguild potential will provide better biocontrol services, and will allow a long-term enemy coexistence. Our findings will provide insights for designing effective natural enemy combinations and will ensure the persistence of released natural enemies in augmentative biocontrol.

Keywords: Biodiversity, Intraguild predation, complementarity, coexistence, biocontrol

*Speaker

Intra-annual dynamics of the carabids' diet in oilseed rape fields

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Carabids are polyphagous and opportunistic predators capable of playing the role of pest regulators in crops. However, most studies on the trophic ecology of carabids lack an analysis of potential temporal variations in pest regulation. Studying their diet and its intra-annual dynamics could help identify key periods for efficient pest regulation.
In this study, we used a metabarcoding approach to analyze the spectrum of animal and plant prey consumed by adult carabid beetles from oilseed rape fields and to investigate its dynamics in spring, from March to June in 2021 and 2022.

Our results revealed that both pest predation and intraguild predation occur dynamically during the spring. Pest predation is at its peak at the beginning of the crop season, while intraguild predation reaches its maximum during the middle of the season. The availability of resources and the predator preferences of different carabid species may explain these temporal dynamics. The redundancy in pest predation among the various carabid species also helps explain why pest consumption remains relatively high throughout the spring. Regarding plants, we found that oilseed rape was the main plant resource consumed by the carabid community, with its consumption being dynamic only in 2021, suggesting the significant contribution of Nebria salina, which was particularly abundant that year.
This study suggests that carabids are likely to play a significant role in pest regulation during the early spring. It also highlights the need to study the temporal variation of predator trophic ecology to assess their potential for pest regulation.

Keywords: Metabarcoding, gut contents, pest regulation, intraguild predation, trophic ecology, temporal variations

*Speaker

Assessing the Determinants of the Distribution of Carabid Communities in Agricultural Landscapes Using Joint Species Distribution Models

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Understanding the factors that determine the distribution of carabid communities, the dominant generalist predatory insects in agricultural landscapes, is essential for improving conservation biological control. Joint Species Distribution Models (jSDMs) provide a robust framework to disentangle the relative influences of environmental conditions and species co-occurrence patterns on carabid assemblages. In this study, we used a jSDM to assess the key determinants of carabid distribution (species abundances) in various agricultural landscapes and production systems. We fitted the model on the SEBIOPAG dataset **(1)**, which includes activity-density recorded for 119 carabid species in 60 cultivated fields per year across three regions in France over five years. It provides detailed agronomic and landscape descriptors, including crop type and height, soil disturbance, chemical inputs, fertilization, and the composition of the surrounding landscape **(2)**. Our model accounted for these predictors while incorporating correlations between species via latent factors. This allowed us to distinguish environmental effects from biotic interactions that shape carabid communities. Additionally, the hierarchical incorporation of species traits provided a more generalisable estimate of predictor effects and supports predictions for rare species. By coupling the predicted distribution of ground beetles with a model estimating their pre-dation rates **(3)** we develop a novel bioncontrol indicator that provides a spatially explicit assessment of natural pest control potential. This framework offers a quantitative tool to eval-uate pest regulation capacity at different spatial scales and inform plant diversification strategies.

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*Speaker

Characterization of Domesticated Endogenous Viruses gene function in parasitoid wasps

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These past decades, an increasing number of endogenous viral elements (EVEs) have been identified within eukaryotic genomes. EVEs result from the integration of complete or partial viral genomes into the host germline. While most EVEs are non-functional and gradually decay over generations, some have been retained and repurposed to serve new functions. Among them, one of the most fascinating examples is domesticated endogenous viruses (DEVs).
DEVs represent a particularly complex form of microbial-trait acquisition, where nearly entire viral genomes have been maintained and repurposed in parasitoid wasps - insects that lay their eggs inside other insects. DEVs are organized into multiple loci within the wasp genome and are activated exclusively in a specific ovarian tissue named the calyx, during pupal development and adulthood. These genetic elements collectively orchestrate the production of virions or virus-like particles essential for parasitism. Female wasps inject simultaneously eggs and DEVs into their host, allowing their offspring to develop by infecting host tissues. DEVs have been identified in several parasitoid wasp lineages, which collectively include tens of thousands of wasp species. To date, four distinct DEV groups, each derived from different DNA virus ancestors, have been found in two wasp families: Braconidae and Ichneumonidae. These independent viral endogenization events have similarly led to the production of virus-derived particles used to transmit virulence to hosts, illustrating a remarkable example of convergent evolution.
Despite their crucial role in parasitoid biology, the factors and mechanisms underlying DEV production remain largely unknown. Here, we will discuss about our current understanding of how these unique endogenous viruses are produced and highlight recent advances concerning the functional characterization of genes involved in DEV morphogenesis.

Keywords: Endogenous viruses, parasitoid wasp, viral replication, gene function

*Speaker

Unravelling the amplification of domesticated endogenous viruses in ichneumonid wasps

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Thousands of Ichneumonid wasps harbor viral sequences in their genomes originating from ancient virus integration. Unlike many endogenous viral elements, these sequences remain functional and are activated in the ovarian calyx during the pupal stage. This activation triggers the production of viral particles, which are stored in the oviducts and injected into the insect host during oviposition. The virus is essential for the parasitoid life cycle, as it induces physiological changes in the host, enabling wasp progeny development. To explore the mechanisms of viral particle production from these unusual endogenous viruses, we analyzed proviral DNA amplification, an early step in the process, in the species *Hyposoter didymator*. The proviral genome consists of (i) proviral segments generating encapsidated circu-lar DNA and (ii) viral machinery genes, organized in clusters, encoding structural and regulatory proteins. gDNA sequencing revealed that proviral DNA amplification starts at pupal stage 2, with both types of viral sequences amplified in large genomic regions. Amplification follows an onion skin pattern, similar to Drosophila chorion gene amplification suggesting similar under-lying mechanisms. While both components undergo amplification, viral segments are amplified to a greater extent, suggesting a second round of replication dedicated to producing high levels of circular DNA molecules. To further investigate proviral DNA amplification, we searched for genes from the viral ma-chinery potentially involved in the process. We performed RNAi-mediated knockdown of a candidate gene, U16, encoding a protein with a conserved primase-associated domain, albeit lacking a functional primase domain. gDNA sequencing revealed that silencing U16 clearly in-hibited viral DNA amplification, demonstrating its involvement in this process. Our findings suggest that this protein, inherited from the viral ancestor, has likely retained its original func-tion. Furthermore, our study highlights that investigating endogenous viruses in ichneumonid wasps may reveal novel proteins involved in the regulation of eukaryotic DNA replication.

*Speaker

Keywords: endogenous virus, ichneumonids, DNA amplification, Hyposoter didymator, RNA in-terference

Search for key regulators of endogenous viruses replication in ichneumonid wasps through differential gene expression analysis

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The endoparasitoid ichneumonid wasp Hyposoter didymator relies on Endogenous Viral Elements (EVEs) for its development. Its chromosomes contain viral sequences that become active during the pupal stage in a specific tissue of the female reproductive tract called the calyx. This activation leads to the production of thousands of virus particles, which are secreted into the female oviduct and transferred to the parasitoid's host during egg laying.
With the availability of the H. didymator genome, EVEs have been previously annotated, revealing the presence of more than 60 viral loci dispersed in the 12 wasp chromosomes (Lorenzi et al. 2024, doi: 10.1371/journal.ppat.1011980.). We also annotated essential genes for insect development and physiology, including transcription factors from the Hox and Hepatocyte nuclear factor families, as well as genes involved in ecdysone and juvenile-signaling and other hormone-related genes (neuropeptide receptors and their ligands).

In this study, we aimed to identify key regulators of the endogenous virus replication by comparing the replicative tissue (calyx) with a non-replicative tissue (oviduct) throughout the wasp pupal development. We used microdissection to separate the calyx and the oviduct tissues from more than 500 insects across three pupal stages (five replicates per stage). To analyze the full gene expression profile of the wasp, these samples were sequenced using RNA-Seq, and differentially expressed genes were identified by comparing the two tissues at each time point and by tracking expression changes over time in both tissues.

*Speaker

Our analysis revealed 3,405 differentially expressed genes out of 14,975, grouped into 13 clusters based on shared expression patterns each revealing enrichments of peculiar biological processes or molecular functions. Notably, two clusters contained nearly all EVE genes, while eight differentially expressed transcription factors and hormone receptors were distributed across six clusters.

Keywords: ichneumonid wasp, endogenous virus, transcriptomics

Insights on the evolution of endogenous viruses involved in parasitism success provided by *Toxoneuron nigriceps* (Braconidae, Cardiochilinae) genome

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Endogenization of viral sequences is common in vertebrate genomes but also in insects. However, in most cases integration has no benefit f or t he v irus, w hich i s t hought t o slowly decay under neutral selection. In the case of virus "domestication" the whole endogenized virus is conserved and used to confer new abilities to the host. Domestications have occurred several times during the evolution of parasitic wasps. This results in the production of particles that are used to alter the immune response of another insect, parasitized by the wasp. The particles allow the successful development of wasp progeny, that develop within the body of the parasitized insect. Otherwise, wasp larvae would be killed by immune defenses of the insect. Two families of "domesticated viruses" originating from endogenizations of unrelated viruses have been described, collectively known as polydnaviruses (PDVs) because their particles contain dozens of double stranded DNA circular molecules. Among PDVs, Bracoviruses (BVs) are associated with an estimated 50 000 species of braconid wasps forming a monophyletic group. They are thought to derive from a single integration event of a nudivirus (nudiviruses constitute a sister group of baculoviruses) into the genome of a common ancestor of this group. Bracovirus genes are now widely dispersed in the chromosomes but they act coordinately to produce their particles in specialized cells of wasp ovaries, which morphogenesis resembles that of nudiviruses replicating in the nucleus. High quality genomes have been previously obtained from wasps belonging to two subfamilies of braconid wasps, Microgastrinae and Cheloninae, allowing by comparative genomics to study how a virus evolve in a genome when it confers a benefit to its host. Here we provide the analysis of the bracovirus associated with *Toxoneuron nigriceps* a wasp from a third braconid subfamily, Cardiochilinae. These new data modify the current picture of bracovirus evolution.

Keywords: polydnavirus, parasitoid wasp, comparative genomics

*Speaker

Discovery of endogenous viral elements in Campopleginae wasps suggest widespread nudivirus domestication

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Nudiviruses, large dsDNA viruses related to baculoviruses, can be endogenized in the genomes of certain parasitoid wasp species, allowing the production of viral particles essential for parasitism success. Alphanudivirus genes, within the genome of *Venturia canescens*, an ichneumonid wasp of the Campopleginae subfamily, allow the production of Virus-Like Particles (VLPs) containing virulence factors. The description of many species phylogenetically related to *V. canescens*, in particular from the *Campoplex* genus, offers the opportunity to describe evolutionary processes involved in viral domestication.
The sequencing of the two Campoplex species *C. capitator* and *C. nolae*, allowed the identification of an endogenized nudivirus corresponding to the same endogenization event as the one described in *V. canescens*. Our results show that endogenization of nudiviruses in these parasitoid wasps has repeatedly led to the conservation of the viral RNA polymerase function, allowing the production of functional VLPs. Furthermore, electron microscopy and proteomic approaches revealed that the particles produced by Venturia and Campoplex parasitoid wasps are very similar in morphology and composition. However, interestingly, the virulence proteins contained within the particles were shown not to be the same. This is possibly due to the different host ranges of these wasps, which may have exercised different evolutionary pressures leading to the recruitment of different virulence proteins.

Keywords: Parasitoid wasp, genomics, nudiviruses, virus, like, particles, virus domestication

*Speaker

Improving parasitism success of a weakly virulent parasitoid strain

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Endoparasitoids possess a whole set of virulence factors to counter the immune response of their host, among which can be found venom, endosymbiotic viruses and ovarian proteins. Depending on the species, some factors are expected to be less necessary than others. Notably, venom is reported as inessential in some parasitoids bearing viruses. We investigated the virulence factors of *Cotesia typhae*, a gregarious endoparasitoid of the stem borer *Sesamia nonagrioides*, using an avirulent (CtV-) and a virulent (CtV+) strain. We tested if virulence of CtV- toward a reference strain could be improved by superparasitism (two females per host) or by injection of CtV+ virulence factors (venom and/or ovarian fluid). Superparasitism by two CtV- females could not increase the parasitism success, but superparasitism by one female of each strain could, showing that CtV+ virulence factors are essential for parasitism success. Superparasitism with at least one CtV+ female decreased the reproductive success of both parasitizing females, and increased the number of non-viable offspring revealing larval competition. Parasitism order impacted the offspring proportion of each strain in the total progeny coming out from one host body, suggesting adaptation of egg-laying behavior in response to an already parasitized host. Injection of CtV+ venom or ovarian fluid alone maintained CtV- success unchanged, but their combination increased it to the level of CtV+ success. Altogether, this study hints towards larval competition, potentially specific to CtV+ strain, and suggests that *C. typhae* females can adapt their oviposition behavior based on the parasitic status of their host. It also demonstrates that, like several other *Cotesia* species, *C. typhae* resorts to a combination of venom and ovarian fluid to overcome the host's immune responses.

Keywords: parasitism success, virulence factors, ovarian fluid, venom, competition, superparasitism

*Speaker

Viral flow among citrus mealybugs and their parasitoid complex

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Viruses play a significant role in parasitoid-host interactions, with DNA viruses-particularly polydnaviruses (PDVs)-being the most extensively studied. PDVs are endogenous viruses restricted to two specific families of parasitoid wasps and facilitate parasitism by suppressing the immune system of the herbivore host. Recent research has indicated that other previously overlooked RNA viruses can also influence parasitism success. These RNA viruses are asymptomatic, ubiquitous, and persist as covert infections. Despite their significance, covert infections remain largely underexplored and may be crucial to the effectiveness of biological pest control.
To gain an understanding on RNA viruses associated with citrus pests and their natural enemies, we aimed to first characterize the RNA virome of two mealybug species of significance to Mediterranean citriculture, *Planococcus citri* and the invasive *Delottococcus aberiae*, along with their respective primary parasitoids, *Anagyrus vladimiri* and the recently introduced *Anagyrus aberiae*. Following, we assessed which of these viruses were transmitted during parasitism and examined whether viral transfer extended to hyperparasitoids.

Via high-throughput sequencing, we identified 15 RNA viruses, including 13 newly identified viral species. *Planococcus citri* and *D. aberiae* shared three viruses, while both parasitoids were infected with three common viral species. Notably, *A. aberiae* and *A. vladimiri* transmitted one and three different viruses respectively to their hosts through parasitism. Additionally, we detected viruses from both mealybugs and primary parasitoids in hyperparasitoids.
Overall, our findings demonstrate that covert viral infections are widespread in both mealybugs and their parasitoids and they may transfer across multiple trophic levels.

Keywords: virome, pseudococcids, Encyrtidae, host, parasitoid interactions

*Speaker

Host regulation by insect parasitoids: The induction of diapause

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Winter dormancy is a crucial part in the life cycle of temperate insects. In koinobiont endoparasitoids, the complex mutual interactions between host and parasitoid are still poorly understood. We investigated diapause induction in *Glyptapanteles porthetriae* and *Glyptapanteles liparidis* (Braconidae), two important natural enemies of the oak forest pest *Lymantria dispar* (Erebidae), which obligately depend on alternative hosts for overwintering. *Lasiocampa quercus* (Lasiocampidae) is a potential overwintering host that allows successful emergence of *G. porthetriae* from the majority of host larvae within one month. By contrast, *G. liparidis* emerges from only a small number of *L. quercus* hosts. However, dissections revealed vital diapausing wasp larvae, regardless of the environmental conditions.

We tested the effect of host nutritional and physiological quality on parasitoid diapause induction by using *L. quercus* larvae that were exposed to a 12-hour-photoperiod at 20/10 ∘C (day/night). We determined selected metabolites (soluble carbohydrates, protein, lipids, glycogen) in the hemolymph and fat body of parasitized and unparasitized larvae at weekly intervals. Additionally, we compared the respiration rates of parasitized versus unparasitized host larvae at different times after parasitism. We assessed the developmental status of the wasp larvae by dissecting parasitized hosts regularly.

Two weeks after parasitization, host larvae showed significantly increased concentrations of storage metabolites and higher respiration rates, indicating preparation for diapause. In *G. liparidis*, host nutritional reserves decreased slowly and host and wasp larvae stopped developing, indicating that diapause was manifesting. In *G. porthetriae*, host metabolic reserves peaked three weeks after parasitization and then declined sharply, indicating that the parasitoid larvae consumed sugars and lipids from their hosts. While hosts were developmentally arrested, the wasps completed development and egressed. Non-parasitized hosts accumulated fewer reserves and were not arrested. This implies a significant influence of parasitic wasps on host physiology and phenology even in imperfect host-parasitoid systems.

Keywords: diapause, endoparasitoid, Microgastrinae, metabolism, Glyptapanteles

*Speaker

Integrative Framework for Sustainable Insect Management

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Insects play a vital role in addressing pressing ecological and agricultural challenges. As ecosystems face mounting pressures, insects contribute to biodiversity, soil health, pollination, and natural pest control. For instance, entomophagous insects provide natural pest control, reducing the reliance on chemical pesticides. Their role in integrated pest management (IPM) supports biodiversity, enhances crop resilience, and mitigates the spread of invasive species. The potential of insects extends beyond ecological services-they serve as a sustainable food source, efficient organic waste recyclers, and producers of biobased products like biostimulants and biomaterials. With their vast diversity, insects also impact human, animal, and plant health in both positive and negative ways. They support plant defense through bioactive compounds and provide medicinal properties beneficial for human and animal health. However, they also act as vectors for diseases, posing significant risks. Despite their importance, public policies often fail to incorporate scientific insights, limiting their potential in sustainable solutions. To bridge this gap, we aim to connect research with real-world applications through a structured framework that:

- Evaluates insects' socio-ecological roles through quantitative metrics.
- Integrates theoretical frameworks with stakeholder perspectives.
- Applies sustainability insights to case studies for real-world impact.

These efforts are reinforced by open science initiatives and stakeholder engagement to facilitate knowledge exchange and policy development. By fostering interdisciplinary collaboration, we seek to develop actionable strategies for insect conservation, farming, and pest control, positioning insect-based sustainability as a cornerstone of global environmental solutions.

Keywords: Public policies, insect management strategies, socio, ecological roles and challenges, sustainability, integrative interdisciplinary framework

*Speaker

Posters

The role of alternative plants for the management of *Nesidiocoris tenuis* in South European greenhouses

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The zoophytophagous mirid *Nesidiocoris tenuis* (Reuter) (Hemiptera: Miridae) is among the most effective biological control agents of key tomato pests, including whiteflies and the South America tomato pinworm, *Tuta absoluta*. Augmentative releases in greenhouses and conservative strategies of this mirid predator are commonly implemented in Mediterranean tomato crops. Nevertheless, *N. tenuis* is also capable to develop and reproduce by exclusively feeding on certain plants, and in shortage of prey it can damage tomato plants. Such biological traits facilitate its establishment when releases occur at low densities of target pests. In such a context, habitat management strategies aiming at increasing the diversity of alternative plants could mitigate the adverse impact of *N. tenuis* on tomato plants. Here, we explored the potential of two alternative plants, i.e., sesame (*Sesamum indicum* L.) and verbena (*Verbena x hybrida* Voss), when planted in proximity to tomato, for the management of the mirid in commercial greenhouses. In particular, four plant combinations were compared: (i) tomato + sesame, (ii) tomato + verbena, (iii) tomato + verbena mixed to sesame, and (iv) tomato only. The number of *N. tenuis* adults and nymphs, as well as the number of 'necrotic rings' caused by the mirid feeding activity on tomato plants was counted. The population density of mirid individuals and that of other pests and/or natural enemies was also recorded throughout the entire tomato life cycle. Results showed that both sesame and verbena plants ensured an early establishment of *N. tenuis*. The ratio between the number of 'necrotic rings' and the number of *N. tenuis* individuals recorded on tomato plants was significantly lower in tomato with alternative plants compared to tomato alone. The results suggest how the presence of alternative plants can ensure the early establishment of *N. tenuis* and mitigate its damage to tomato plants in South European greenhouses.

Keywords: habitat management, IPM, mirid predator, natural enemies, verbena, sesame, Tuta absoluta

*Speaker

Does pre-imaginal exposition affect behavioral response of *Trichogramma* egg parasitoid to host pheromones?

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1

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Parasitoid olfactory conditioning (POC) consists in training parasitoids to respond more effectively (strongly and/or specifically) to olfactory signals involved in host recognition (finding and/or acceptance). The POC leverages parasitoids' learning ability either in association with a given reward (i.e. associative learning) or without. This study aims to test POC using a non-associative learning process during the pre-imaginal development of an egg parasitoid.
We focused on the genus *Trichogramma*, which are tiny wasps commonly used for augmentative biocontrol against many Lepidopteran pests. We used *Trichogramma cordubensis* as a model species. We designed a specific experimental setup to study the olfactory preference for egg-laying behavior. The setup was coupled with an image-recognition model, trained with artificial intelligence, that automatically counts the number of parasitized eggs.

We first demonstrated that naive *T. c ordubensis* were slightly attracted to a potential host (*Mythimna unipuncta*) sexual pheromone. We then hypothesized that this attraction would be stronger if individuals had developed in the presence of this odor. Surprisingly, our results suggest the contrary: *T. cordubensis* females that were exposed to the pheromone during their pre-imaginal development were no longer attracted after emergence.
These preliminary experiments seem to indicate that pre-imaginal POC of *Trichogramma* might not be an effective lever to improve their efficiency in augmentative biocontrol program.

Keywords: Conditioning, Olfaction, Kairomone, Egg parasitoid, Trichogramma, Mythimna unipuncta

*Speaker

Oviposition in a parasitoid fly: A matter of host abundance, size, sex, and mating

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Istocheta aldrichi (Diptera: Tachinidae), a parasitic fly specific to the Japanese beetle, *Popillia japonica* (Coleoptera: Scarabaeidae), was introduced to North America from Japan in the 1920s as part of a large biological control program. Very little information has been published on *I. aldrichi* since its introduction, but there is currently a regain of interest because this biological control agent is expanding its range naturally and through redistribution releases in newly areas invaded by the Japanese beetle in USA and Canada. Furthermore, the Japanese beetle has started to invade areas in Europe where *I. aldrichi* is now considered for release. This study is part of a larger research program designed to characterize the biology of *I. aldrichi* and evaluate its population-level impact on Japanese beetle populations. The main objective was to determine the extent to which host sex, size, abundance, and mating influence oviposition decisions in *I. aldrichi*. Using field-captured Japanese beetles, over a six-year period (2019–2024) in Quebec, Canada, we showed that (i) there is strong bias toward female Japanese beetles being more parasitized than males, (ii) sex-specific parasitism rates vary throughout the season, and (iii) parasitoid females more readily attack large hosts, both males and females, than small hosts. Oviposition success in *I. aldrichi* is also shaped by the mating and defensive behaviors of the Japanese beetle; oviposition usually takes place upon mating pairs and being immobilized during copulation females cannot achieve the typical defensive behavior they use when attacked by a natural enemy. Egg-laying decisions by *I. istocheta* females are shaped by trade-offs between host suitability, seasonal abundance, and defensive behavior. Results are discussed in the context of the mating-risk mortality hypothesis and the impact oviposition determinants may have on demographic dynamics of the host.

Keywords: oviposition determinant, egg, laying decision, Japanese beetle, tachinid fly

*Speaker

Caterpillar parasitism by wasps and flies after more than half a million rearings in the Area de Conservación Guanacaste (ACG) northwestern Costa Rica: specialism and generalism

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For more than 45 years, but especially since 1990, a team of approximately 20 parataxonomists have collected and individually reared virtually every caterpillar they have located. As of 31st December 2023 this amounted to 508,881 individuals, and from these 48,531 ichneumonoid mostly primaries), 34,298 tachinid flies, and 2004 other Hymenoptera groups were reared. These raw data have subsequently been cleaned extensively to ensure that only definitively independent rearings are considered here - for example, rearings of multiple caterpillars off the same host plant on the same date may have produced more than one record of a given parasitoid. As this descriptive project progressed, collaboration with Paul D.N. Hebert and M. Alex Smith led to samples being barcoded which meant that some older morphospecies became recognised as complexes of cryptic, usually more host specific species, both of caterpillars and of their parasitoids. Here we will illustrate some of the more interesting take-away messages in terms of total species richness, toxic plants and caterpillars, and the generalist-specialist spectrum. In short, despite the unprecedented sample size and small area, there is no indication that plant sampling (currently 2575 spp.), caterpillar (currently 10,927 spp.), tachinid flies (1334 spp.) or ichneumonoid (2284 spp.) are in any way tending to a plateau, indeed the accumulation curves are completely linear, similarly interspecies interactions. Some of this is likely due to ongoing succession and also climate change, however, the overall picture is one of enormous species richness and food web complexity.

Keywords: Area de Conservacion Guanacaste, Braconidae, Ichneumonidae, Lepidoptera, COI, DNA barcoding, species identification, trophic interactions

*Speaker

Spatio-temporal activity of egg parasitoids at the processionary moth, *Thaumetopoea pityocampa* (Denis & Schiffermüller 1775) (Lep.,Thaumetopoeidae) in cedar and pine forests (Algeria)

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Thaumetopoea pityocampa is the main defoliating pest in both cedar and pine forests in northern Algeria. Populations of this pest are naturally controlled by parasitoids, making it crucial to identify and quantify the main species. A study of 604 egg batches collected from the biosphere reserve of Chrea, Djurdjura and Theniet El-Had as well as from the pine forests of the semi-arid areas highlighted three species of egg parasitoids: *Ooencyrtus pityocampae* (Mercet) (Hymenoptera, Encyrtidae), considered polyphagous, *Baryscapus servadeii* (Domenichini) (Hymenoptera, Eulophidae), a specialist of the genus *Thaumetopoea* emerging in synchronization with their host's oviposition patterns. These two parasitoids were foundin all the surveyed sites of both bioclimatic stages. However, the third species *Trichogramma embryophagum* (Hartig) (Hymenoptera, Trichogrammatidae) was only present in altitudinal cedar forests. The presence of these antagonists is related to the activity of the epidemic phase of the processionary clade (*Pityocampa* and *Eastern North African* clade). The analysis of the egg batches showed an average of 246 $\pm$ 47 eggs per batch from cedar forests, and 142 $\pm$ 40 eggs per batch from pine forests. The parasitoids *Baryscapus servadeii* and *Ooencyrtus pityocampae* were found at varying rates of parasitism, up to 48% per egg mass in the cedar plantation, and up to 28% in the pine forest. *Trichogramma embryophagum* was collected in cedar plantations, at a rate not exceeding 3% despite its frequency of presence in the eggs located at the upper and basal of the ovipositions in elongated from 4 to 6 centimeters. These results show that these embryonic parasitoids prefer the oviposition of processionary moth that develop in cedar. The performance of these parasitoids is highly related tothe host species forest and the altitudinal variables that influence the intra-interspecific competition between the egg parasitoid species. Understanding these dynamics is essential for developing sustainable forest protection strategies.

Keywords: Algeria, clade, egg parasitoids, processionary moth.

*Speaker

Assessing the role of generalist predators in legume biocontrol with a new trophic diagnostic tool

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Pesticide-free cereal-legume cropping systems represent a major environmental and economic challenge, but their adoption by farmers is hampered by phytosanitary problems, including potentially significant pest damage. Recent studies show that in mixed cereal-legume crops, the action of generalist predators is promoted, sometimes at the expense of the more widely studied specialist predators. However, the study of generalist predators is complex and their effect on pests is often assessed indirectly, making the studies less reliable and accurate as they have a potentially large panel of prey. This study aims to assess predation by generalist predators in mixed cereal-legume crops thanks to molecular diet diagnostic.
First, we investigated the effect of cropping system (organic vs conventional), cultivation method (pure stand vs intercropping), distance from the field border and season on generalist predator assemblages. In this goal, we monitor the major communities of generalist predators in mixed cereal-legume crops, carabids and spiders, in two types of crops: pure faba bean stands and mixed inter-cropping faba bean – cereal (wheat or triticale) in 10 to 20 fields per year from 2017 to 2023 around Angers, France.

Second, we developed a trophic diagnostic tool to detect pest species DNA in predator stomach, by extending a molecular diagnostic tool initially developed for cereal pests with legume pests. We include major pest species as aphids (*Aphis fabae*, *Acyrthosiphon pisum, Sitobion avenae*), the pea leaf weevil (*Sitona lineatus*, Curculionidae) and seed-beetles (*Bruchus rufimanus*, bean seed beetle and *Bruchus pisorum*, pea weevil).
Finally, we used this diagnostic tool to describe the consumption of pest by the generalist predators, using individuals collected in 2024 during the communities monitoring, and we revealed the diet changes in carabids and spiders induced by plant diversification methods. The results on effective consumption helped to refine the results obtained by monitoring communities.

Keywords: biocontrol, pest regulation, carabids, spiders, generalist predator, molecular tool, diet, intercropping

*Speaker

The role of olfaction in the perception, localization and selection of trophic resources by carabids

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Carabids are predators commonly found in arable fields and can contribute to the biological regulation of weed seeds and pests such as aphids and slugs. As generalist predators, carabids can switch between different prey types, which could indirectly affect their efficiency in regulating a targeted pest. Understanding their sensory ecology can enhance our knowledge of their foraging behavior, particularly how they locate and select among different prey types, including pests, weed seeds, and alternative prey such as Collembola. Despite the importance of olfaction in insects, its significance for carabids remains underexplored. Our study aimed to investigate how carabids detect and use odors from trophic resources during foraging. We first examined the detection of odors emitted by seven prey items, including weed seed species (*Viola arvensis*, *Taraxacum officinale*, *Chenopodium album*, *Capsella bursa-pastoris*), Collembola (*Folsomia candida*), aphids (*Sitobion avenae*), and their alarm pheromone ((E)-β-farnesene), by eight carabid species using electroantennography. The carabid species were selected to represent a gradient of food preferences, including carnivorous, omnivorous, and granivorous species, based on the literature. We hypothesized that resource detection would align with food preferences, which was partly supported by our results. However, we also observed significant variability in the olfactory capacities of different species within the same trophic guild. This suggests more complex diets and diverse foraging strategies than previously described among carabid species. Next, we assessed the behavioral response to food stimuli using olfactometer bioassays. We tested the behavioral responses of three carabid species to olfactory cues from weed seeds (*T. officinale*) and Collembola.

Keywords: electroantennography, olfactometer, carabid, olfaction, aphid, collembola, weed seeds

*Speaker

Do Agroecological Approaches Boost Functional Biodiversity And Natural Pest Control In Tomato Crop?

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Agroecological farming practices aim to achieve effective pest control by fostering biodiversity, which supports the conservation of natural enemies. In this study, we compare the functional biodiversity within two open-field tomato crops with distinct farming approaches-one following conventional practices and the other agroecological practices-over two consecutive years. The agroecological approach was implemented at the Aristotle University Farm, where we established a tomato crop with two distinct plots, each bordered by flower margins sown with Phacelia tanacetifolia and Fagopyrum esculentum, along with soil application of the beneficial fungus Trichoderma harzianum T22. The conventional tomato crop was located approximately 15 km away. Throughout the growing seasons, we monitored insect populations multiple times using Malaise traps and visual observations. Our focus was on wasps, hoverflies, and mirid bugs, examining differences in their abundance and diversity between the two cropping systems. Additionally, we assessed the population levels of key tomato pests, including Tuta absoluta, Bemisia tabaci, and Tetranychus urticae. Our findings support the sustainability of the agroecological approach, as it enhances natural pest control and crop productivity. Specifically, we observed higher species diversity and abundance, along with lower pest pressure, in the agroecological field compared to the conventional field. The goal of this project is to develop a model that can be easily adopted by small-scale tomato farmers in Mediterranean countries to protect and enhance functional biodiversity, enabling sustainable pest management.

Keywords: agroecology, parasitoids, predators, functional biodiversity, biological control

*Speaker

Assessing the feasibility of pre-emptive biological control in a European context

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Pre-emptive biological control concerns the evaluation of biological control agents before the arrival of an invasive species to enhance biosecurity preparedness. To assess feasibility of pre-emptive biological control, several key considerations must be addressed. These include the likely relevance of the target pest, the available information on efficacy and environmental risk of the biocontrol agent, and considerations around rearing, importation and the regulatory framework for the release of the agent.
As a case study, we evaluated the feasibility of pre-emptive biological control of the emerald ash borer *Agrilus planipennis* (Coleoptera: Buprestidae), a destructive wood-boring pest of ash trees (*Fraxinus* spp.). Based on the North American experience with classical biological control using hymenopteran parasitoids imported from Asia, four agents were evaluated using a recently developed standard protocol (Avila et al. 2023).
Among those agents we deemed pre-emptive biocontrol with *Oobius agrili* (Hymenoptera: Encyrtidae), *Spathius galinae* (Hymenoptera: Braconidae) and *Tetrastichus planipennisi* (Hymenoptera: Eulophidae) feasible, albeit certain information for a full risk assessment, such as the potential for attack of European non-target *Agrilu*s species, would still have to be gathered. The fourth species, *Spathius agrili,* we deemed unsuitable due to its poor establishment in similar North American climates. Although ultimately depending on regulatory decisions, no major practical hurdles for the release of the natural enemies were detected.

Keywords: parasitoid, risk assessment, classical biological control, invasive species

*Speaker

Orchard plant diversification to divert ants away from aphid colonies and improve biological control of the rosy apple aphid *Dysaphis plantaginea*

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Sap-sucking hemipterans such as aphids, mealybugs, or psyllids, include some of the most harmful pests in agriculture, due to the direct damage they cause to cultivated plants and the transmission of phytopathogenic viruses. They are the target of numerous insecticide treatments that are harmful to biodiversity and health. Diversification measures that favor regulation by natural enemies, such as predatory arthropods and parasitoids, are promising alternatives to

*Speaker

agrochemicals. However, the frequent mutualistic relationship between these pests and ants strongly impedes the effectiveness of biological control. In exchange for honeydew, ants repel, disrupt or kill aphid natural enemies. Plant diversification measures in and around the plot could modify the range of resources available to ants and reduce mutualistic ant-aphid interaction, in favor of aphidophagous species. The impact of these measures on the frequentation of aphid colonies by ants and on aphid biological control needs to be assessed, and the conditions for their effectiveness determined. The Diver'Ant project (Ecophyto-II+, 2025-2027) aims to test this strategy in apple orchards against the rosy apple aphid. The spatial distribution of ant nests and the seasonal dynamics of food foraging (honeydew, nectar, preys) by the main aphid mutualist ant species, will be analyzed as a function of the level of plant diversification. The effectiveness of faba bean strips as a mean to divert ants away from aphids, by providing them with extrafloral nectar or alternative honeydew producing aphids will be assessed. In 2025, the study is replicated in four orchards in Angers, Avignon (France) and Lleida (Spain). Collected data will be used to analyse the impact of ant-aphid-natural enemies' interaction on aphid dynamics and to determine the influence of habitat distribution in orchard on ant local abundance. Ultimately, these results will provide the basis to develop a decision-support tool for optimal setting of agroecological infrastructures in orchards.

Keywords: Ant, Mutualism, Aphid, Foraging, Conservation biological control, Apple orchard, Vicia faba, Diversification

Mastrus ridens' importation in France against *Cydia pomonella*: recapture data and implication of single-locus Complementary Sex Determination in establishment

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Importation (=Classical) Biological Control (IBC) is the deliberate introduction of an exotic biological control agent for its permanent establishment and long-term pest regulation. In addition to being a potentially durable and inexpensive control method for growers, these programmes provide unique opportunities to study voluntary and controlled biological invasions, especially with demogenetic approaches. With a mean establishment rate of 33% when targeting arthropods, IBC practices may also benefit from studies on small populations and in relation to inbreeding. A good candidate to reach both those applied and academic goals is *Mastrus ridens,* an ichneumonid ectoparasitoid of *Cydia pomonella,* the codling moth, originating from Central Asia. It has been used in multiple countries for IBC programmes against *C. pomonella,* with varying success. Among mechanisms affecting small populations, *M. ridens*' establishment could be hindered by its sex determination mechanism. Due to single-locus Complementary Sex Determination (sl-CSD), homozygosity of diploid individuals at csd locus leads to the development of males instead of females. In small or inbred populations, like those reared for IBC programmes, this phenomenon may be heightened, and finally lead to local extinction. *Mastrus ridens* was introduced in France between 2019 and 2023, in 60 apple or walnut orchards, located throughout metropolitan territory. Among those sites, 18 were considered to test the impact of sl-CSD on establishment, with two levels of inbreeding for the released populations. *Mastrus ridens* and *C. pomonella* populations were monitored before introductions and following releases using corrugated cardboards or sentinel larvae. Although more than 30,000 *C. pomonella* were collected, recaptures of *M. ridens* were scarce throughout the whole sampling, with only 35 individuals found. To date, data don't allow to conclude on the effect of sl-CSD on *M. ridens'* establishment but field surveys will be continued in the future. Hypotheses explaining this lack of recapture are discussed.

Keywords: Importation (=Classical) Biological Control, Mastrus ridens, Cydia pomonella, Demogenetic processes, single, locus Complementary Sex Determination

*Speaker

Functional diversity of the bacterial microbiota of industrially produced parasitoids

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Insect biology depends to a large extent on the diversity of the microorganisms with which they interact closely and which form their microbiota. The bacterial dimension of the insect microbiota has received increasing attention in recent years, as it has been shown to play a central role in the evolutionary ecology of insects, influencing their phenotype in many ways. Surprisingly, while significant attention has been paid to the virobiota of parasitoid wasps (Hymenoptera), the bacterial microbiota remains elusive and very few studies have addressed this diversity, even though it can have significant effects on their fitness and reproductive behavior, important aspects in the context of mass production for biological control. For instance, it is only known that parasitoids can be associated with heritable symbionts that are reproductive manipulators, notably *Wolbachia* and *Cardinium*. These symbionts tend to manipulate their host by skewing the sex ratio towards females and could be harnessed to produce more females. To fill this gap in our knowledge, we analysed the functional bacterial diversity of five industrially produced aphid parasitoid species: *Aphidius ervi*, *Aphidius colemani*, *Aphelinus abdominalis*, *Aphidius matricariae*, and *Praon volucre*. The samples were obtained from the main insect-producing companies. Our hypothesis is that the closer the species are on a phylogenetic point of view, the more they will share a common microbiota. We will also test for the presence of heritable bacteria, with a potential role in inducing parthenogenesis in Hymenoptera, which may influence mass production. After DNA extraction, a metabarcoding approach based on the Oxford Nanopore strategy was used to capture bacterial diversity. The first results are presented for the parasitoid species including the level of prevalence. This study will be a first step towards understanding how environmental factors, especially temperature, affect bacterial symbionts of parasitoids and towards optimizing biological control of aphids.

Keywords: Parasitoid, aphid, microbiota, DNA extraction, Wolbachia

*Speaker

Side effects of sweet orange essential oil on the parasitoid *Exorista larvarum*, chosen as a model non-target insect

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The use of biomolecules in agriculture is grown in recent years, but the effects on non-target species remain insufficiently understood. We present the results of a study aimed at assessing both the direct (e.g., mortality rate) and indirect (e.g., fecundity) effects of sweet orange essential oil (EO) (the only EO marketed in Italy as an insecticide) on the tachinid fly *Exorista larvarum* (L.). This species was chosen as a model non-target insect, due to its dual ecological role as both a parasitoid of pest lepidopterans and a pollinator. The experimental techniques were adapted from internationally recognized protocols used for studying pesticide toxicity on *Apis mellifera* L., a reference insect species in Environmental Risk Assessment. Mated *E. larvarum* females were utilized for our experiments. Both acute contact (a) and oral (b) toxicity were tested, by applying a single 1 μL drop of EO suspension onto the fly thoraxes (a) and offering 10 μL of OE suspension in a drinking trough to flies (b). Different concentrations (0.5%, 5%, 10%, 20%) were tested. The results showed that sweet orange EO had no direct or indirect adverse effects on *E. larvarum* upon contact. It showed direct toxicity when ingested at high concentrations, but, interestingly, at these same concentrations, it also acted as a repellent for *E. larvarum*.

Keywords: Essential oils, side effects, Tachinidae

*Speaker

Assessment of the role of greenhouse borders as sources of pest and beneficial insects in protected crops

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Managing pests in greenhouses and other sheltered crops requires an understanding of the origin of colonizing individuals. Nearby vegetation can serve as a source not only for pest insects but also for their natural enemies, making it a key factor in developing conservation biological control strategies. We conducted a study on protected strawberry crops across 50 French farms, examining the presence of major pests and their natural enemies in both greenhouses and the vegetation of crop borders. Our results showed that while crop borders primarily harboured generalist aphid species, aphids specialized in strawberry were nearly absent. Few phytophagous bugs were observed in either sampling sites. In contrast, natural enemies, such as aphid parasitoids and generalist predators, were found in both greenhouses and borders. We further analysed how factors such as crop location, growing season, and surrounding vegetation characteristics influenced the presence of pest and beneficial insects in crop borders. The presence of Rosaceae plants (strawberry's botanical family) had no effect on insect populations. Although there was limited co-occurrence of the studied taxa between protected crops and their borders, higher botanical diversity and vegetation cover in borders were associated with increased populations of generalist pests and biological control agents. These findings highlight the crucial role of crop borders in providing resources and refuges for generalist pest and beneficial insects while having a limited impact on specialized pest populations. Targeted border management could either prevent pest colonization of crops or enhance natural enemy populations, contributing to improved pest regulation in greenhouses.

Keywords: Greenhouse pests · Insect origins · crop edges · biological pest management

*Speaker

Biological control of the tarnished plant bug in the context of climate change

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Climate change and agricultural intensity (landscape simplification and pesticides) modulate the abundance of tarnished plant bugs, *Lygus lineolaris*, and their predators in agricultural environments. Climate change accelerates arthropod development, increasing their populations and causing more crop damage due to higher water stress. Predators can mitigate these effects by controlling pest populations and causing changes in pest-feeding behaviour that are sensitive to risk. In this research, we aim to assess how ecological factors-such as weather, landscape, and the use of insecticides-affect the effectiveness of biological control in strawberry fields. Additionally, we will examine the relationship between the abundance of Lygus and fruit damage, considering the presence or absence of the predator. A geolocated monitoring of Lygus and Nabis populations on 20 farms in Quebec and Ontario (along a climate gradient) will be conducted over four years. In the laboratory, the relationship between the abundance of Lygus and strawberry damage will be measured under different ecological conditions (i.e., predators and temperatures). The preliminary results will be presented.

Keywords: Lygus, Nabis, biological control, climate change, ecological conditions

*Speaker

Rasing the Warning for the Invisible Death of Parasitoid Wasps Posed by the Fungicide, Benomyl - Assessing Risks to Their Conservation -

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Parasitoid wasps are important as biological control agents in IPM. While interactions between parasitoids and insecticides have been extensively studied, interactions between fungicides and parasitoids remain poorly understood. Recently, benomyl, a commonly used fungicide in Asia and Africa, has been reported as lethal to parasitoids. Previous studies showed that when *Pieris rapae* (Lepidoptera: Pieridae) caterpillars parasitized by *Cotesia glomerata* (Hymenoptera: Braconidae) were fed diets containing 0.025% benomyl, the fungicide caused mortality in parasitoid eggs and larvae in the host. This finding suggests potential challenges in concurrent use of fungicides and parasitoids as pest control agents. To evaluate the possibility that benomyl causes invisible mass death of parasitoids , we performed laboratory experiments using three braconid parasitoid wasps: the larval parasitoids *C. kariyai* (host: *Mythimna separata*) and *Meteorus pulchricornis* (hosts: *M. separata* and *Spodoptera litura*), and the egg-larval parasitoid, *Ascogaster reticulata* (host: *Adoxophyes honmai*). Lethal effects of benomyl were observed in two of the three species. With *C. kariyai* and *M. pulchricornis*, parasitism never succeeded in benomyl-fed host caterpillars. In contrast, *A. reticulata* successfully parasitized even benomyl-fed hosts. We also examined the relationship between benomyl concentration in the host's diet and parasitism success and evaluated the risk to *C. kariyai* and *M. pulchricornis* based on the method of Preetha et al. (2009), which is widely used to evaluate impacts of insecticides on non-target insects. As a result, the recommended maximum field application of benomyl was classified as "slightly to moderately toxic" to these parasitoids. On the other hand, using benomyl at the minimum field application posed "safety risks" to these parasitoids. Our results suggest that reducing agricultural application levels of benomyl may permit combined use of parasitoid wasps and fungicides, to achieve IPM.

Keywords: Cotesia kariyai, Meteorus pulchriconis, IPM, biological control, side effect

*Speaker

Investigations on the biology and parasitism activity of *Aphelinus mali* on the woolly apple aphid *Eriosoma lanigerum*

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Eriosoma lanigerum (Hemiptera: Aphididae), commonly known as the woolly apple aphid (WAA), has become an increasing threat to apple orchards, partly due to the withdrawal of several active substances, such as neonicotinoids and organophosphates. Native to North America, WAA completes its life cycle on apple trees in Europe, infesting roots, trunks, and branches. Although numerous natural enemies contribute to its regulation, biological control of this aphid depends mainly on the activity of the coevolved and specialized endoparasitoid *Aphelinus mali* (Hymenoptera: Aphelinidae). This species was introduced as a biological control agent in one of the most successful examples of classical biological control. *Aphelinus mali* completes multiple generations per year on its host, overwintering as a pupa or larva in parasitized aphids and reaching high parasitism rates toward the end of the season. From 2021 to 2024, surveys were conducted in apple orchards in northwestern Italy (both organic and IPM) to assess i) the presence and parasitism rate of *A. mali* on WAA through visual plant inspections and yellow sticky traps, and ii) the parasitoid's overwintering survival by collecting WAA colonies in winter and rearing them under natural and controlled conditions. The presence of *A. mali* was consistently higher in organic orchards, with the first adults captured from the 20th week of each year. Despite these early captures, parasitoid activity became evident from the 28th week, reaching parasitism rates close to 100% from the 32nd to the 36th week. From overwintering WAA colonies, *A. mali* emerged at rates ranging from 8% to 44% under natural conditions and from 13% to 54% under controlled conditions, with a female-biased sex ratio. These findings highlight the need for further research to improve knowledge of biology and behavior of *A. mali* and consequently WAA control throughout the growing season.

Keywords: Hymenoptera Aphelinidae, Hemiptera Aphididae, biological cycle, overwintering survival, parasitism rate

*Speaker

Parasitic Wasp Viriforms: Change Nucleocapsids to Nucleocassettes?

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Particles produced by certain braconid and ichneumonid female wasps that suppress innate immunity of lepidopteran hosts have been referred to as virions of enveloped DNA viruses known as polydnaviruses (PDVs). However, in a paper in 1991, another in paper in 2003, it was suggested PDV virions functioned like organelles that evolved similar to mitochondria and chloroplasts, by fusion of genomes with host genomes. The latter paper predicted PDV virions did not contain typical viral genomes. Subsequently, researchers in 2004 and 2009 reported that PDV virions primarily contained genes that suppressed host innate immune immunity, not typical viral genes. More recently, via papers from 2021 – 2023, the International Committee on the Taxonomy of Viruses, decided PDVs, based on the genes in the particles, were not viruses. Therefore, a new category of genetic elements named viriforms was created for bracoviruses and ichnoviruses. Thus, new terminology is needed to refer to their structures. In the first 2003 paper noted above, based on their immunosuppressive functions, these particles were referred to as "suppressons." If the particles are not virions, then the protein/DNA core that transports viriform genes into the nuclei of host cells is not a nucleocapsid. In this presentation I suggest this structure be referred to as a "nucleocassette" or "nucleocapsule," consistent with their virus ancestries and current functions.

Keywords: Bracoviriformids, Ichnoviriformids, viriform structure, viriform terminology

*Speaker

Invasion-driven changes in *Drosophila* and their parasitoid communities along a latitudinal gradient in the Rhône valley

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With more than 1,500 species spread across the globe, *Drosophila* is a widespread group that can be found in every continent. Although *Drosophila* usually feed on decaying fruits, the arrival of *Drosophila suzukii* in Europe and America over the last decade - a crop-pest originating from East-Asia capable of feeding on ripening fruits - has led to significant losses in berry production. We suspect that the invasion of *D. suzukii* has profoundly transformed *Drosophila*community in France, which could have cascading effects on their natural enemies. Among these natural enemies, parasitoid wasps are the most common. They can be classified into two main groups based on their host stage preference: pupal parasitoids, which lay their eggs inside *Drosophila* pupae, and larval parasitoids, which target *Drosophila* larvae. However, in Europe, only pupal parasitoids can develop on *D. suzukii*, as larval parasitoids succumb to a strong immune response. In its native range, several larval parasitoid species, such as *Leptopilina japonica*, can parasitize *D. suzukii*. *L. japonica* was first observed in Europe in 2019 and detected in France in 2023 in various locations. We therefore hypothesize that its arrival has also affected *Drosophila* and their parasitoid communities. Thanks to a long-term sampling effort, conducted from 2009 and still ongoing along the Rhône valley, we have identified *Drosophila* and their sympatric parasitoid communities at different points in time and locations to answer two main questions: (1) How does latitude impact community composition, and how has it evolved over time? (2) How have the arrivals of *D. suzukii* and *L. japonica* affected the composition and distribution of those communities?

Keywords: Drosophila suzukii, Leptopilina japonica, Parasitoid wasps, Host, parasitoid interactions, Biological invasions, Community dynamics

*Speaker

A meta-analysis on the role of complementarity and intraguild predation on biological control.

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Ecologists have long sought to understand how biodiversity influences ecosystem functions. In arthropod communities, one key service provided by diversity is the regulation of herbivore populations, which has crucial implications for biological pest control. A fundamental question in biological control is to understand how multiple natural enemies interact to suppress pests considering positive or antagonistic interactions among species. These interactions can be neutral or synergistic if the combined effect of all enemies is equal to or greater than the sum of their individual effects. Interactions can also be antagonistic, particularly due to intraguild predation, which occurs when species that compete for a shared prey also prey on each other. Despite several decades of research, we still lack a comprehensive understanding of the factors that determine which natural enemy combinations are most effective for pest suppression, and the conditions that maximize synergistic effects. Through the lens of a meta-analysis, we synthesize findings from 153 studies and 1052 observations that have investigated how multiple enemies influence herbivore and enemy populations, and the experimental conditions influencing them. We integrate these results within a phylogenetic framework to examine how taxonomic and functional group similarity among species influence whether interactions are neutral, synergistic, or antagonistic. We relate these findings to the degree of complementarity and intraguild predation potential among species. Our findings highlight the importance of considering experimental conditions, taxonomy, and functional traits to improve predictions of biological control outcomes when multiple natural enemy species act in concert.

Keywords: aphid, complex interactions, enemy complementarity, intraguild predation, meta, analysis, parasitoid, spider, mite

*Speaker

Parasitoids and hyperparasitoids of aphids in agricultural landscape in Poland

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[2]

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Aphids (Hemiptera: Aphididae) reduce crop yield directly by removing nutrients from plant transporting vessels and indirectly as very efficient vectors of plant virus diseases. The direct damage due to aphid feeding is estimated at approximately 2% of all damage due to insect herbivores. At the same time, the losses due to virus diseases transmitted by aphids may exceed the level of direct damage many times: aphids are vectors of nearly 50% of insect-borne viruses. Aphids are parasitized by several species of Hymenoptera. These parasitoids can cause important mortality in aphid colonies and they are often used in biological control programs. However, parasitoids are parasitized by hyperparasitoids, also of the order Hymenoptera. Thus, hyperparasitoids may affect herbivore population dynamics, and they have been identified as a major challenge in biological control.

This presentation is a review of the research on aphid parasitoids and hyperparasitoids in economically important crops, Brussels sprouts, cabbage, cereals (barley, oats, rye, triticale, and wheat), maize, mustard, and oilseed rape. The parasitoid and hyperparasitoid guilds were analyzed in terms of species richness and structure in parasitoid communities, population dynamics, aphid population parasitism rates, and the effect of crop field arrangement on the occurrence of parasitic Hymenoptera. The response of aphid parasitoids to aphid sex pheromones release under field conditions is reported as well.
The presented analysis covers the research that was carried out in Poland in the past 45 years.

Keywords: aphid parasitoids, primary parasitoids, secondary parasitoids

*Speaker

Laboratory evaluation of the potential of *Exorista larvarum* (L.) as a biocontrol agent against the box tree moth *Cydalima perspectalis* (Walker)

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The Box Tree Moth (BTM), *Cydalima perspectalis* (Walker) (Lepidoptera: Crambidae), is an invasive pest native to Asia, first detected in Europe in 2006, likely introduced through infested *Buxus* seedlings. This species is a serious threat for the genus *Buxus*, leading to losses in boxwood populations. In Italy the boxwood is highly valued for ornamental purposes, and natural stands can be found in beech forests and on rocky Alpine slopes, contributing to the formation of EU Habitat 5110. Even though in its native range the parasitoid complex is more diverse, in Europe only a few parasitoid species have been found to attack BTM, at a very low rate. In this context, the ability of *Exorista larvarum* (L.) (Diptera: Tachinidae) to parasitize BTM larvae has been investigated in laboratory conditions. A stock colony of *E. larvarum* was maintained in the laboratory of Entomology of the University of Bologna, using *Galleria mellonella* (L.) (Lepidoptera: Pyralidae) as factitious hosts. In no-choice experiments, field-collected BTM and laboratory-reared *G. mellonella* mature larvae were separately exposed to mated *E. larvarum* females. The larvae were considered as "accepted" when at least one parasitoid egg was detected on their integument, and as "suitable" when at least one puparium formed. The results about host acceptance and suitability showed that *E. larvarum* may contribute to limit BTM in a context of conservation biological control. Bioclimatic models, predicting the future distribution of this pest, indicate a rapid expansion across the entire European continent, with a significant impact in southern regions, leading to the loss of a highly valuable ecological habitat. Given these predictions, research about parasitism by native parasitoids (including *E. larvarum*) is of vital importance for developing biocontrol strategies aimed at mitigating the impact of this pest in natural habitats.

Keywords: Tachinidae, host selection, oviposition, biological control

*Speaker

Can mutualistic interactions between ants and aphids be modified by the use of an addictive artificial sugar source ?

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Aphids are among the most important crop pests, with many species being myrmecophilous. In exchange for honeydew, ants provide aphids with protection against predators and parasitoids. This interaction can interfere with the natural regulation of aphid populations and undermine biological control programs. However, this relationship between ants and aphids may vary, from mutualism to parasitism (exploitation of honeydew by ants without protection) or even predation, depending on the ant colony needs, as well as on the availability and quality of alternative sugar sources. Interestingly, the aphids themselves can influence this interaction by modifying the composition of their honeydew. For example, a compound involved in addiction mechanisms can not only enhance honeydew exploitation by the ants, but also influence ant aggressive behavior.
To optimize biological control strategies, several approaches are being developed to divert ants from aphids, including the provision of artificial sugar feeders. However, current methods require to enhance feeder attractiveness relative to natural honeydew.

The Obedi'ant project (PUI PREDICT 2025) aims to develop an addictive artificial sugar source by adding an addictive compound to a sucrose solution and to assess its ability to redirect ant foraging away from aphids while increasing aphid predation. First, we have tested the effect of a supplemented sucrose solution on ant foraging and feeding behavior, as well as on ants' mortality, using no-choice behavioral experiments. Thereafter, two-choices experiments have been carried out to determine the effect of this addictive substance on ants' preference in comparison with sucrose-only solution and with honeydew produce by aphids.

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*Speaker

Keywords: Ant, aphid, addiction, preference, artificial sugar source, biological control, honeydew

Climate change impact in the population of entomophagous epilachna beetle on vegetable crops and harmful effect of insecticides

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Various predators cause natural suppression of pests of different vegetable crops particularly brinjal, tomato, chilli, ladysfinger etc. Among the different predators epilachna beetles play an important role in natural suppression of destructive pests viz., jassid, aphid, thrips, mites etc. *Coccinella sp.*, an important epilachna beetle in West Bengal province, India was found active on different pests of brinjal throughout the year. The population varied from year to year depending on host and weather conditions. Its population was recorded higher during March-April and then declined. Highest population (4.87 *Coccinella*/plant) was recorded during March (11th standard week) when the mean temperature, mean relative humidity and weekly rainfall were 23.8∘C, 74.2 % and 8.2 mm respectively. *Coccinella* incidence showed significant positive correlation (p= 0.05) with maximum temperature and significant negative correlation with relative humidity whereas with minimum and mean temperature and rainfall the correlation was negative but non-significant. The population of *Coccinella* was found throughout the growing period of ladysfinger feeding on destructive pests. In the kharif season, population was found higher (3.5/plant) during 3rd and 4th week of July in active vegetative growth of the crop. Destructive insect pests on vegetable crops can be controlled with synthetic insecticides but cause harmful effect to the bio-agents. The control of pests through synthetic pesticides is difficult as there is possibility to retain toxic residues in vegetables which cause health hazard and environmental pollution. From field evaluation it was revealed that bio-pesticides were less harmful to *Coccinella* than synthetic ones. The pathogens, *Bacillus thuringiensis* Berliner and *Beauveria bassiana* (Bals.) Vuillemin caused significant lower killing of the predator (less than 40 %) whereas the synthetic insecticides, DDVP and chloropyrephos, acephate etc caused significantly higher killing (more than 50 %). Biopesticides can be incorporated in IPM programmes and organic farming.

Keywords: Seasonal incidence, predator, biopesticides, vegetable IPM, organic farming

*Speaker

Effects of low doses of a neonicotinoid insecticide on *Harmonia axyridis* (Coleoptera: Coccinellidae) behavior

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Harmonia axyridis (Pallas) (Coleoptera: Coccinellidae) is an important predator of phloem-feeding insects of economic importance in agriculture. Like other entomophagous insects, its presence in the agroecosystems is determined by its susceptibility to lethal and sublethal effects of commonly used insecticides. Even when not lethal, insecticides can interfere with feeding and reproductive behavior and alter learning abilities. In this study, through bioassays conducted in experimental arenas, we evaluated the effects of different concentrations (inducing 0, 0.2, and 20% ladybird mortality, respectively) of an acetamiprid-based neonicotinoid insecticide, on the behavior and associative learning of *H. axyridis* males. Virgin (inexperienced) and mated (experienced) males were tested. Results revealed that untreated *H. axyridis* males are capable of associating cues from plant-prey complex with a rewarding experience, in this case mating with a partner. In fact, compared to inexperienced males, experienced males demonstrated greater ability to evaluate the environmental conditions (e.g., absence of a potential partner), as demonstrated by a shorter residence time in the area of the arena contaminated with plant-prey cues. Regardless of prior experience, individuals treated with neonicotinoid exhibited behavioral alterations. Consequently, the effects of insecticides on the behavior of entomophagous insects could influence their reproductive capacity, an aspect that should be carefully considered for biocontrol efficacy.

*Speaker

Efficacy of T*richogramma evanescens* (Hymenoptera, Trichogrammatidae) in controlling *Helicoverpa armigera* on organic corn

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We assessed the effectiveness of the host-associated strain (Ha-strain) of the egg parasitoid *Trichogramma evanescens* in controlling the cotton bollworm, *Helicoverpa armigera*, on organic corn. The Ha-strain was sourced from *H. armigera* eggs collected from corn in the Poltava region (Ukraine) and reared in a biolaboratory for the experiments. The trials were conducted from 2019 to 2021 on organic corn fields managed by Agro-industrial Group Arnika (Poltava region, near Hlobyne, Ukraine).
In 2019, a non-Ha strain of *T. evanescens* was tested against the cotton bollworm. The results indicated a low parasitism rate (up to 23%), which was only slightly higher than the control group (15%), where parasitism was caused by *T. semblidis* from the local natural population.

In 2020, the Ha-strain of *T. evanescens* was released in two forms: 1) as adults on unprotected paper carriers, and 2) as parasitized *Sitotroga cerealella* eggs on folded cardboard cards. In the test plots, *H. armigera* eggs were placed on marked corn plants. Nearly all exposed *H. armigera* eggs were either completely destroyed by *T. evanescens* or other natural enemies. The parasitism rate by *T. evanescens* ranged from 31% to 97%, while other natural enemies destroyed between 3% and 69% of the eggs. The Ha-strain demonstrated notable efficacy, although in four out of 10 cases, other natural enemies contributed more to the destruction of *H. armigera* eggs, highlighting the role of biodiversity in natural plant protection. The release of *T. evanescens* as parasitized eggs on folded cardboard cards resulted in a higher percentage of parasitized *H. armigera* eggs in the field.
In a follow-up trial in 2021, where *T. evanescens* was applied manually without special carriers, the infestation rate ranged from 11% to 88.9%, with an average of 56.76%. Once again, a significant proportion of the eggs was destroyed by other natural enemies.

Keywords: Trichogramma, Trichogrammatidae, Hymenoptera, Helicoverpa armigera, organic corn, Ukraine

*Speaker

Natural enemies of *Ostrinia nubilalis* (Lepidoptera, Crambidae), a key pest of organic agriculture in Ukraine

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The European corn borer (Ostrinia nubilalis, ECB) is a major pest that affects the production of corn, hemp, and millet globally, including in Ukraine. The taxonomic classification of ECB within the genus *Ostrinia* remains debated and requires a combination of both morphological and molecular data. Between 2018 and 2024, monitoring and experiments on *O. nubilalis* and its parasitoids were conducted in organic fields in the Poltava region of Ukraine.
Trichogramma species are commonly employed for ECB control; however, species identification is often not prioritized. In Ukraine, most laboratory cultures breed *Trichogramma pintoi*, even though *T. evanescens* and *T. brassicae* are well-established biocontrol agents against ECB in Europe. We evaluated the efficacy of *T. evanescens* and *T. pintoi* on corn in central Ukraine during 2018-2019. Both species effectively parasitized ECB eggs under laboratory conditions, but their efficacy in the field warranted a comparative field trial.

In the field, we applied each Trichogramma species to separate sections of the corn field. Efficacy was assessed by monitoring ECB egg mass infestation on corn plants placed in experimental pots. These pots were exposed to ECB in the laboratory before being placed in the field shortly after Trichogramma application. The parasitism rate of ECB egg masses in both treated areas was high; however, only *T. evanescens* was identified from both areas. This suggests that *T. pintoi* has lower efficacy against ECB under natural field conditions, supporting the preference for *T. evanescens* or *T. brassicae* from laboratory cultures or natural sources.
In 2020, *Bracon brevicornis* was observed parasitizing *O. nubilalis* larvae in hemp stems. Additionally, in 2021, *O. nubilalis* larvae showed a 10% parasitization rate by tachinid flies. In 2023, larvae exhibited parasitism by *Tachinidae* and *Ichneumonidae* (Campopleginae), with infestation rates of 21.2% in corn and 4.17% in hemp.

*Speaker

Laboratory biology and ecology of *Trichopria drosophilae* (Hymenoptera: Diapriidae) and its rival *Pachycrepoides vindemiae* (Hymenoptera: Pteromalidae), parasitoids of Drosophila flies

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The life history and immature developmental stages of the diapriid wasp *Trichopria drosophilae* (Hymenoptera: Diapriidae), a biocontrol agent for drosophilid flies (Diptera: Drosophilidae), including the invasive *Drosophila suzukii*, were investigated. *T. drosophilae* is a solitary endoparasitoid that develops from egg to adult in 22-26 days under laboratory conditions at room temperature. The egg of *T. drosophilae* is broad and ovate, with a short petiole when freshly laid, becoming more elongated as it matures. *T. drosophilae* has three larval instars. The freshly hatched first instar has a narrow caudal region with bifurcated, indentate abdominal appendages, enlarged thoracic segments, and a head equipped with sclerotized, sharp mandibles. The second instar is poorly sclerotized and features distinctive everted (exodont) mandibles. The third instar is grub-like, with three pairs of thoracic spiracles and stylet-shaped mandibles. The ratio of parasitoids reared in experiments examining the competitive interactions between *T. drosophilae* and a rival ectoparasitoid, *Pachycrepoides vindemiae* (Hymenoptera: Pteromalidae), was influenced by the ectoparasitoid, regardless of the oviposition priority.

Keywords: Hymenoptera, Diapriidae, parasitoids, immature morphology, Diptera, Drosophilidae

*Speaker

Behaviour of the natural enemies of *D. suzukii* exposed to volatile organic compounds characterized from wild strawberry.

Francesc Gómez Marco * [1], Paula Mestre [1], Nuria Agustí [1], Judit Arnó [1], Riudavets Jordi [1]

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Drosophila suzukii Matsumura (Diptera: Drosophilidae), is a polyphagous pest of thin-skinned fruits as berries and grapes. It is present on five continents and its distribution expands yearly. Current management relies on chemical insecticides, trap and kill strategies and on biological control. To integrate with biological control methods, an effective *D. suzukii* repellent will contribute to reduce insecticides use. Volatile organic compounds (VOCs) of stressed plants play an important role in transferring information to plants but also to insects. (E)-2-hexenal is a commonly occurring compound in VOCs, and preliminary results showed that on wild strawberries, *Fragaria vesca* (Rosales: Rosaceae) cv. Reine des Vallées, isomerization of (Z)-3-hexenal to (E)-2-hexenal is increased. One of the characteristics of (E)-2-hexenal is that deters *D. suzukii* oviposition behavior. The development of a control tool for *D. suzukii* based on the use of plants as biofactories of these VOCs is being investigated. To develop an effective and sustainable pest management strategy for *D. suzukii*, it is necessary to understand the effects of selected VOCs on the efficacy of natural enemies. To test this, we compared the attraction/repellency of two natural enemies, the predator *Orius laevigatus* (Fieber) (Hemiptera: Anthocoridae), and the parasitoid, *Trichopria drosophilae* (Perkins) (Hymenoptera: Diapriidae) to the pure VOCs, *F. vesca*, *F. vesca* near-isogenic line (which produce less (E)-2-hexenal), and other plant species in choice and non-choice laboratory assays. Do these selected VOCs originated from plants compatible with natural enemies to control *D. suzukii*?

Keywords: parasitoid, predator, VOC, E, 2, hexenal, biological control, spotted wing drosophila

*Speaker

Screening on evolution, prevention, and management of entomopathogen *Nosema bombycis* threats on silkworms *Bombyx mori*

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Since domestication, the silkworm *Bombyx mori* has become susceptible to a variety of diseases that are the main source of challenges facing sericulture. The aim of this paper was to investigate the parasite *Nosema bombycis*, which has a detrimental effect on silkworm rearing. Microsporidia *Nosema bombycis* are a contagious intracellular protozoan parasite that caused pébrine, one of the most devastating diseases for silkworms *B. mori* with implication on fertility and cocoon quality (cocoons weight, shell and the silk fiber ratio). Pébrine threatened the survival of the French sericulture sector in the middle of the 1800s. Soon after, the illness spread worldwide and continue to exist although is less prevalent. The methods of prevention assume: examination of silkworm eggs in real time; disinfection on Standard Operating Procedure; maintaining hygienic practices throughout silkworm life cycle; control of silkworm rearing temperature and humidity; monitoring and control of environmental air quality; real-time monitoring of mulberry field water and fertilizer; real-time monitoring of mulberry pests; using of the procedures for eliminating infected silkworm feces, cocoons, or eggs; monitoring for pébrine disease during the raising phase. The detection methods evolved from visual observation to microscopy technique and then to immunological testing, and to modern molecular biology-based detection. Additionally, chemical and new biosensor techniques have been developed to identify *N. bombycis*. However, microscopic analysis of adult females continues to be the most often used detection technique, although numerous elements, including the inspector's eyesight, the number of visual fields, and the working environment, influence accuracy. Eliminating transovarial transmission, rigorously preventing oral transmission (through feed), and producing non-infested silkworm eggs are the keys to prevention and management. Consequently, the implementation of detection approaches in production and on-site for more effective and real-time detection remains challenging. These techniques ought to identify pébrine diseases quickly and enable prompt control measures.

Keywords: Nosema bombycis, parasite, pébrine, silkworms

*Speaker

Effects of humidity on parasitoid wasps

Forough Afshari [1], Konstantinos Zigras [1], Ian Hardy * [1]

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Parasitoid wasps are key organisms for the study of natural behaviour, evolution and ecology and are beneficial in human agro-ecosystems as agents of biocontrol. Their performance can be influenced by a range of environmental variables, some of which are of anthropogenic origin. The effects of temperature have received a great deal of attention, with recent studies stimulated by concerns about 'global warming'. In contrast, less attention has been paid to the effects of humidity, even though climate change may greatly affect humidity, which, in turn, could have substantial impacts on a wide range of organisms. Here we summarise literature evidence for effects of humidity variation on parasitoid wasps and consider this in the context of parasitism of hosts, developmental time, diapause, survival, offspring emergence, sex ratio, offspring size, adult longevity, activity and fecundity. Further, we present new experimental evidence demonstrating low humidity reduces the life-expectancy of adults and the survival of immatures of the bethylid wasp *Goniozus legneri*. Following from these results, we test the hypothesis that females would attune their foraging and reproductive decisions to the humidity of the environment that they experience.

Keywords: Humidity, Life, history, performance, climate change

*Speaker

Kinship and strain effects on offspring development and sex ratios in bethylid wasps

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Female-biased sex ratios under Local Mate Competition (LMC) are well known among parasitoid wasps, with most focus on the predicted effect of variation in the number of foundresses (mothers) contributing offspring to a mating group. LMC theory has been modified to include variation in kinship between foundresses and also variation in kinship between foundresses and the males they have mated with (sibling or non-sibling mating). There have been few prior tests of these aspects of LMC theory, and the available evidence has not strongly supported theory. Here we consider recent and new evidence for predicted sex ratio effects of genetic relatedness in several bethylid wasp species in the genus *Goniozus*. It has been shown, using a single strain, that groups of foundresses that are kin produce more female biased sex ratio than groups that are not kin. We widen investigation to consider cross-strain combinations and find effects on both offspring sex ratio and juvenile mortality. We also widen investigation to consider a greater array of mating partner relatednesses and present the effects on brood sex ratios. Finally, we present evidence for effects of intra-brood relatedness on *Goniozus* developmental mortality.

Keywords: Sex ratio, Local Mate Competition, Kinship, Genetic strain effects, Developmental mortality

*Speaker

A multi-scale approach to bruchid pest dynamics and its biological control in grain legume crops

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Grain legumes provide multiple ecological services to agriculture, but are highly sensitive to biotic stresses that reduce their yields and their value to farmers. Among these stresses, bruchids (Coleoptera: Chrysomelidae) are pests that have a very significant impact on legume production. They develop inside the grain, reducing their weight, decreasing their nutritional value, altering their germination potential, and increasing the risk of fungal infestation. To date, limited effective management strategies are available in Europe, even with insecticide treatments. This study aims to unravel the complex interactions among lentil and faba bean bruchids, their parasitism, and agroecological factors across various spatial and temporal scales. Using a comprehensive dataset collected from 110 fields across four production basins in France over three years (2020-2022), we analysed how local practices and landscape structure influence bruchid populations, their damage, and their biological control by parasitoids. Results showed that landscape composition plays a significant role in shaping bruchids population by providing food resources and overwintering sites. Additionally, the presence of wild flowering plants, both in borders and in fields, attract bruchids populations and potentially exacerbate infestations. Number of days above 12^{o}C also emerged as key factor determining pest activity and potential crop damage, whereas techniques applied on the field did not influence bruchid populations and parasitism. Based on these results, an integrated pest management approach combining landscape-level strategies, and conservation of natural enemies, could offer a more effective and sustainable solution to mitigate bruchid damage in grain legume.

Keywords: Leguminous, bruchids, pest management, biological control, landscape composition

*Speaker

Revealing insect resistance mechanisms in a host-parasitoid interaction

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1

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Insects are subject to infectious organisms and defend themselves with an innate immune system, as they are generally thought to lack acquired immunity. The innate defense is divided between humoral immunity, which consists in multiple anti-pathogen molecules, and cellular immunity, which is based on hemocytes. Those cells are able to discard larger invaders, either by phagocytosis or encapsulation. The latter is used against large foreign bodies, and consists in enclosing them in a multi-layer cellular shell, which will produce toxic compounds and melanin in addition to preventing interactions with other tissues. Parasitoid eggs, when triggering immune system, are killed by this phenomenon. Our study focuses on the host/parasitoid couple formed by the Lepidopteran stem borer *Sesamia nonagrioides* and the Hymenoptera *Cotesia typhae*. Parasitism success of a *C. typhae* strain is low on the French *S. nonagrioides* population due to encapsulation. To study the dynamic of capsule formation and the targeted egg or larval stages, we used several methods and compared their results. First, we dissected non-resistant hosts to characterize parasitoid larval development. We then dissected resisting hosts to retrieve and observe capsules under microscopy, especially because they do not melanize and are hard to detect. We labelled their hemocytes with immunohistochemistry techniques to identify their populations, and finally, we checked for the structural arrangement of the capsules with histology sectioning. Together, those methods gave us a broad understanding of capsule formation dynamics and of the cell populations involved.

Keywords: parasitoid, host resistance, encapsulation, insect immunity, hemocytes

*Speaker

Quantitative DNA metabarcoding to evaluate the effect of flower strips on natural enemy diversity in Quebec lettuce fields

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Considering the detrimental effects of insecticides on both the environment and human health, it is essential to develop sustainable pest control alternatives. Conservation biological control, such as planting flower strips around crops to provide resources for natural enemies, offers a promising solution. These beneficial insects can disperse into surrounding fields, helping to naturally control pest populations. Despite its potential, research on the effectiveness of this strategy in Canada remains limited. In our study, we evaluated the impact of various flower strip designs on the attractiveness of natural enemies in lettuce crops grown on Quebec histosols. With over million of insect specimens collected in our study, traditional morphological identification proved impractical. To address this, we implemented a new quantitative DNA metabarcoding using the 'spikepipe' approach, which integrates a calibrated DNA sample to improve species abundance estimates, correct biases, and reduce pipeline errors. Preliminary results suggest that spikepipe correction improved accuracy of abundance estimates from samples of known composition. This approach allows for rapid and efficient quantification of species abundances from bulk samples, facilitating comparisons of the attractiveness of various flower strips to beneficial insects. The results will guide the selection of flower strips that attract a higher abundance of potential biological control agents, to enhance pest management and promote more sustainable agricultural practices.

Keywords: Conservation biological control, flower strips, natural enemy diversity, quantitative DNA metabarcoding

*Speaker

Potential distribution of four *Cotesia* species (Hymenoptera, Braconidae), parasitoids of *Vanessa cardui* (Lepidoptera, Nymphalidae) in Ukraine

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A significant outbreak of the Painted Lady butterfly (*Vanessa cardui*) was documented in the Poltava region of Ukraine, causing considerable damage to soybean crops in 2019. However, in the fields of the Agro-industrial Group Arnika, the outbreak was controlled by natural enemies, particularly the parasitoid *Cotesia vestalis* (Braconidae). A smaller outbreak occurred in 2022, and once again, braconid parasitoids from the *Cotesia* genus (*C. vestalis* and *C. vanessae*) effectively suppressed *V. cardui* within a month, demonstrating the efficiency of natural pest control.
To further assess the potential for natural biocontrol of large-scale *V. cardui* outbreaks in organic agriculture in Ukraine, we evaluated the potential distribution of its parasitoids from the genus *Cotesia*.

Currently, 30 *Cotesia* species are recorded in Ukraine, of which four - *C. glomerata*, *C. spuria*, *C. vanessae*, and *C. vestalis* - have been identified as parasitoids of *V. cardui*. Given the lack of comprehensive distribution data for *Cotesia* in Ukraine, we conducted species distribution modeling using MaxEnt v.3.4.4, Worldclim data for current climate conditions, and species occurrence data from the Global Biodiversity Information Facility (GBIF; https://doi.org/10.15468/dl.kbz64q; https://doi.org/10.15468/dl.jbfjxs; https://doi.org/10.15468/dl.fsxvmq; https://doi.org/10.15468/dl.wrhf8r). The modeling results indicate that the climatic conditions in much of Ukraine are highly suitable for *C. vanessae* and *C. vestalis*, with the exception of the Carpathian region. In contrast, habitat suitability for *C. glomerata* and *C. spuria* is more limited. Specifically, optimal conditions for *C. glomerata* are found mainly in Crimea, the Zakarpattia region, and parts of Odesa region, while *C. spuria* is best suited to Crimea. Although these modeling results may be influenced by data limitations, *C. vanessae* and *C. vestalis* are likely to play a central role in the natural suppression of *V. cardui* during large-scale outbreaks in Ukraine.

Keywords: Cotesia, Hymenoptera, Braconidae, parasitoids, Vanessa cardui, Nymphalidae, Ukraine

*Speaker

Feeding behaviour of the omnivorous pest species *Thrips parvispinus*

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Thrips parvispinus Karny (Thysanoptera: Thripidae) is an invasive thrips species from South-East Asia, which has spread to Europe, Oceania, Africa and North America over the last 20 years. This polyphagous insect causes damage on many ornamental, fruit and vegetable crops around the world. Besides plant tissue, *T. parvispinus* can feed on alternative food sources such as pollen and arthropod eggs. The omnivorous and polyphagous nature of this species makes it a difficult pest to control, calling for more research to better understand its feeding behaviour in agroecosystems. In this study, we focused on three aspects of *T. parvispinus'* feeding behaviour. First, we studied its predation rate on the eggs of *Amblyseius swirskii* Athias-Henriot (Acari: Phytoseiidae), a predatory mite commonly used in biological control against thrips. We looked at the effect of the host plant quality and the presence of pollen on this predation rate. Second, we studied the effect of three different food sources commonly used in biological control strategies (*Typha angustifolia* pollen, *Artemia franciscana* cysts, *Thyreophagus entomophagus* prey mites) on the oviposition rate of *T. parvispinus* females. Third, we evaluated the feeding preference of *T. parvispinus* between four varieties of the same host plant: *Anthurium andreanum*; an ornamental crop particularly vulnerable to this pest. Our results show that *T. parvispinus* adult females and L2 larvae can feed on a limited number of *A. swirskii* eggs and that their predatory behavior is significantly affected by the nutritional quality of the host plant and the presence of pollen. Additionally, the oviposition rate of *T. parvispinus* females over 6 days did not significantly increase in the presence of pollen, Artemia cysts or prey mites. Finally, we showed that *T. parvispinus* has a significant feeding preference on certain Anthurium varieties. We discuss the implications of these results for biological control against *T. parvispinus*.

Keywords: Invasive thrips, omnivory, predatory mites, biological pest control

*Speaker

Biological biocontrol of *Drosophila suzukii* in France: establishment of the exotic parasitoid *Ganaspis kimorum*

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Drosophila suzukii (Dsuz), an invasive pest originating from Asia, has spread to numerous regions worldwide, including Europe and France. This pest induces damages to fruit crops, particularly red stone fruits. Field explorations in China, Japan, and Korea by international researchers aimed to identify potential biological control agents (BCAs) (Girod et al. 2018). After several years of laboratory evaluation and integrative characterization of these BCAs, Ganaspis kimorum (Gk) Buffington (Hym., Figitidae) appears as the most promising BCAs in particular regarding its high specificity toward Dsuz (Sosa-Calvo et al. 2 024). This parasitoid is currently being released in Europe and North America.
In France, authorization of release of Gk was obtained in 2022 and since 2023, experimental releases are done with the main objective of (i) establishing this parasitoid in wild host-plants to reduce Dsuz populations at a landscape scale and (ii) document main ecological factors that are important to optimize the control of Dsuz in the field as well as potential unintentional effects. In 2023 and 2024, releases were done in 5 and 29 sites respectively located in métropolitain France. These sites, consisted a host-plant crop (mostly cherry) surrounded by natural or semi-natural habitats hosting wild plants known to be a resource for Dsuz. Additional releases are planned in 2025. First post-release surveys did not allow to recapture Gk one year after its introduction but more extensive field surveys will be conducted in future. Interestingly, field samplings detected the presence of the exotic parasitoid Leptopilina japonica (Hym., Figtidae) in several regions. As this parasitoid has been discarded from authorization applications because of its ability to develop in several native species of Drosophila, ongoing research are needed to document the potential unintentional effects of L. japonica in France such as the impact on native Drosophila species and the interactions with Gk.

Keywords: Drosophila suzukii, Ganaspis kimorum, Leptopilina japonica, Biological control agents

*Speaker

Predator-Prey Odorant Recognition: Insights from Odorant-Binding Protein and Odorant Receptor Interactions

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In predatory insects, odorant-binding proteins (OBPs) transport environmental odor molecules to odorant receptors (ORs), initiating the detection of prey-associated chemical cues critical for predator-prey interactions. These OBP-OR interactions enable predators to detect and exploit chemical signals, such as sex pheromones, alarm pheromones, and herbivore-induced plant volatiles. For instance, ladybirds detect moth sex pheromones through specific OBPs, guiding them toward prey habitats. In *Forcipomyia taiwana*, a ceratopogonid biting midge, we identified several ORs co-expressed with a specific OBP, all showing particularly high expression levels in virgin females according to transcriptome analysis, suggesting their involvement in odor-mediated host-seeking behavior. Using AlphaFold3-mediated structural prediction and screening of odorant molecules by molecular docking analyses, we demonstrated that specific odorants could bind to the OBP, prompting dimerization that stabilizes odorant transport toward ORs. This ligand-induced OBP dimerization likely applies broadly to natural odorants essential for predatory or parasitic behaviors, enabling precise prey detection and effective host selection. Moreover, through molecular modeling, the dimerized OBP carrying odor molecules could subsequently bind to the OR, releasing the odorant for receptor activation. By elucidating the molecular basis of odorant transport and receptor activation, this study provides new insights into the evolution of olfactory mechanisms in predatory insects. Additionally, our findings highlight the fundamental role of OBP-OR interactions in insect olfactory systems and provide a molecular framework for understanding how entomophagous insects utilize olfactory cues in predator-prey dynamics.

Keywords: Odorant Binding Protein, Odorant Receptor, biting midge

*Speaker

Drosophila parasitoid interactions and implications for biological control of the Spotted Wing Drosophila

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Pachycrepoideus vindemiae (Rondani) (Hymenoptera: Pteromalidae) and *Trichopria drosophilae* (Perkins) (Hymenoptera: Diapriidae) are idiobiont solitary parasitoids attacking the pupal stages of many *Drosophila* species, including the invasive pest *Drosophila suzukii* (Matsumura) (Diptera: Drosphilidae). Recently, the Asian larval parasitoid *Ganaspis kimorum* Buffington (Hymenoptera: Figitidae) has been implemented as a classical biological control agent against this pest in Europe and North America, and as a koinobiont it does not kill its hosts until they form pupae within puparia. Because a host parasitized by a larval parasitoid could subsequently be attacked by a pupal parasitoid through multi-parasitism or hyperparasitism, this study investigated potential interactions of *P. vindemiae* and *T. drosophilae* with *G. kimorum* in *D. suzukii* puparia and with *Leptopilina heterotoma* Thomson (Hymenoptera: Figitidae) (a common larval parasitoid of *Drosophila melanogaster* Meigen (Diptera: Drosophilidae)) in *D. melanogaster* puparia. No-choice tests showed that both pupal parasitoids can parasitize puparia previously parasitized by either larval parasitoid, with *P. vindemiae* exhibiting successful development but with a reduced female progeny. Choice tests indicated a significant preference for unparasitized puparia in both pupal species. Stereomicroscopic observations of multiparasitized *D. suzukii* puparia revealed that *P. vindemiae* may act as an interspecific competitor, interfering with *G. kimorum* development. These findings would contribute to the understanding of *Drosophila* parasitoid interactions and help predict potential interference with the implementation of *G. kimorum* as a classical biological control agent.

Keywords: pupal parasitoids, Ganaspis kimorum, Drosophila suzukii, biological control, host preference, interspecific interaction.

*Speaker

Hornet workers are attracted by venom gland volatiles whatever their colonial origine

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The invasive Yellow-legged hornet (*Vespa velutina nigrithorax*) poses significant ecological threats, particularly to honeybee populations and biodiversity in Europe. This study explores the chemical communication of *V. velutina*, focusing on the alarm pheromone molecules contained in the venom gland and their potential attraction for workers. Using Y-tube olfactometer assays, we evaluated worker hornets' preferences for the content of the venom gland from intra-colonial versus inter-colonial sources and compared these signals to an appetitive stimuli like honey. Results demonstrated a significant attraction to venom gland signals, but no significant preference for intra-colonial over inter-colonial signals. Interestingly, venom gland cues elicited stronger responses than honey, underscoring their potency in triggering behavioral reactions. These findings highlight the importance of venom-derived signals in *V. velutina*'s communication and suggest potential applications in pest management through the development of targeted attractants.

Keywords: alarm pheromone, Vespa velutina, bait

*Speaker

A potential biocontrol agent of the key European vector of *Xylella fastidiosa* *Ooctonus vulgatus* (Hymenoptera: Mymaridae) in Northwestern Italy

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Philaenus spumarius L. (Hemiptera: Aphrophoridae) is the primary vector of *Xylella fastidiosa* Wells in Europe. Managing vector population is crucial for containing the bacterium's spread, currently relying on tillage and insecticide applications. New sustainable control strategies are crucial to effectively tackle *X. fastidiosa* epidemics in Europe. Exploitation of egg parasitoids as biological control agents of *P. spumarius* is a promising tool to reduce vector population abundance in the context of IPM strategies against plant diseases caused by *X. fastidiosa*. The egg parasitoid *Ooctonus vulgatus* Haliday (Hymenoptera: Mymaridae) has previously shown parasitisation rates of up to 69% in Corsica, suggesting a potential as a biocontrol agent. This ongoing work aims to estimate the presence and prevalence of *O. vulgatus* in Northwestern Italy and study some relevant biological traits. Over three years, sentinel egg techniques have been used to assess the parasitoid prevalence in the field. Approximately 13,000 *P. spumarius* eggs were exposed in ten field sites from September to January, resulting in about 700 parasitoids emerging in the first two years, all identified as *O. vulgatus*. The egg parasitoid was i) collected from most of the sites (75% during 2nd year exposition), ii) emerging mostly from eggs oviposited directly in experimental field sites, iii) showing an average parasitisation rate higher in Liguria ($>$ 30%) than in Piedmont ($\approx$ 8%). Petri dish assays under controlled conditions tested parasitisation efficiency on fresh (in diapause) and old (embryonated) eggs, with a few adults emerging from fresh eggs only. Longevity of adult parasitoids was 10 days in average, with females living longer (12.2 days) than males (8.8 days). This study provides methodologies for collecting egg parasitoids associated with *P. spumarius* and preliminary data on the presence, prevalence, and biological traits of *O. vulgatus* in Northern Italy.

Keywords: insect vectors, Xylella fastidiosa, parasitoids, biological control, native natural enemy

*Speaker

An update to biology and distribution of *Leptopilina japonica* Novković & Kimura, 2011 (Hymenoptera: Figitidae) in Central Europe and implications for biological control

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The parasitoid *Leptopilina japonica* Novković & Kimura, 2011 (Hymenoptera: Figitidae) is a natural enemy of the invasive *Drosophila suzukii* Matsumura, 1931, which is a significant pest in berry and fruit production. Both species originate from Southeast Asia and after its initial detection in Southern Europe in 2019 (Puppato et al., 2020), *L. japonica* has quickly spread and has been recorded more northwards in various European countries, too. Repeated records over multiple years in several locations in Germany show that the species has established stable populations. European field records of *L. japonica* were made between May and November. The flight periods overlap with those of native *Leptopilina* species, highlighting the need for updated taxonomic key to facilitate identification.

To better understand the possible impact on *D. suzukii* populations, laboratory experiments on life history of the parasitoid with simulated climate conditions of an average day in South-West Germany in June and September were conducted (June: 16.1-27.2∘C, 47.6-88.2% relative humidity; September: 12.3-23.9∘C, 50.4-91.4% relative humidity; 16 h light/8 h dark). The results showed that *L. japonica* had a higher lifetime fecundity, higher proportion of female offspring and longer survival under the colder conditions of September.

Given its high abundances and high parasitism rates in some locations, it is likely that *L. japonica* can contribute to the regulation of *D. suzukii* populations, especially during the end of the season (early autumn). As *L. japonica* is also able to attack a small number of other fruit-feeding *Drosophila* (Girod et al., 2018; Daane et al., 2021), further research is required to understand possible impacts on the diversity of parasitoid- and *Drosophila*-communities also in Central Europe, especially in natural habitats.

Keywords: Leptopilina, Drosophila, biological control, parasitism

*Speaker

A closer look to the particular sensilla found in the anntennae of Tersilochinae subfamily (Hymenoptera: Ichneumonidae)

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Tersilochinae are a small-sized subfamily of Darwin wasps which parasitizes mainly coleoptera larvae feeding on fungus, although little is known about the biology of most of species or their behaviour. As in many other Darwin wasps, many chemosensory sensilla are distributed along the antennae to detect particular odours associated to their mates and their potential hosts. However, particular modified sensory structures have been reported recently, which seem to be only occurring in Tersilochinae species (including the microphrudines after the recent phylogenies of Ichneumonidae subfamilies), both in males and females. We have taken Scanning Electron Microscope photographs to the antennae of most of available Tersilochinae genera, looking for the sensilla shape and distribution. From the 38 genera currently known in Tersilochinae, at least 24 have this particular sensilla, apparently lacking in only three genera. The sensilla are usually placed in the apical part of 3-5 consecutive subbasal flagellomeres (from 3rd or 4th to 6th or 7th), although in two species the sensilla were present in more than 15 flagellomeres. In this communication we provide a categorization of the sensilla based on the relative depth of the groove, the level of projection from the groove and the tip shape. Considering the apparent absence of porous on the surface, we hypothesize that it is a sensilla coeloconica, which could be involved in hygro or termoreception.

Keywords: Sensilla, Scanning Electron Microscope phographs, Flagellomeres, Microsculpture, Parasitoids

*Speaker

Kaironomal use of the vine mealybug sex pheromone for citrus mealybug management: field applications

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The citrus mealybug *Planococcus citri* and the vine mealybug *Pl. ficus* (Hemiptera: Pseudococcidae) are the most economically important species of the genus *Planococcus* worldwide and their management remains problematic. The female sex pheromones of *Pl. citri* and that of *Pl. ficus*have been identified and used mainly for monitoring purposes and recently for mating disruption for the vine mealybug. Here we present a different aspect for utilisation of the vine mealybug pheromone for management of the citrus mealybug.
The sex pheromone of *P ficus,* Lavandulyl senecioate, has been shown to act as a kairomone for the parasitoid species *Anagyrus* spec. nov. near *pseudococci* (now *A. vladimiri*) (Hymenoptera: Encyrtidae). It has also been shown that in the presence of the vine mealybug sex pheromone, parasitism rates by *A.* spec. nov. near *pseudococci* on citrus mealybugs was increased. In a set of experiments, we have tried to use the kairomonal potential of the vine mealybug sex pheromone for enhancing the performance of *A. vladimiri* in the field. In citrus orchards, we deployed capsules loaded with the vine mealybug sex pheromone and subsequently we release adults of the parasitoid *A. vladimiri*. Using mealybug-infested potato sprouts we measured the dispersal of the parasitoids in the orchard and parasitism rates in relation to the placement of the pheromone capsules. The placement of the pheromone capsules affected the parasitism rates. Its implication in citrus mealybug management in the field is discussed.
The study was part of the project "Innovations in Plant Protection for sustainable and environmentally friendly pest control, InnoPP - TAEDR-0535675 that is ¨Funded by the European Union- Next Generation EU, Greece 2.0 National Recovery and Resilience plan, National Flagship Initiative "Agriculture and Food Industry"

Keywords: Pseudococcidae, parasitoids, hymenoptera, Anagyrus vladimiri, Encyrtidae

*Speaker

Can *Anastatus bifasciatus* (Hymenoptera: Eupelmidae) provide biotic resistance against *Lycorma delicatula* (Hemiptera: Fulgoridae)?

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Lycorma delicatula is an emerging pan-invasive species native to Asia that poses a significant threat to agriculture, urban areas, and natural ecosystems worldwide. Invasive populations of *L. delicatula* can cause substantial damage to vineyards, and ecological niche modeling has identified Europe as a high-risk region for future establishment. However, no research has yet explored potential natural enemies of *L. delicatula* that could be suitable for use in Europe. Since hymenopteran parasitoids of the genus *Anastatus* are known to parasitize *L. delicatula* eggs, *Anastatus bifasciatus*, a species native to Europe and already used for the biological control of invasive populations of *Halyomorpha halys* (Hemiptera: Pentatomidae), may be a promising candidate. This study investigates the ability of *A. bifasciatus* to parasitize, reproduce on, and induce mortality in *L. delicatula* egg masses under a controlled quarantine laboratory setup.

Keywords: proactive biological control, egg parasitoid, pest management

*Speaker

Modelling the evolution over time of *Trissolcus japonicus* and *Trissolcus mitsukurii* as biological control agents of *Halyomorpha halys* in NW Italy

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Native to Asia, since its accidental introduction, the brown marmorated stink bug *Halyomorpha halys* has become a key pest of many important crops in North America and Europe. *Trissolcus japonicus* is the main egg parasitoid of *H. halys* in China and Japan, and has been considered a candidate for classical biological control in both North America and Europe. Prior to field release, authorized in Italy from 2020, adventive populations of *T. japonicus* have been detected in northern Italy from 2018. Furthermore, adventive populations of *Trissolcus mitsukurii*, another egg parasitoid of *H. halys* in Japan, have been found in northern Italy from 2016. Both parasitoid species have the potential to establish and spread in Europe. However, data on their spreading pathways and dynamics of establishment and impact on *H. halys* in newly invaded areas are currently scarce. Therefore, data from a multi-year field collection of *H. halys* eggs in Piedmont (NW Italy) were used to model and simulate the spatial distribution and temporal evolution of both *Trissolcus* species at sites with or without release of *T. japonicus*. Both species showed increasing parasitism rates and spread independently over the years, especially in response to the presence of *H. halys* eggs. To model evolution over time, scenarios in future years were generated by iteratively applying calibrated models, assuming time invariant parameters. Results showed that *T. japonicus* could reach the parasitism levels observed in its native area, especially when supported by field releases; indeed, it can move to twice the values of parasitism at sites within 5 km of where it was released, compared with sites far from the releases. *Trissolcus mitsukurii*, on the other hand, appears to establish at lower parasitism levels, becoming a secondary species in the egg parasitoid complex of *H. halys*, as observed in Japan.

Keywords: Hymenoptera Scelionidae, Hemiptera Pentatomidae, brown marmorated stink bug, adventive populations, classical biological control

*Speaker

Coffee berry borer infestations and natural enemy communities: Influence of chemical control, shade and management practices

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The coffee berry borer (*Hypothenemus hampei* Ferrari, **CBB**) is the most damaging pest of coffee worldwide. Chemical control is ineffective due to CBB's life cycle inside coffee berries, and crop sanitation is labor intensive. Conservation biological control offers a sustainable alternative by enhancing natural enemy populations through habitat management. However, its potential to control CBB remains unclear.
We studied the impact of chemical control, shade trees, crop characteristics, farm management, and arthropod natural enemies on CBB infestations across 24 coffee farms in Valle del Cauca, Colombia, in 2022 and 2023. We visually assessed infestation levels and berry damage severity, and assessed predator and parasitoid abundance using sweep netting (for flying insects), beat-sheet sampling (for tree-dwelling species), and tuna baits (for predatory ants). Farm characteristics and management practices were documented through semi-structured farmer interviews.

Our results revealed that CBB infestations exceeded the economic threshold of 2.34% in 2022 and 2023, posing a threat to Colombian coffee production. Neither chemical insecticides nor shade trees significantly influenced infestation rates. However, altitude was negatively associated with CBB infestations. Greater natural enemy diversity was supported in shade-coffee systems, crops with higher tree densities, and less frequent weeding. We identified ten ant species and three beetle species inside infested berries, indicating potential CBB predation by these species.
Our findings highlight the complex interactions between environmental factors, farm management, and coffee crop characteristics in shaping natural enemy communities and CBB infestation levels. Chemical control was ineffective to control CBB infestations. Weeding negatively impacted natural enemies, whereas shade and higher crop density enhanced predator and parasitoid diversity, reinforcing the value of structural vegetation complexity. Enhancing natural enemy populations through vegetation diversification, reduced mowing, and maintaining shade trees offers a promising approach for long-term CBB management.

Keywords: Conservation biocontrol, Insecticides, Hypothenemus hampei, Shade coffee, Farm management

*Speaker

Competitive interactions between generalist predators and their impact on pest control in greenhouse chrysanthemum

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Generalist predators are increasingly used in biological control programmes, because they consume multiple pests and can be maintained in the crop through supplemental feeding. Practitioners often release multiple generalist predators in the crop, which then compete for the shared food sources. Furthermore, generalist predators engage in intraguild predation, which may or may not be reciprocal, further complicating the outcome of combined predator releases. In this study, we first evaluated how the interactions between two commonly used biological control agents, *Orius laevigatus* (Hemiptera: Anthocoridae) and *Transeius montdorensis* (Acari: Phytoseiidae), influence their population dynamics on greenhouse chrysanthemum when provided with a shared supplemental food source (*Artemia* cysts). These predators are often employed together for the control of thrips, and *O. laevigatus* engages in non-reciprocal intraguild predation of phytoseiid mites. Both predators negatively affected each other's abundance to a similar extent, suggesting resource competition as the primary mechanism rather than intraguild predation, which would have benefited *O. laevigatus*. Next, we assessed the pest control efficacy of single and combined predator releases against two major chrysanthemum pests: the western flower thrips *Frankliniella occidentalis* (Thysanoptera: Thripidae) and the common cotton aphid *Aphis gossypii* (Hemiptera: Aphididae). Our results showed that the addition of predatory mites did not improve the control of thrips exerted by *O. laevigatus*, but it negatively affected its population growth due to resource competition. However, this did not compromise its pest suppression ability, as *O. laevigatus* effectively controlled both thrips and aphids in all treatments. Meanwhile, densities of *T. montdorensis* were lower in the presence of *O. laevigatus* due to competition and intraguild predation, but increased in the presence of aphids, likely due to feeding on aphid honeydew.
Overall, our findings highlight the complex interactions between generalist predators and emphasize the need to consider interspecific competition when designing biological control strategies.

Keywords: resource competition, intraguild predation, Aphis gossypii, Frankliniella occidentalis, Orius laevigatus, Transeius montdorensis

*Speaker

Enhancing quality control processes for the production of Trichogrammatoidea cryptophlebiae (Hymenoptera: Trichogrammatidae) using artificial intelligence

Megan Mulcahy * [1], Sean Thackeray [1], Khaalid Beckett [1], Jeannine Du Plooy [1], Naho Muleya [1], Tanna Hewett [1], Tukela Hlazo [1]

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Quality control plays a vital role in the delivery of successful biocontrol solutions for integrated pest management (IPM) in agriculture. However, it can be difficult to understand which quality parameters should be recorded for mass production of living natural enemies. There is a lack of clearly defined quality control procedures for biocontrol agents due to the diversity and complexity of organisms used in commercial products. The quality control parameters required for predators, parasitoids and pathogens can differ greatly according to the ecology of the biocontrol species and their target hosts. For example, numerous parameters, including quantity, percentage parasitism, percentage emergence, sex ratio, adult longevity, lifecycle duration, and more, can be used when reporting quality data for parasitoids alone. Thus, it is evident that a multifaceted suite of quality control measures is needed at various stages of biocontrol production. Furthermore, data collection for quality control of biologicals is often tedious and labour intensive, which can negatively impact sample size. Technological advancements in automated biological processes and artificial intelligence can be used to improve the quantity and accuracy of quality control in insect mass-rearing systems. This presentation discusses the quality control parameters used for assessing the efficacy of a commercially produced parasitoid, namely *Trichogrammatoidea cryptophlebiae* (Hymenoptera: Trichogrammatidae), which is an egg parasitoid of moths in the family Tortricidae. This wasp is considered an important biocontrol agent of the phytosanitary pest, *Thaumatotibia leucotreta*, and is used widely in South African agriculture. A series of studies were conducted on *T. cryptophlebiae* to identify suitable sampling procedures and sample sizes for adequate decision-making and product quality control. Manual counting measures were developed, assessed, and compared to automated methods that use artificial intelligence to increasing quality control outputs. The implications for development and delivery of a thorough and transparent product quality control system are discussed.

Keywords: Egg parasitoid, mass, rearing, quality control, artificial intelligence

*Speaker

The Importance of Carabid beetles in the Cork forests at Eastern Algeria

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The study conducted on the beetles diversity in oak forests at northeastern Algeria identified 21 species of carabid species out of a total of 76 distributed between 12 genera. Most of these species were characterized as predators. Among the species recorded, some hold particular importance for legislation protection. Species such as Eurycarabus faminii, Calosoma inquisitor, and the North African endemic species Calathus fuscipes algericus are examples. This bio-indicator group of insects plays a fundamental role in bio-controlling of forest pests particularly the oak defoliators, such as Lymantria dispar. Based on the data collected, we found that the temporal abundance of species varied considerably across different oak forests surveyed, due to their structural characteristics and floristic composition. Among the studied sites, the cork oak forest stands out notably for its biological diversity, which promoted a tritrophic relationship between the host plant, its defoliator, and its predator. Among the three studied sites, the identified carabid species were strategically distributed according to floristic and faunistic composition. Despite its crucial role in preserving biodiversity, the floristic and faunistic diversity, particularly the carabid fauna, remains threatened by anthropogenic effects, including periodic forest fires. The low numbers observed during our investigations indicated a significant regression of carabid beetles in this sensible forest stand.

Keywords: Diversity, Carabid Beetles, Oak Forests, Eastern Algeria

*Speaker

Effects of the Agricultural Fungicide, Benomyl, on a Parasitoid Fly, Pales pavida (Diptera: Tachinidae)

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Parasitoids provide important ecosystem services by suppressing insect pest populations. However, recent studies have reported non-target effects of pesticides against parasitoids. One example is the failure of parasitism by some braconid parasitoids when host larvae were fed diets containing a benzimidazole fungicide, benomyl. These studies suggest that agricultural fungicide applications might also have adverse effects on parasitoids other than braconid wasps, such as flies belonging to the family Tachinidae. The order Diptera contains the largest number of parasitoid species after the order Hymenoptera, and the Tachinidae is the largest dipteran family among them. However, the relationship between the Tachinidae and benomyl has not been evaluated. *Pales pavida* (Diptera: Tachinidae) uses an indirect parasitism strategy in which it lays tiny eggs on leaves for the host to eat. In this study, we evaluated effects of benomyl on the parasitoid fly, *Pales pavida*.

The parasitism success rate of *P. pavida* was calculated by exposing its eggs to benomyl and then allowing host larvae (*Mythimna separata*; Lepidoptera: Noctuidae) to consume them, or by allowing parasitized host larvae to ingest benomyl. Furthermore, we determined 48-h survival rates after direct treatment of adult *P. pavida* in oral, residual, and topical toxicity tests, when benomyl was applied at a standard concentration. In egg exposure and oral ingestion tests of parasitized hosts, no significant difference in successful parasitism rate was observed between benomyl-treated and control host groups. Oral, residual, and topical toxicity tests of benomyl against *P. pavida* adults also showed no significant difference in survival between treatment and control groups.

These results suggest that some tachinid flies may be less susceptible to benomyl during parasitism than braconid wasps. We also confirmed that benomyl is not acutely toxic to adult *P. pavida*.

Keywords: IPM, side effects, biological control, Pales pavida, Mythimna separata

*Speaker

Intercrop, Cover Crop, and Relay Crop: Habitat Heterogeneity for Natural Enemy Conservation and Pest Suppression

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Three multi-year field studies elucidated the role of cover crops, intercrops, and relay crops in predator enhancement and pest suppression in row crop systems. *Study 1.* Relay intercropping winter and spring strip crops with cotton enhanced the densities of the cotton aphid (*Aphis* gossypii) predators. The intercrops acted as a reservoir for predators during the non-cotton season and 'relayed' aphid predators from canola and wheat in the winter to sorghum in the spring and finally to cotton in the summer. Aphid abundance was lower in relay intercropped cotton than in isolated cotton while the predator densities were higher in intercropped cotton than in isolated cotton. Results demonstrated that where cotton is grown without insecticides, relay intercropping aids the early colonization and continuous population increase of arthropod predators in cotton, thereby reducing numbers and postponing the initial population increase of cotton aphids. *Study 2.* The effect of cover crop – tillage systems (rye cover – no-tillage (R-NT), mixed cover – no-tillage (M-NT), and no-cover – conventional tillage (CT)) on abundance and diversity of predatory ground beetles was characterized in cotton where a mixed cover crop treatment (mixture of rye, vetch, radish, and winter pea) significantly enhanced the predator abundance. Predatory beetle abundances were 9.7, 16.2, and 28.2 beetles/trap/week in CT, R-NT, and M-NT plots, respectively. Predator diversity was significantly greater in M-NT (1.15) compared to that in R-NT (0.75) and CT (0.64). *Study 3.* A wheat monoculture crop versus wheat embedded with one strip each of three floral crops (wild radish, *Raphanus raphanistrum*, coriander, *Coriandrum sativum*, and linseed, *Linum usitatissimum*) demonstrated increased predator populations and decreased aphid (*Rhopalosiphum padi* and *Sitobion avenae*) populations on strip-planted wheat. These case studies clearly demonstrate the value of crop diversification in increasing predator activities and lowering the pest risks across various row crop systems.

Keywords: cotton, aphids, strip crops, cover crops, relay crops, carabids

*Speaker

Heterospilus sicanus as biological control agent of the book-boring beetle *Gastrallus pubens* in historical libraries; a possible tool for the management of Cultural Heritage pest infestations

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Cultural Heritage assets are frequently subject to biodeterioration caused by various biological agents, such as fungi and insects. Among them, several insect pest species pose a significant risk to structures and objects in museums, archives, libraries and historic buildings. Recently, *Gastrallus pubens* Fairmaire (Coleoptera: Ptinidae) has emerged as a notable pest in historic libraries in Italy, due to the considerable damage it causes to the stored rare books. During the inspections in a historic library in Palermo, Italy, carried out in the period from June 2023 to March 2025, apart from the presence of *G. pubens*, we observed the presence of a significant number of wasps on the shelves and inside the damaged books. These were identified as *Heterospilus sicanus* (Marshall) (Hymenoptera, Braconidae) and this finding r epresented the first instance of *H. s icanus* associated with *G. p ubens* in a confined en vironment. Although the presence of this braconid parasitoid was not able to reduce the beetle population and to limit the associated damages, the discovery could offer a new approach for limiting *G. p ubens* populations by biological control in Integrated Pest Management context. In general, factors such as contamination, hygiene, and potential impacts on human health make complicated the applying of biological control strategies in areas closely intertwined with human activities. However, the use of parasitoid wasps has recently gained some attention in IPM in stored product protection. Here, we discuss the possibility of applying this strategy as an additional potential approach for managing Cultural Heritage insect pests.

Keywords: Parasitoid, Cultural Heritage pest, IPM

*Speaker

Bottom-up impacts of invasive alien plants on parasitoid wasps through their aphid host

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Invasive alien plants are a major factor in the loss of biodiversity notably because they can modify trophic (and non-trophic) interactions. By acting as a potential alternative food source for phytophagous insects, they can affect their development and by a bottom-up effect, impact the development of their natural enemies such as parasitoids. On the contrary, invasive alien plants could play the role of barrier or even trap for the phytophagous insects and thus be detrimental for higher trophic levels. In this context, we studied the bottom-up effect of different invasive species (*Galinsoga quadriradiata*, *Reynoutria japonica* and *Senecio inaquidens)* on the black bean aphid (*Aphis fabae*), a major crop pest, and one of its parasitoids (*Aphidius colemani*) used as a biological control agent. To do this, several life history traits were measured and used as proxies to evaluate the fitness of (1) aphids (pre-reproductive period, biomass, lipid and water contents) and (2) parasitoids (developmental time, sex ratio, hind tibia size and female egg load). This study reveals contrasting bottom-up effects on the performance of aphids and their parasitoids depending on the alien host plant species, suggesting that invasive alien plants could alter the population dynamics of the natural enemies of aphid crop pests

Keywords: Aphis fabae, Aphidius colemani, bottom, up effect, exotic plant, host suitability, life history traits, natural enemies, trophic interaction

*Speaker

Compared reproductive biology of two mirid species used in tomato biological integrated protection.

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In the tomato greenhouses of the tropical island of la Réunion, the populations of the exotic mirid *Nesidiocoris tenuis* (Hemiptera, Miridae) are outcompeting the indigenous mirid *N. volucer*. Both species are zoophytophagous predators capable of regulating the main pests of tomatoes, but *N. tenuis* under the tropical conditions is deeply damaging the tomato crops. The problematic is therefore to find ways to maintain and enhance *N. volucer* populations while decreasing *N. tenuis* ones. Reproductive biology could be a factor of exclusion, we thus described their behavioural and physiological sexual maturation, their timing of mating and re-mating capacities. In males, we compared the seminal glands and accessory glands filling dynamics, and the length of testis and sperm cells, as clues of potential spermatic competition and cryptic post copulatory choice in females. In females we assessed ovarian maturation and egg production. First, we observed that both species had similar glands filling and egg production dynamics. Second, *N. tenuis* have longer sperm cells but shorter testis, suggesting that sperm competition is not a main constraint selecting for sperm numbers, and then that multiple mating of females has not driven male physiological adaptations. Third, *N. volucer* is more active for mating activities early in the morning, while *N. tenuis* is capable to mate all day long. Fourth, we observed re-mating in females of both species the day after a first mating, and also that *N. volucer* began to be sexually active younger than *N. tenuis*. In conclusion, except for a wider mating period, *N. tenuis* might not over perform *N. volucer* regarding its reproductive biology. The replacement of *N. volucer* by *N. tenuis* should therefore be studied through other fitness traits, potential intra guild predation, and or a better adaptation to the greenhouse tomato crops conditions.

Keywords: sexual maturation, insect physiology, oogenesis, spermatogenesis, mating behavior, Integrated Pest Management

*Speaker

IDMABIO: A Platform for the Molecular Characterization of Biological Agents and Pests

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The biodiversity of most agrosystems remains poorly understood due to taxonomic issues (cryptic species, species complexes, biotypes, etc), rapid changes in communities (invasive exotic species, re-emerging native species, etc) and limited diagnostic capabilities in terms of throughput, time and/or price.
This context led to the formalisation in 2024 of the IDMABIO platform (https://idmabio.com/), a service open to the various players in biocontrol, whether public research laboratories, agronomic players (Agricultural Technical Institutes, Chambers of Agriculture, FREDON, etc.) or private biocontrol manufacturers.
The services offered include DNA barcoding *i.e.* the use of a short DNA sequence considered necessary and sufficient to affiliate individuals at the species level. Since the launch of IDMABIO, this approach has been successfully applied to a wide range of taxa, crop pests (Coleoptera, Hemiptera, Lepidoptera, Neuroptera, Thysanoptera etc) or biological control agents (predatory bugs as well as egg, larval or pupal parasitoids).

Keywords: Agrosystem, Biodiversity, Biocontrol, DNA Barcoding

*Speaker

Aroplectrus dimerus (Hymenoptera: Eulophidae), Ectoparasitoid of the Nettle Caterpillar, *Oxyplax pallivitta* (Lepidoptera: Limacodidae): Evaluation in the Hawaiian Islands

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The stinging nettle caterpillar, Oxyplax pallivitta is a serious invasive pest of agricultural products and a health hazard on the Hawaiian Islands since 2001. Nursery workers and homeowners have been stung by the caterpillars while handling their plants. Throughout its invaded range, it causes wide-spread damage including the many cultivated and native palm species grown in Hawaii. Of medical importance are the stinging spines of the larva, which cause irritation on contact with the skin. Horticulture products impacted by the limacodid pest are estimated at $84.3 million. Suppression efforts with pesticides and lure traps were ineffective and the moth population continued to spread to major Hawaiian Islands. The introduction of specific biocontrol agents from the native region was thought to be the long-term solution. The oriental wasp, Aroplectrus dimerus, idiobiont gregarious ectoparasitoid, was introduced from Taiwan in 2004. Host range testing showed the parasitoid attacked only limacodid species and it was approved for field release in 2 010. The parasitoid identity, host specificity, reproductive performance, colonization on infested sites were assessed. A total of 13379 parasitoids were colonized on 162 release sites on four Hawaiian Islands. Field parasitism was thoroughly investigated on Oahu Island averaging 18.9 ± 5.6% of 3923 collected larvae during 2010 – 2023. The numbers of male moths caught/trap/month were significantly reduced. Recently, the hyperparasitoid, Pediobius imbreus (Hymenoptera: Eulophidae), was detected reducing the efficiency of A. dimerus in the field. Mean hyperparasitism of pupae was 27.3 ± 7 .6%. There was no detailed biological assessment for A. dimerus or its field evaluation available in scientific li terature. Results were discussed for its potential use in biocontrol elsewhere if the stinging nettle caterpillar invaded in the future.

Keywords: host specificity, r eproductive p erformance, c olonization, p arasitism r ates, secondary parasitism, moth traps catch, Eulophidae, Limacodidae

*Speaker

Study of Multitrophic Interactions and Bioinsecticide Efficacy under the Influence of Global Change in Beet Crops

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Trophic interactions are affected by abiotic factors such as climate and, in agroecosystems, by anthropogenic factors such as pesticides. In the context of global change, variations in climatic factors such as temperature and humidity may affect these interactions directly, as well as through a modulation of pesticides efficiency. As part of the INTERREG "Transpest" programme (Biocontrol 4.0), this project aims to assess the persistence of biopesticides efficiency under climatic variations, on a three-level trophic chain : the sugar beet *Beta vulgaris* (first level), the black bean aphid *Aphis fabae*, one of the two main beet yellows viruses vectors (second level), and one of its parasitoids *Aphidius colemani* (third level). Three types of biopesticides that have already shown aphicidal activities are considered for this work : surfactin bacterial lipopeptides, essential oils and entomopathogenic fungi. Direct effects of these products on treated aphids and on treated parasitoids, as well as indirect effects through the treated host plant, will be assessed using physiological and behavioral approaches. Variations in temperature and humidity will then be applied to the tritrophic system to investigate whether the toxicity of these biopesticides persists under changing climatic conditions.

Keywords: aphid, aphid parasitoid, lipopeptide, essential oil, entomopathogenic fungus

*Speaker

Dietary niche overlap between the introduced Joro spider (Trichonephila clavata) and native orb-weaving spiders

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The introduction of novel generalist predators into new ecosystems can dramatically alter species interactions. While introduced predators contribute to pest control services, a net loss of biodiversity may occur if they displace natives through intraguild predation or competition over food resources and suitable habitat. Joro spiders (*Trichonephila clavata*) are an introduced, orb-weaving spider that show rapid range expansion in the United States. Here, we used molecular gut content analysis to explore diet diversity and prey overlap between Joro spiders and three co-occurring, native orb-weaving species. Female spiders were collected from 52 sites and their gut content analyzed determined via DNA metabarcoding and high-throughput sequencing. Despite diet overlap between the introduced Joro spider and native spiders, consumed taxa by each species were distinct, with unique prey taxa found only in that species. Moreover, we observed dietary overlap amongst native spiders regardless of whether or not Joro spiders were present at that location. Thus, our initial analysis suggests that while Joro spider diets do overlap with native spiders, they are unlikely to outcompete native spiders over food resources alone. However, additional mechanisms, that underlie their invasion success may also contribute to declines in native predator populations.

Keywords: molecular trophic interactions, predation, webspider

*Speaker

A predatory mite as potential biological control agent of the invasive *Thrips parvispinus*

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Biological control provides an effective strategy for managing multiple pest problems and several invasive pests. Thrips are one of the most damaging and economically costly pests in agricultural crops. *Thrips parvispinus* is an invasive species which has recently spread across Europe. It is a polyphagous pest that infests both vegetable and ornamental crops. At present, the use of biological control against *T. parvispinus* is at its infancy. Here, we tested the potential of predatory mites as biocontrol agents of *T. parvispinus*. We evaluated the predation and oviposition rates of two predatory mites, *Amblyseius swirskii* (Athias-Henriot) and *Iphiseius degenerans* (Berlese), when offered 1st instar larvae of *T. parvispinus* and found that predation and oviposition rates of *A. swirskii* were higher than those of *I. degenerans*. Furthermore, *A. swirskii* had higher juvenile survival and developmental rate when provided with pollen or a diet of pollen with thrips larvae than when provided with a diet of thrips larvae alone. A small-scale greenhouse population experiment on isolated sweet pepper plants showed that *A. swirskii* effectively controlled *T. parvispinus*, both with and without the supply of pollen as alternative food for the predators. Our results confirm that releasing *A. swirskii* before pest invasion can efficiently control *T. parvispinus* populations on sweet pepper.

Keywords: thrips, greenhouse, population dynamics, phytoseiidae, biocontrol

*Speaker

Exploring population dynamics and host plant interactions of *Lygus lineolaris* in organic solanaceae farms

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Lygus lineolaris, the tarnished plant bug, is a significant pest affecting over 130 crops, including tomatoes and peppers in the Solanaceae family. Its distribution relies on the availability of both crops and weedy host plants, with a strong preference for flowering species that attract it through visual cues and nutrient availability. Effective biological control requires coordinated Integrated Pest Management (IPM) strategies, which include managing wild host plants through mowing or selective herbicide applications and employing pheromone-baited traps to reduce adult populations..

In this study, we sampled 16 organic Solanaceae farms in Quebec, monitoring *L. lineolaris* populations from June to October using 12 pheromone traps per field with bimonthly captures. Additionally, at three points during the production season, we examined three 1 m^2 quadrants in flower strips adjacent to the crops, identifying all plant species present, noting their phenological stages and the percentage of space occupied.

Preliminary results from the first year of a three-year study reveal a consistent presence of *L. lineolaris* adults throughout the monitoring period, with notably higher captures recorded at the end of August, averaging 10.75 ± 2.52 captures per farm. This increase coincides with the emergence of second-generation adults and a peak in yellow flower abundance. Additionally, we identified 75 non-crop plant species along field edges, primarily featuring white flowers, as well as yellow and mauve varieties. This diversity of host plants maintains floral resources throughout the production period, ensuring a consistent supply of food for feeding and overwintering. Understanding these interactions is crucial for developing effective pest management strategies and promoting sustainable agricultural practices.

Keywords: tarnished plant bug, pest, flower, feeding host, pheromone trap

*Speaker

Non-target effects of chemical sprays on Trichogrammatoidea cryptophlebiae life stages and the integration of this beneficial species into South African IPM programs

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The adoption of Integrated Pest Management (IPM) strategies in South African agriculture is increasing due to tightening Maximum Residue Limit (MRL) regulations. As farmers' options for pest management through chemical usage decrease, *Trichogrammatoidea cryptophlebiae* is an egg parasitoid wasp that can be integrated into pest management programs to support this transition. This study evaluates the effects of 14 chemical products, including two bio-insecticides, ten chemical insecticides, and two fungicides, on the survival and parasitism abilities of *T. cryptophlebiae,* providing insights for its effective use in IPM strategies.
To assess these effects, dip assays and semi-field residue tests were conducted. In dip assays, developing parasitoid eggs were exposed to each chemical at recommended field concentrations. Parasitoid survival was assessed at egg-larval, pupal, and adult female stages, and parasitism rates were recorded by allowing exposed females to parasitize pest eggs. In semi-field residue tests, pesticide residues were left on foliage, and parasitoid mortality was monitored at 0, 7, 14, 21, and 28 days.

Results showed that Lambda-Cyhalothrin, Tau-fluvalinate, and Abamectin resulted in emergence rates below 60% in the egg-larval stage, while Chlorantraniliprole had the highest emergence (95.94%). In the pupal stage, Lambda-Cyhalothrin (37.72%) and Tau-fluvalinate (41.56%) showed the lowest emergence, while Azoxystrobin and Difenoconazole had higher rates (73.55%). Parasitism was inhibited by Lambda-Cyhalothrin and Tau-fluvalinate, while Azoxystrobin and Difenoconazole, and *Beauveria bassiana* supported parasitism rates ranging from 10 to 18 eggs over 24 hours. Residue testing revealed that most chemicals were non-lethal by day 7, except Acephate, which had a long residual effect with 14% mortality recorded on day 28.
These findings emphasize the importance of selecting compatible chemicals to preserve *T. cryptophlebiae*. As harmful chemicals are phased out, this research provides valuable guidance for integrating *T. cryptophlebiae* into pest management programs, offering sustainable alternatives for South African farmers.

Keywords: IPM, Trichogrammatoidea, Biological Control, Chemical usage, Non, target effects

*Speaker

Spider and scorpion diversity in Khok Huai Wang Saeng community forest, Khon Kaen province, Thailand

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Spider and scorpion are important for ecosystem as insect and small animal predators. We aimed to survey spider and scorpion diversity in Khok Huai Wang Saeng community forest, Khon Kaen Province, Thailand. The forest is a dry dipterocarp forest, with prominent Dipterocarpus and Shorea tree species. We walked along the forest trails and looking for insects in trees, shrubs, ground cover plants, ground surfaces and under plant litters in June 2024. We found 65 species of spiders from 18 families such as *Cyriopagopus lividus*, *Pardosa pseudoannulata*, *Nephila pilipes*, *Parawixia dehaani*, *Argiope pulchella*, *Cyclosa insulana* and *Leucauge decorate*. *Cyriopagopus lividus*, native to Myanmar and Thailand, is rare and threatened species found in this site. We also found 3 species of scorpions from 3 families including *Heterometrus laoticus*, *Lychas mucronatus* and *Liocheles australasiae*. This community forest contains diverse spider and scorpion species, so it is still well protected by local people.

Keywords: spider, scorpion, biodiversity, dry dipterocarp forest, tropic

*Speaker

Dual Effects of Endophytic *Metarhizium anisopliae* on Maize Developmental Dynamics and *Spodoptera frugiperda* Biocontrol in Agroecosystems

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Endophytic colonization by *Metarhizium anisopliae* (Clavicipitaceae, Hypocreales) has emerged as a promising tool in integrated pest management (IPM) due to its dual role in plant growth modulation and pest suppression. This study investigates the stage-specific effects of *M. anisopliae* endophytic colonization on Maize (*Zea mays* L.) growth and its consequences for the performance of the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae), a key maize pest. Maize plants were inoculated at one- and three-leaf stages, with growth parameters monitored over four weeks. Larval and pupal development of *S. frugiperda* reared on colonized plants were assessed. Colonization exerted growth stage-dependent effects: at the three-leaf stage, treated plants exhibited reduced height (49.0–56.9 cm vs. 52.9–60.2 cm in controls) and narrower leaves, while one-leaf-stage inoculation enhanced early leaf elongation (43.2 cm vs. 40.8 cm by Week 3) but reduced leaf count (6.50 vs. 7.30 leaves/plant by Week 4). Notably, *M. anisopliae* significantly impaired *S. frugiperda* performance, extending larval development (11.9 vs 9.86 days), reducing larval weight (47.1 mg vs. 67.7 mg), and increasing mortality (66.7% vs. 10.0%). Pupal metrics were similarly affected, with delayed development (14.0 vs. 10.3 days), lower weight (348.6 mg vs. 400.1 mg), and reduced formation rates (30.0% vs. 86.7%). These findings highlight *M. anisopliae*'s capacity to disrupt pest lifecycles while eliciting context-dependent growth responses in Maize, underscoring its potential as a multifunctional IPM agent that balances crop resilience and biocontrol efficacy.

Keywords: Metarhizium anisopliae, endophytic colonization, maize growth, Spodoptera frugiperda, integrated pest management

*Speaker

Parasitoids and pesticides: insecticides and the behaviour, ecology and applications of parasitic wasps

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Parasitoid wasps are excellent organisms for the study of natural behaviour, evolution and ecology. They are also tremendously beneficial in human agro-ecosystems as agents of biological pest control. Their field performance may, however, be compromised by the application of chemical insecticides which target insect pests but can also affect non-target insects. Some chemical insecticides have been banned in some countries but, overall, the manufacture and use of insecticides remains substantial. Restrictions that have been put in place have often been stimulated by concerns over non-target effects on commonly visible insect pollinators (with most attention on honeybees and bumblebees), with less attention paid to the less 'publicly visible or well known' hymenopteran parasitoids. Here we summarize the evidence for insecticide effects on parasitoid wasps.

Keywords: Pesticides, insecticides, parasitoids, non target effects, pests

*Speaker

Spider Egg Sac Ecosystem: A Universe Within

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Abstract

Trophic interactions involving the transfer of nutrients and energy are fundamental to ecosystem dynamics. The present study from India focuses on the regulation of spider density by egg parasitoids and egg sac predators, conceptualizing an individual spider egg sac as a complex ecological unit encompassing a network of multiple species, often with temporal overlap. By deciphering direct trophic interactions in simple food webs related to spider egg sacs, this work explores for the first time trophic networks intrinsic to spider egg sacs.

This study, conducted in the Indian Sundarbans, collected approximately 1,055 egg sacs over three years (2021–2024) and documented about 6% spider egg sac parasitism. In total, nine species from eight genera, spanning five families across three insect orders, were recorded, highlighting diverse, multiple trophic interactions. The identified egg parasitoids and egg sac predators belong to the families Scelionidae, Eulophidae, and Ichneumonidae (Hymenoptera); Chloropidae (Diptera); and Mantispidae (Neuroptera). The presence of multiple parasitoid species underscores complex interspecific interactions, most of which are newly documented.

Keywords: Egg parasitoids, Egg sac predators, Indian Sundarbans, Trophic interactions.

*Speaker

The utilisation of DNA barcoding in the study of parasitoid communities of *Cydia pomonella*

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Cydia pomonella (Lepidoptera: Tortricidae), commonly known as the codling moth, is a major pest affecting apples, pears, and walnuts worldwide. It has been present in France for over 250 years and became a significant issue with the expansion of orchards in the 18th century. Various parasitoid species have been identified as potential biological control agents, but only a few have a significant impact on codling moth populations.
In the frame of a classical biological control program using the exotic parasitoid *Mastrus ridens* (Hymenoptera: Ichneumonidae), field samplings using corrugated cardboards and sentinel larvae were done on several crops hosting the codling moth (apple, walnut) between 2019 and 2023 and on a large experimental design of 66 sites in metropolitan France (see P. Decoeur poster for details). At least 700 hymenopteran parasitoids were collected including several families such as: Ichneumonidae, Braconidae, Perilampidae, Pteromalidae.

Ichneumonidae was the most represented family (about 80% of the individuals). Species identification within this family represents a hard challenge because of a complex taxonomy and high levels of morphological homoplasy. While experienced taxonomists can often assign specimens to the correct subfamily/genus/species, DNA analysis can provide invaluable insights when morphological identification is not possible, especially when collected specimens are pre-imaginal instars. We use thus a cost-effective molecular technique using **MinION sequencing** for precise identification of parasitoid communities. This technique is being implemented within the molecular characterization platform **IDMABIO** (https://idmabio.com/).
Taken as whole, the most abundant being the primary specialized parasitoid *Ascogaster quadridentata* (Hymenoptera: Braconidae), which attacks codling moth eggs and emerges from larvae in their penultimate stage. Other species, such as *Liotryphon caudatus, Pristomerus vulnerator* (Hym., Ichneumonidae) and *Perilampus tristis* (Hym. Perilampidae) were also present frequently in the samples.

Keywords: DNA barcoding, Cydia pomonella, parasitoid communities, pest

*Speaker

Biological control initiative against native and invasive stink bugs in French hazelnut orchards: progress and prospects

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The green shield bug (*Palomena prasina*) is an emerging native pest in France, increasingly causing damage to hazelnut crops. In parallel, the brown marmorated stink bug (*Halyomorpha halys*), an invasive alien species, has been a major agricultural pest worldwide for over 40 years. Since its detection in mainland France in 2012, *H. halys* has established itself and become a serious threat to various crops, including hazelnuts.
To address these challenges, the REPLIK project, led by the Association Nationale des Producteurs de Noisettes (ANPN) in collaboration with INRAE and DISAFA, aimed to study biological control strategies against *P. prasina* and *H. halys*. This project enabled the collection of indigenous pentatomid parasitoids in southwestern France and led to the first detection of *Trissolcus mitsukurii* in 2020, one of the two most promising biocontrol agents against *H. halys*. A pilot production chain was developed to rear *T. mitsukurii*.

Building on REPLIK's findings, the RIPPOSTE project (2021–2024) was launched to implement a biological control program using egg parasitoids. The first releases of *T. mitsukurii* took place in 2021 across three sites (200 parasitoids per site per year). Monitoring efforts led to the successful recapture of individuals 18 months after the first release, and in 2022, a second key parasitoid species, *Trissolcus japonicus*, was detected in France. In 2024, *T. mitsukurii* was released at five additional sites in hazelnut orchards at a tenfold higher dose (2,000 per site per year), with recaptures conducted in the first year. Further experiments under RIPPOSTE project assessed the acclimatization capacity of both parasitoids focusing on overwintering survival and post-winter fecundity, and evaluate efficacy under semi-controlled conditions.
In 2025, a new national research initiative, PARSADA, will expand the fight against *H. halys* to multiple crops, enhancing the potential for long-term biological control success.

*Speaker

Assessing the efficacy of the parasitoid wasp *Aganaspis daci* as a biocontrol agent of *Dacus ciliatus* in Israel

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The cucurbit fruit fly, *Dacus ciliatus* (Diptera: Tephritidae) is a devastating pest affecting cucurbit crops. *Dacus ciliatus* invaded Israel from Egypt in the late 1990s, spread to most parts of Israel, and to this date its control relies entirely on chemical pesticides.
The parasitoid wasp *Aganaspis daci* Weld (Hymenoptera: Figitidae) was imported to Israel in the 1950's for the control of the Mediterranean fruit fly, *Ceratitis capitata* and it is unknown whether this wasp also attacks *D. ciliatus*. Therefore, the aims of the current study are: 1. To determine whether *D. ciliatus* is a suitable host for *A. daci*; 2. To study if *A. daci* can serve as an effective biocontrol agent of *D. ciliatus,* and; 3. To study the effect of the wasp's host background (wasp lines that were reared for multiple generations either on *C. capitata* or *D. ciliatus*) on its host preference and fitness.

We found that *A. daci* successfully develops on *D. ciliatus*, producing an average of 58.1 offspring throughout its lifetime. Females live on average 13.9 days and males live 13.3 days. Wasps that were reared on *C. capitata* exhibited a higher parasitization compared to wasps that were reared on *D. ciliatus*, across both hosts. Furthermore, wasp that were reared on *C. capitata*, parasitized higher numbers of *D. ciliatus* than *C. capitata* itself. The host preference experiment of the two wasp lines were inconclusive.
This is the first report showing that *D. ciliatus* is a suitable host of *A. daci*. Based on the information from this study, and additional experiments that should be done, an integrated pest management strategy for this pest can be formulated.

Keywords: Biological control, fly pest control, Tephritidae, Cucurbitaceae, Figitidae

*Speaker

The hymenopterous parasitoids of *Phyllonorycter* Hübner (Gracillariidae) and *Coptotriche* Walsingham (Tischeriidae) on oaks in Xiangkhouang province, Laos

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The parasitoid assemblage of Phyllonorycter acutissimae (Kumata) was studied on Quercus acutissima in Japan and Korea (Sato el al. 2002), and by us in October–March 2018–2019 in Laos. The moth species was identified for the first time for Laos based on the male genitalia. Caterpillars developed in characteristic folded mines on the leaf lower side. We reared nine species of Eulophidae and two species of Microgasterinae (Braconidae) from larvae of P. acutissimae. All ectoparasitoids (71.1%) including Pnigalio sp. (26.9%), Cirrospilus ingenuus (19.2%), Diglyphus isaea (7.7%) Hemiptarsenus ornatus (7.7%) and Sympiesis gordius (9.6%) were attacking 2nd–3rd instars of caterpillars. Endoparasitoids (29.7%) such as N. formosus (7.7%), N. chlorogaster (3.8%), Chouioia cunea (7.7%) and Chrysocharis sp. (11.5%) are attacking the last instar. In the parasitoid complex of P. acutissimae, the number of ecdoparasitoid species is slightly greater compared to the number endoparasitoid species, but quantitatively ectoparasitoids are 3.1 times as abundant as endoparasitoids. This is the first host record of Gracillariidae caterpillars for the tetrastichinae wasps C. cunea. The tischeriid genus Coptotriche Walsingham was identified based on the male genitalia, the moths being reared from the typical for Tischeriidae whitish mines on the upper side of the Quercus dentata leaves. The parasitoid complex includes eight eulophid species and two Braconinae. The dominant species are Pleurotroppopsis japonica 54.4%, other koinobionts include Closterocerus trifasciatus 16.4%, Pediobius foveolatus (2.5%) and Neotrichoporoides viridimaculatus (3.8%). All ectoparasitoids (including both species of Braconinae), S. sericeicornis 8.8%, Elachertus sobrinus 3.8%, Diglyphomorphomyia sp. 5% and Notanisomorphella flaviventris 5 %. The endoparasitoids are attacking the last instar larvae and prepupae of Coptotriche. The number of endoparasitoid species is equal to the number of ectoparasitoid species, but the reared endoparasitoids are 3.6 times as abundant as the ectoparasitoids.

Keywords: Eulophidae, Braconidae, ectoparasitoids, endoparasitiods, Southeast Asia

*Speaker

Temperature-Dependent Life History Traits of Two *Nesidiocoris tenuis* Populations from Different Geographic Regions

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The dicyphine mirid *Nesidiocoris tenuis* (Reuter) (Heteroptera: Miridae) is a zoophytophagous biological control agent used in integrated pest management (IPM) programs in the Mediterranean, particularly against *Phthorimaea absoluta* (Meyrick) (Lepidoptera: Gelechiidae) and whiteflies (Hemiptera: A leyrodidae). I ts e fficacy as a b io logical con trol age nt is infl uenced by temperature, which affects i ts d evelopment, s urvival, a nd r eproductive p otential. I n t his study, we investigated the life table parameters of two *N. tenuis* populations from different geographic regions (a wild Greek population and a commercial population) at 25∘C and 30∘C, using a mixed diet of *Ephestia kuehniella* (Zeller) (Lepidoptera: Pyralidae) eggs and *Artemia* cysts (Anostraca: Artemidae). Both populations exhibited longer nymphal developmental times at 25∘C than at 30∘C, with females taking longer to complete development than males. Prey consumption varied significantly d uring n ymphal d evelopment, w ith t he G reek p opulation c onsuming m ore t han the commercial population. Fecundity was higher at 30∘C, but female longevity significantly decreased compared to 25 ∘C in both populations. These findings r eveal population-specific differences i n n ymphal d evelopment a nd p rey c onsumption d epending o n t emperature, which may influence t he p erformance o f *N. t enuis* i n b iological c ontrol p rograms. U nderstanding how environmental factors shape life history traits is vital for optimizing its application in IPM strategies, particularly under variable climatic conditions.

Keywords: Nesidiocoris tenuis, predatory mirids, life table parameters, temperature, intraspecific variation, biological pest control

*Speaker

On the rise? *Anastatus disparis* as spongy moth egg parasitoid in Austrian oak forests

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The spongy moth, *Lymantria dispar* (Lepidoptera: Erebidae), is a forest defoliating insect pest with a rich complex of larval and pupal parasitoids. By contrast, egg parasitoids are considered to play only a minor role in regulating host populations in Central Europe and egg masses with parasitized eggs of > 10 % are reported exclusively from southern regions of the native range. However, we observed average egg parasitism rates of 19 % in the recent spongy moth outbreak in Austria in 2020. Egg clusters collected occasionally at various forest sites confirmed that the egg parasitoid *Anastatus disparis* (Hymenoptera: Eupelmidae) caused unexpectedly high parasitism rates also in the present latency period. A more systematic survey is currently conducted. The results suggest that the eupelmid wasp is becoming more abundant in Austria in recent years, thereby causing increasingly higher egg parasitism rates in spongy moth, eventually mediated by climate change.

Our laboratory experiments also shed new light on the biological features of *A. disparis*, regarding suitability of spongy moth eggs in the course of embryonic development. Information from the literature is partly contradictory, but it is generally stated that spongy moth eggs are suitable hosts only 2-3 days after egg deposition or shortly before embryonic development is completed. In contrast, we were able to culture *A. disparis* wasps in fully mature, post-diapause eggs of *L. dispar*.

Our poster serves as a platform to share observations and studies on *A. disparis* in other countries, to introduce our current and future experiments, and to present initial results of our research.

Keywords: egg parasitism, Chalcidoidea, climate change

*Speaker

Resistance traits in tomato genotypes affect the biological performance of natural enemies of the tomato leaf miner *Phthorimaea absoluta*

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Combining host plant resistance and natural enemies is a promising strategy against *Phthorimaea* (*Tuta*) *absoluta*, a major tomato pest. Therefore, understanding how plant resistance traits affect natural enemies can provide key insights for selecting or breeding tomato genotypes that enhance both pest resistance and biocontrol. In this study, we investigated the efficacy of three biological control agents on six tomato genotypes exhibiting various resistance levels to *P. absoluta* under laboratory conditions. First, we determined parasitism by the egg parasitoid *Trichogramma achaeae* on hosts from parents reared on the different tomato genotypes, either isolated or provided on the tomato plant. Second, we assessed parasitism by the larval parasitoid *Necremnus tutae* on tomato genotypes hosting *P. absoluta* larvae. Finally, we evaluated the predatory efficacy of the mirid *Macrolophus pygmaeus* on tomatoes hosting *P. absoluta* eggs and larvae, all derived from parents reared on the respective genotypes, along with nymphal survival, both in the presence and absence of *P. absoluta* eggs. Parasitism and emergence rates of *T. achaeae* and *N. tutae* were not significantly affected by susceptible tomatoes, the resistant domesticated Corona F1, or the resistant wild *Solanum neorickii*, all presenting relatively low densities of glandular trichomes. Only minor effects were visible, such as smaller *P. absoluta* eggs laid by moths reared on Corona F1 resulting in reduced proportion of female *T. achaeae* offspring, and larvae from *S. neorickii* reducing the proportion of female *N. tutae* offspring. Additionally, *M. pygmaeus* consumed fewer eggs on Corona F1 than on *S. neorickii* and susceptible tomatoes. In contrast, the resistant wild tomato *S. arcanum*, presenting a high density of glandular trichomes, impaired *T. achaeae* performance, reduced *N. tutae* parasitism, and negatively impacted *M. pygmaeus* predatory efficacy and nymphal development. The implications of plant defense traits in integrated management of *P. absoluta* are discussed.

Keywords: Host plant resistance, predator, parasitoid, glandular trichomes, tri, trophic interactions, integrated pest management

*Speaker

Longevity and parasitism of *Mastrus ridens* (Hymenoptera: Ichneumonidae), when exposed to different sources of non-floral sugars

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Sugar intake in adult parasitoids is key for expressing their maximum reproductive potential which can impact its biological control's success. In the field there may be different sources of sugar, however, not all of them are equally beneficial for different natural enemies. The objective of this study was to evaluate the impact of adult feeding on non-floral sugar sources on the longevity and parasitism of *Mastrus ridens* (Hymenoptera: Ichneumonidae), a key codling moth (*Cydia pomonella*, Lepidoptera: Tortricidae) parasitoid. To this end, the honeydew of *Eriosoma lanigerum* (Hemiptera: Aphididae) and *Pseudococcus calceolariae* (Hemiptera: Pseudococcidae) was evaluated, in addition to the extrafloral nectar of fava bean plants. Diluted honey was used as a positive control and water as a negative control. The results indicate that all sources of sugar had a positive impact on the longevity of *M. ridens*, with honey being the one that obtains the greatest longevity, followed by extra-floral nectar. Similarly, the largest number of parasitized larvae were obtained with extra-floral nectar and honey. The number of larvae parasitized when feeding on the honeydew of *P. calceolariae* was similar to the water control. The results indicate that non-floral sugar sources can positively impact the performance of *M. ridens*, with extrafloral nectar being a better source of sugar than honeydew of the hemipteran species evaluated. These results have practical implications for decision-making when establishing conservation biological control initiatives.

Keywords: Extra, floral nectar, honeydew, longevity, parasitoids, conservation biological control

*Speaker

Spread and multitrophic interactions of the exotic parasitoid *Leptopilina japonica* Novković & Kimura, 2011 in Lombardy region (Northern Italy)

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Leptopilina japonica Novković & Kimura, 2011 (Hymenoptera: Figitidae) is an Asian parasitoid wasp, known for its role in parasitizing the Spotted Wing Drosophila (SWD), *Drosophila suzukii* (Matsumura, 1931) (Diptera: Drosophilidae). *Drosophila suzukii* is a highly polyphagous invasive species native to eastern and south-eastern Asia, causing significant economic losses to small fruits and stone fruits. *Leptopilina japonica* was first recorded in Italy and in Europe in 2019, in Trentino-Alto Adige and has quickly settle down and spread in different Italian areas. This study presents the results of a two-year monitoring effort (2023–2024) aimed at assessing the presence and distribution of *L. japonica* in Lombardy region (Northern Italy). In 2023 and 2024, six sites across four provinces (Sondrio n=3, Bergamo n=1, Como n=1, Varese n=1) were monitored from June to September. In 2024 at the end of the summer other 12 in six provinces were added (Mantova n=4, Pavia n=3, Milano n=2, Lodi n=1, Cremona n=1, Como n=1). To evaluate parasitoid presence, ripe fruits were collected from the monitored sites and transferred to the laboratories in climatic chambers to evaluate the *L. japonica* emergence, its interactions with *D. suzukii* and other drosophilids, and also with the fruits. Adults of *L. japonica* were consistently recorded in the initial six locations throughout the monitoring periods of both years, confirming the stable presence of the parasitoid in these areas. In the additional 12 sites surveyed in 2024, *L. japonica* was recorded only in the provinces of Como and Lodi. The parasitoid wasp emerged predominantly from *Rubus* spp. (*R. ulmifolius* and *R. fruticosus*), expecially from fruits collected between late August and early September. These findings confirm the establishment of *L. japonica* in a wide area in Lombardy region and suggest a potential role in regulating *D. suzukii* populations.

Keywords: Pest, Invasive, Parasitoid wasp, Biocontrol, Behaviour

*Speaker

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