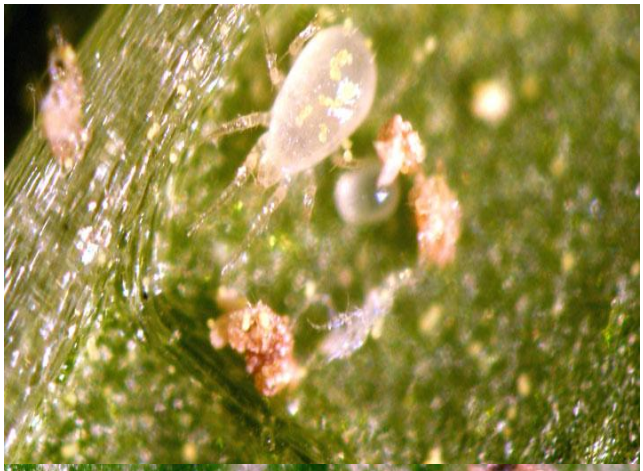

BOOK OF ABSTRACTS

IOBC MEETING OF THE WORKING GROUP

Integrated Control of Plant-Feeding Mites

4-7 September 2017
Chania, Greece

DEMOCRITUS UNIVERSITY OF THRACE

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IOBC MEETING OF THE WORKING GROUP

Integrated Control of Plant-Feeding Mites

4-7 September 2017
Chania, Greece

This meeting is sponsored by:

Cover photos of mites: Konstantinos Samaras (Democritus University of Thrace)

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Welcome Note

Dear attendee,

It is a great pleasure and honor for the organizing committee of the 6th meeting of the IOBC Working Group "Integrated Control of Plant-Feeding Mites" to welcome you at the Mediterranean Agronomic Institute of Chania (MAICh) Conference Centre in Chania, Greece.

The meeting aims to provide a forum for disccusion on new reaserch results on the biology, behavior, ecology and integrated control of plant feeding mites. The scientific porgramm is organized in two-day sessions with four key note speakers giving insight to different approaches, trends and perspectives in chemical and biological control of plant feeding mites. We anticipate more than 60 participants from all over the world.

We hope that the oral and poster sessions as well as the social events will give the opportunity for fruitful discussions and exchange of ideas.

We wish you an inspirational and fruitful meeting.

Sincerely,
On behalf of the organizing committee,

George Broufas

Keynote Speakers

Dr Thomas Van Leeuwen
Department of Crop Protection, Faculty of Bioscience Engineering, Ghent University, Ghent, BELGIUM

Talk title: The elucidation of adaptation mechanisms in spider mites: recent progress and future perspectives

The main research interests of Thomas Van Leeuwen center on the physiology, genetics, genomics and molecular biology of adaptive mechanisms in spider mites such as *Tetranychus urticae* in relation to the xenobiotic metabolism and resistance. This entails the study of acaricide resistance, as well as mechanisms of adaptation to novel host plants, including plant-mite molecular interactions.

Dr Angelo Pallini
Laboratory of Acarology, Federal University of Viçosa, BRAZIL

Talk title: From mite ecology to applied acarology in Neotropical agroecossystems

Research interests of Dr Angello Pallini focus on mite ecology, applied acarology in agroecossystems with emphasis on the ecology of an invasive mite species, *Tetranychus evansi*, and how it manipulates plant defense to is own sake. His laboratoy investigates food web ecology and biological control in agroecosystems as coffee, strawberry, litchi, chili peppers, and eucalyptus/guava trees.

Dr Takeshi Shimoda
Insect Biocontrol Lab., National Agricultural Research Center, Tsukuba, Ibaraki, JAPAN

Talk title: A novel method for protecting slow-release sachets of predatory mites (*Neoseiulus californicus*) against environmental stresses and for increasing predator release to greenhouse crops

Dr Takeshi Shimoda is an entomologist studying tritrophic interactions between plants, herbivores and their natural enemies. He is interested in the role of insect and mite predators in controlling spider mites in orchards. He recently joined as a leader a research project (2014-2017) that aims to develop "sheltered sachets of predatory mites". Sheltered sachets that are commercially available in Japan can protect slow-release sachets of predatory mites against environmental stresses (e.g. pesticides, drenching) enhancing the predator's release in crops.

Dr Marie-Stéphane Tixier
Department of Biology & Ecology, Montpellier SupAgro, UMR CBGP, FRANCE

Talk title: Why multidisciplinary approaches for controlling mite pests?

Marie-Stéphane Tixier is a professor in crop protection in Montpellier SupAgro (France) and head of the Department Biology and Ecology. Her research activity deals with the taxonomy of the mite family of Phytoseiidae (Acari: Mesostigmata): diagnostic, ecology, biodiversity, biogeography and phylogeny of the family and the use of those mites for biological control in various crops, mainly vineyards, orchards and tomato crops. As key recent activities, she coordinates the MOOC Nectar and the Acarosol, a research project that aims to develop new biological control solutions for mite pests in tomato crops

Program

MONDAY SEPTEMBER 4

17:00 -19:00 Registration
19:00 -21:30 Welcome reception in MAICh, sponsored by Biobest NV

TUESDAY SEPTEMBER 5

8:00 Registration
9:00 Welcome, Introduction

SESSION 1

MODERATOR: ERIC PALEVSKY

9:30 Plenary talk — **From mite ecology to applied acarology in Neotropical agroecosystems** — **O1.1**
Angelo Pallini, Arne Janssen, Renato Sarmento, Felipe Lemos, Cleide Dias, Madelaine Venzon, Livia Ataide, Marcus Vinicius Alfenas Duarte

10:15 — **Moving forward in putting predatory mite learning into practice: prey cue analyses and organizational upward cascades** — **O1.2**
Peter Schausberger, Michael Seiter, Günther Raspotnig, Stefan Peneder, Inga Christiansen

10:30 — **Effects of the plot landscape and pollen concentration on phytoseiid mites (Acari: Phytoseiidae) in three French viticultural regions** — **O1.3**
Serge Kreiter, Ghais Zriki, Marie-Stéphane Tixier, Gilles Sentenac, Adrien Rusch, Julien Thierry, Lionel Delbac, Matthieu Madejsky, Marc Guisset

10:45 COFFEE BREAK

SESSION 2

MODERATOR: PETER SCHAUSBERGER

11:15 — **Provision of pollen allows *Tetranychus urticae* control in clementines with *Euseius stipulatus*** — **O2.1**
F. Javier Calvo, Moreno Jesús, Markus Knapp

11:30 — **Spider mites perform worse on tomato plants infested by the endophytic fungus *Fusarium solani* strain K** — **O2.2**
Maria Pappas, Maria Liapoura, Vasiliki Skiada, Dimitra Papantoniou, George Broufas, Kalliope Papadopoulou

11:45 — **Artificial selection for aerial dispersal tendency in *Phytoseiulus persimilis* (Acari: Phytoseiidae)** — **O2.3**
Alexandra M. Revynthi, Dirk Verkleij, Arne Janssen, Martijn Egas

12:00 — **Continuously exhausting air (Hypobaric Treatment) to selectively control spider mites *Tetranychus urticae* and *T. kanzawai* (Acari: Tetranychidae) and its impact on their natural enemy *Neoseiulus californicus* (Acari: Phytoseiidae)** — **O2.4**
Chih-Hung Wang, Ayaka Hosomi, Tetsuo Gotoh

12:15	**Temperature-mediated functional responses of *Neoseiulus womersleyi* and *N. longispinosus* (Acari: Phytoseiidae) to *Tetranychus urticae* (Acari: Tetranychidae)** *Mohammad Shaef Ullah, Reo Sugawara, Tetsuo Gotoh*	**O2.5**
12:30	LUNCH	

SESSION 3

MODERATOR: NORIHIDE HINOMOTO

13:30 Plenary talk	**A novel method for protecting slow-release sachets of predatory mites *Neoseiulus californicus* (McGregor) against environmental stresses and for increasing release of predators in greenhouses** *Takeshi Shimoda, Norihide Hinomoto*	**O3.1**
14:15	**Feeding and Survival of *Eriopis connexa* (Coleoptera: Coccinellidae) on broad mites** *Juliana Andrea Martinez Chiguachi, Juliana M. Oliveira, Jéssica Bravim, Luan B. Rodrigues, Angelo Pallini, Sebastião Martins Filho, Madelaine Venzon*	**O3.2**
14:30	**Biological control of the tomato russet mite *Aculops lycopersici* (Acari: Eriophyidae) in greenhouse grown tomatoes** *Juliette Pijnakker, Felix Wäckers*	**O3.3**
14:45	**Improved UV-Resistance by pollen feeding in Phytoseiid mite** *Nariaki Sugioka, Mari Kawakami, Nobuhiro Hirai, Masahiro Osakabe*	**O3.4**
15:00	COFFEE BREAK	

SESSION 4

MODERATOR: DANIEL CARRILLO

15:30	**Identification and evaluation of soil borne predatory mites for root knot nematode control in protected organic cropping systems** *Eric Palevsky, Shira Gal, Patricia Bucki, Sigal Brown Miyara*	**O4.1**
15:45	**Susceptibility of the bulb mite, *Rhizoglyphus robini* (Acari: Acaridae), to entomopathogenic fungi** *Rostislav Zemek, Jana Konopická, Andrea Bohatá, Jiří Nermuť, Zdeněk Mráček, Eric Palevsky*	**O4.2**
16:00	**Entomopathogenic nematodes as natural enemies for control of *Rhizoglyphus robini* Claparede (Acari: Astigmata)** *Jiří Nermuť, Rostislav Zemek, Zdeněk Mráček, Vladimír Půža*	**O4.3**

POSTER SESSION

MODERATOR: FIRDEVS ERSIN

16:15	**ITS Sequences of the predatory mites; *Iphiseius degenerans* (Berlese) and *Phytoseius ibrahimi* Döker & Kazak (Acari: Phytoseiidae)** *İsmail Döker, Cengiz Kazak, M. Mete Karaca, Kamil Karut*	**P1**

16:17	***Phytonemus pallidus* (Acari: Tarsonemidae); a new potential pest in strawberry Production and it's Phytoseiid predators (Acari: Mesostigmata) in Silifke, Turkey** *İsmail Döker, Kemal Yalçın, Kamil Karut, Cengiz Kazak*	**P2**
16:19	**Detecting acaricide resistance in *Tetranychus urticae* (Red Form) (Acari: Tetranychidae) collected from strawberry fields in Silifke, Turkey** *Kemal Yalçın, İsmail Döker, Cengiz Kazak*	**P3**
16:21	**Three plant protection agents compared in their efficacy against *Aculops lycopersici* on Tomato** *Alexander Pfaff, Martin Hommes, Elias Böckmann*	**P4**
16:23	**Compatibility of *Neoseiulus californicus* and *Orius insidiosus* for two-spotted spider mite control in roses** *Ana Luiza Viana de Souza, Brígida Souza, Madelaine Venzon*	**P5**
16:25	**Intraguild predation among exotic and native phytoseiids as influenced by pollen provisioning** *Konstantinos A. Samaras, Evaggelos Fytas, Vassilis Karageorgiou, Savvina Toufexi, Maria L. Pappas, George D. Broufas*	**P6**
16:27	**An integrative approach to the molecular and morphological identification of mites associated with the red poultry mite** *Shira Gal, Eric Palevsky, Eitan Recht, Yuval Gottlieb, Efrat Gavish, Lise Roy, María L. Moraza, Eddie Ueckermann, Monica Young*	**P7**
16:29	**Effects of commercial beneficial fungi and a plant strengthener on the two-spotted spider mite *Tetranychus urticae*** *Maria L. Pappas, Maria Liapoura, Konstantinos Samaras, Soraya França, Felix Wäckers and George D. Broufas*	**P8**
16:31	**Developing strategies for controlling tarsonemid and eryophyoid mites with phytoseiid predatory mites in flower bulbs, Bromeliaceae, gerbera and blackberry** *Ada Leman, Renata van Holstein-Saj, Karin Winkler, Fons van Kuik, Herman Helsen and Gerben J. Messelink*	**P9**
16:45	MEETING PHOTO	
17:00	DRINKS IN THE "MEDITERRANEAN" RESTAURANT IN MAICH	

WEDNESDAY SEPTEMBER 6

	SESSION 5	
	MODERATOR: JOHN VONTAS	
08:30 Plenary talk	**The elucidation of adaptation mechanisms in spider mites: recent progress and future perspectives** *Thomas Van Leeuwen*	**O5.1**
9:15	**Functional characterization of insecticide resistance in *Tetranychus urticae*** *John Vontas, Maria Riga, Stavrini Papadaki, Nena Pavlidi, Vassilis Douris, Ralf Nauen,Thomas Van Leeuwen*	**O5.2**

9:30	**Acaricide resistance status of *Panonychus citri* (Acari: Tetranychidae) collected from citrus orchards in Adana, Turkey** *İsmail Döker, Cengiz Kazak, Recep Ay*	**O5.3**
9:45	**Efficacy of chemical and bio-pesticides on the tomato russet mite *Aculops lycopersici* (Acari: Eriophyidae)** *Paraskevi Kolokytha, Guido Sterk*	**O5.4**
10:00	COFFEE BREAK	
	SESSION 6	
	MODERATOR: SAURO SIMONI	
10:15	**Comparison of sprays from a fixed overhead spray boom with overall air-assisted knapsack spraying for control of *Tetranychus urticae* and the effects on phytoseiids in raspberry** *Chantelle Jay, Zeus Mateos Fierro, Adrian Harris, Jerry Cross*	**O6.1**
10:30	**Pesticide toxicity in a pyrethroid resistant strain of *Phytoseiulus macropilis* (Acari: Phytoseiidae)** *Maria Cristina Vitelli Queiroz, Mario Eidi Sato*	**O6.2**
10:45	**Side effects of five pesticides on different stages of *Amblyseius swirskii* (Acari: Phytoseiidae) under laboratory conditions** *Firdevs Ersin, İsmail Döker, Ferit Turanlı*	**O6.3**
11:00	COFFEE BREAK	
	SESSION 7	
	MODERATOR: ROSTISLAV ZEMEK	
11:15	**Population structure of the phytoseiid mite, *Neoseiulus womersleyi*, in an experimental organic tea field** *Norihide Hinomoto, Yukie Sato, Kaori Yara, Takeshi Shimoda*	**O7.1**
11:30	**Field evaluation of sixspotted thrips, *Scolothrips sexmaculatus* (Pergande), as a predator of Pacific spider mite, *Tetranychus pacificus* (McGregor), in California almonds** *David Haviland, Stephanie Rill*	**O7.2**
11:45	**In preparation for the potential incursion and spread of citrus leprosis in Florida** *Daniel Carrillo, Marielle Berto, Clemente Garcia, Guillermo Leon, Ronald Ochoa, Luisa Cruz, Evan Braswell, Roxanne Farris, Amy Roda*	**O7.3**
12:00	**Resurgence of phytophagous Acarina in papaya: can natural enemies provide a lasting solution to the increasing mite problem in papaya in the Americas?** *Daniel Carrillo, Sabyan Faris Honey, Leonardo Alvarez Rios, Rita E. Duncan, Martha de Coss, N. Viscarra, Hugo Arredondo, Jorge E. Peña*	**O7.4**
12:15	**Mitespotting - approaches for detection and quantification of *Aculops lycopersici* on tomato and a few findings along the way** *Alexander Pfaff, Martin Hommes, Elias Böckmann*	**O7.5**
12:30	LUNCH	

	SESSION 8	
	MODERATOR: SERGE KREITER	
13:30 Plenary talk	**Why multidisciplinary approaches for controlling mite pests?** *Marie-Stéphane Tixier*	**O8.1**
14:15	**Phytoseiid (Acari: Mesostigmata) mite abundance and diversity in Belgian apple orchards** *Eveline Driesen, Marie-Stéphane Tixier, Serge Kreiter, Wannes Keulemans, Dany Bylemans*	**O8.2**
14:30	**Assessing uncertainties related to vine damage by *Eotetranychus carpini* via machine learning technique** *Sauro Simoni, Elena Gagnarli, Silvia Guidi, Donatella Goggioli, Franca Tarchi, Simone Bregaglio*	**O8.3**
14:45	**Metabarcoding for rapidly identifying Phytoseiidae predatory mite species** *Marie-Stéphane Tixier, Jean-François Martin*	**O8.4**
15:00	COFFEE BREAK	
	SESSION 9	
	MODERATOR: MARKUS KNAPP	
15:30	**Mite species of cultivated mushrooms in Turkey** *Sebahat K. Ozman-Sullivan, Vahit Tekbas*	**O9.1**
15:45	**Species composition of spider mites and predatory mites (Acari:Tetranychidae, Phytoseiidae) on *Rubus* spp. in Serbia** *Bojan Stojnić, Katarina Mladenović, Dejan Marčić*	**O9.2**
16:00	**Occurrence of Phytoseiid Species on vegetables in Samsun province, Turkey** *Fatma Oksuz, Marie-Stephanie Tixier, Sebahat K. Ozman-Sullivan*	**O9.3**
16:15	**Spider mites in protected natural areas of Serbia** *Ivana Marić, Dejan Marčić, Radmila Petanović, Philippe Auger*	**O9.4**
16:30	CONCLUSIONS STUDENT AWARDS sponsored by Koppert Biological Systems Hellenic Entomological Society	
17:30	CONVENOR ELECTION	
20:30	GALA DINNER	

THURSDAY SEPTEMBER 7

Excusion (08:00 – appox. 20:00)

Abstracts

O1.1 *Plenary talk*

From mite ecology to applied acarology in Neotropical agroecosystems

Angelo Pallini[1], Arne Janssen[2], Renato Sarmento[3], Felipe Lemos[1], Cleide Dias[1], Madelaine Venzon[4], Livia Ataide[1,2] and Marcus Vinicius Alfenas Duarte[1]

[1]Department of Entomology, Federal University of Viçosa (UFV), 36570-000,Viçosa, Minas Gerais, Brazil; [2]University of Amsterdam, Science Park 904, Amsterdam, Netherlands; [3]Federal University of Tocantins, Gurupi, To; [4]Agriculture and Livestock Research Enterprise of MinasGerais (EPAMIG), 36570-000,Viçosa, Minas Gerais, Brazil.
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Abstract: In a food web where the two-spotted spider mite *Tetranychus urticae* is the inducer and the red spider mite *Tetranychus evansi* is the suppressor of plant defence, the ecological consequences may vary from the expected among the members of the arthropod community in agroecosystems. We studied how defence suppression by *T. evansi* on tomato plants impacts its population through competition with other herbivores and predation in the field. With a population biology and evolutionary ecology approach, we expected obtain some insights required for new crop protection strategies to combat plant-defence-suppressing pests.

O1.2

Moving forward in putting predatory mite learning into practice: prey cue analyses and organizational upward cascades

Peter Schausberger[1,2], Michael Seiter[2], Günther Raspotnig[3], Stefan Peneder[2] and Inga Christiansen[2]

[1]Department of Behavioural Biology, University of Vienna, Althanstrasse 14, 1090 Vienna, Austria; [2]Group of Arthropod Ecology and Behavior, Department of Crop Sciences, University of Natural Resources and Life Sciences, Gregor Mendelstrasse 33, 1180 Vienna, Austria; [3]Institute of Zoology, University of Graz, Universitätsplatz 2, 8010 Graz, Austria.
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Abstract: Generalist predatory mites such as *Neoseiulus californicus* and *Amblyseius swirskii* are well able to learn prey in early life, profoundly and persistently enhancing the predators' foraging performance on this prey later in life. Enhanced foraging performance is evident in quicker prey recognition, shorter attack latencies, and higher predation rates, accompanied by higher oviposition rates. Here we report on two ongoing major steps in putting this knowledge into practice. First, we determined that non-polar hexane extracts of Western flower thrips, *Frankliniella occidentalis,* are repellent to *A. swirskii*, whereas polar water extracts are attractive. Early life experience with water extracts alone was sufficient to enhance the foraging performance of the predators later in life. Second, using whole plants infested by thrips, we observed that early learning effects cascade up to the population and community levels and

enhance the biocontrol efficacy of *A. swirskii* against *F. occidentalis*. Populations founded by thrips-experienced *A. swirskii* females were more efficacious in thrips control and plant damage reduction than populations founded by thrips-naïve predators. Both studies together emphasize the promising potential of translating early learning abilities into practice and enhancing the biocontrol efficacy of predatory mites on a large scale.

O1.3

Effects of the plot landscape and pollen concentration on phytoseiid mites (Acari: Phytoseiidae) in three French viticultural regions

Serge Kreiter[1], Ghais Zriki[1], Marie-Stéphane Tixier[1], Gilles Sentenac[2], Adrien Rusch[3], Julien Thierry[4], Lionel Delbac[3], Matthieu Madejsky[2] and Marc Guisset[4]

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Abstract: The aim of the research activities conducted in the three French vineyards was to assess the landscape complexity effect on phytoseiid mites. Densities of these predatory mites and of their preys were assessed during 3 years in 20 plots of each region twice per year. Landscape structure around the plots was analysed at different spatial scale (100, 250, 500, 750 and 1000 m). Pollen density was assessed in Roussillon in 2 plots during 2 years (2014 and 2015) each month, from May to September. Densities of Phytoseiidae were very high in the three regions. Correlations between their densities and landscape complexity were variable with the region, period of the year and buffer size. Pollen abundance has had a positive effect on densities of the various stages of *Kampimodromus aberrans* but variable depending on the period of the year. The effect of landscape complexity on pollen density is also variable between years of study.

O2.1

Provision of pollen allows *Tetranychus urticae* control in clementines with *Euseius stipulatus*

F. Javier Calvo[1], Moreno Jesús[1] and Markus Knapp[2]
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Abstract: The phytoseiid mite *Euseius stipulatus* (Acari: Phytoseiidae) is a type IV predatory mite which commonly occurs in citrus orchards in Spain and other Mediterranean countries. This predator is able to feed and reproduce on pollen, though it is also known as a predator of several major mite pests of citrus including *Panonychus citri* or *Tetranychus urticae* (Acari: Tetranychidae). The capability of other phytoseiid mites to develop and reproduce on pollen has been utilized to control different mite pests by increasing predator numbers in the crop with artificial supply of pollen. Thus, in our study, we hypothesized that the addition of pollen would have the same effects on *E. stipulatus*, ultimately allowing effective *T. urticae* control in clementines. We conducted three semi-field trials on small clementine trees. The first aimed at evaluating whether the addition of pollen would increase predator numbers in the crop, and revealed that *E. stipulatus* numbers were much higher when pollen was added. Once this was confirmed, the second and third trials focused on testing under spring and summer conditions, respectively, whether the addition of pollen would allow *T. urticae* control with *E. stipulatus* and if supplemental releases of *Phytoseiulus persimilis* (Acari: Phytoseiidae), a specialist predator of Tetranychidae, would increase the effectiveness against *T. urticae* compared to releases of only *E. stipulatus*. Five treatments were compared: 1) *T. urticae*, 2) *T. urticae* + *P. persimilis*, 3) *T. urticae* + *E. stipulatus* + *P. persimilis*, 4) *T. urticae* + *E. stipulatus* + pollen and 5) *T. urticae* + *E. stipulatus* + *P. persimilis* + pollen. *Phytoseiulus persimilis* releases began and continued weekly when pest density exceeded 0.13 *T. urticae* per/leaf, the action threshold in clementine trees. Both experiments confirmed earlier results, as more *E. stipulatus* were recorded when pollen was added. In the spring trial, when pollen was added, pest levels remained under the above-mentioned threshold and thus no *P. persimilis* releases were necessary. In the summer experiment, *T. urticae* levels were again significantly suppressed when pollen was supplied, though the pest slightly exceeded the action threshold, thus requiring *P. persimilis* releases. Nevertheless, '*E. stipulatus* + pollen + *P. persimilis*' did not provide better control than '*E. stipulatus* + pollen'. Thus, our results revealed that *T. urticae* control in clementines could be possible by increasing *E. stipulatus* populations with artificial supply of pollen. Nevertheless, our results should be confirmed under field conditions before this control strategy could be recommended in practice.

O2.2

Spider mites perform worse on tomato plants infested by the endophytic fungus *Fusarium solani* strain K

Maria L. Pappas[1], Maria Liapoura[1], Vasiliki Skiada[2], Dimitra Papantoniou[2], George D. Broufas[1] and Kalliope Papadopoulou[2]

[1]Laboratory of Agricultural Entomology and Zoology, Department of Agricultural Entomology, Democritus University of Thrace, 68200 Orestiada, Greece; [2]Department of Biochemistry and Biotechnology, University of Thessaly, 41500, Larisa, Greece.
email: mpappa@agro.duth.gr

Abstract: Spider mite – plant – microbe interactions are only rarely addressed despite the importance of spider mites as pests of major crops as well as the need for alternative methods to chemical control for the suppression of their populations. Nevertheless, beneficial microorganisms may consist promising biological control agents for use in Integrated Pest Management programs. In the present study, we assessed the efficiency of *Fusarium solani* strain K (FsK), an endophytic fungus previously shown to confer resistance against plant pathogens, on the performance of the two-spotted spider mite *Tetranychus urticae*. We found that spider mites performed worse on plants infested with the fungus, with no effect on plant growth parameters. Furthermore, inoculated plants were more attractive to *Macrolophus pygmaeus*, a natural enemy of spider mites. Our results highlight the role of FsK in promoting plant growth but also protecting plants from spider mites in addition to pathogens.

O2.3

Artificial selection for aerial dispersal tendency in *Phytoseiulus persimilis* (Acari: Phytoseiidae)

Alexandra M. Revynthi, Dirk Verkleij, Arne Janssen and Martijn Egas

Population and Evolutionary Biology, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, P.O. box 94248, 1090 GE, Amsterdam, The Netherlands.
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Abstract: The two-spotted spider mite (*Tetranychus urticae*) is one of the most important pests worldwide. The predatory mite *Phytoseiulus persimilis* is a biological control agent commonly used to suppress spider mite infestation in crops and ornamentals in greenhouses and fields. This is a specialist predator of spider mites and therefore it goes extinct from the crop after it eliminated its prey. Thus, growers need to do multiple releases in order to secure that the predator will be present when another spider mite outbreak appears. Creating predator strains with desirable traits, such as high dispersal tendency, that could remain on the crop longer can lead to a more effective biological control. Theory predicts the existence of two types of predator dispersal strategies: a strategy with high dispersal tendency, which is called Milker, and a strategy with low dispersal tendency, which is called Killer. It has not been established, however, whether dispersal tendency of this predator is genetically determined and heritable. In this study,

we selected for the earliest and the latest dispersers from rose leaves with two-spotted spider mites. We show that 6 rounds of strong selection for early or late dispersal resulted in a line of *P. persimilis* displaying earlier or later dispersal, respectively. Moreover, in a population dynamics experiment we show that by selecting for timing of dispersal, we also obtained lines that differ in interaction time with the prey, cumulative number of dispersers, and population growth rate. We conclude that timing of dispersal is a heritable trait that can be selected for. This study can provide a basis for breeding programs to create strains with desirable traits and improve biological control of two-spotted spider mites.

O2.4

Continuously exhausting air (Hypobaric Treatment) to selectively control spider mites *Tetranychus urticae* and *T. kanzawai* (Acari: Tetranychidae) and its impact on their natural enemy *Neoseiulus californicus* (Acari: Phytoseiidae)

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Abstract: Environmental and human health issues restrict the use of traditional chemical treatment of agricultural pests. Hypobaric treatment disinfests goods by adjusting atmospheric pressure to be unfavorable to pests. In the present study, we assessed the effectiveness of hypobaric treatment against eggs and adults of two most injurious plant pest mites, *Tetranychus urticae* and *T. kanzawai*, and its impact on a biological control agent, the predatory mite *Neoseiulus californicus*. Experiments were performed at 20, 25 and 30°C, and the hypobaric exposure durations were 0 (control), 6, 12 and 24 h. Egg hatchability of *N. californicus* reduced just slightly even after treatment for 24 h at 30°C, at which no spider mites survived. However, the effect on adult female mites was the reverse: spider mites were more tolerant than the predatory mite, and there were still a few surviving spider mites even after treatment for 24 h at 30°C. If water was available to the mites, survival of all species exceeded 90% after the same treatment. These results suggest that (1) the lethal factor in hypobaric treatment is dehydration, and (2) hypobaric treatment can selectively control only the eggs of spider mites.

O2.5

Temperature-mediated functional responses of *Neoseiulus womersleyi* and *N. longispinosus* (Acari: Phytoseiidae) to *Tetranychus urticae* (Acari: Tetranychidae)

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Abstract: The effect of temperature on the functional response of *Neoseiulus womersleyi* and *N. longispinosus* to eggs of the spider mite *Tetranychus urticae* was examined. Logistic regression indicated that both *N. womersleyi* and *N. longispinosus* exhibited a type II functional response on eggs of the prey. The attack rate coefficient (*a*) of *N. womersleyi* increased with temperature increasing from 15 to 30°C and declined at 35°C, whereas that of *N. longispinosus* peaked at 20°C. At 30 and 35°C the attack rate was higher in *N. womersleyi* than in *N. longispinosus*. The handling time (*Th*) of both species declined exponentially with temperature increasing from 15 to 35°C. At all temperatures the handling time of *N. longispinosus* was shorter than that of *N. womersleyi*. The efficiency of conversing ingested food into egg biomass (ECI) was affected by temperature and prey density. The temperature-mediated ECI model indicated that the coefficient differed between the two species at 30 and 35°C. The implications for the interaction of temperature, prey and predator should be considered for suitable biological control strategies against spider mites.

O3.1 *Plenary talk*

A novel method for protecting slow-release sachets of predatory mites *Neoseiulus californicus* (McGregor) against environmental stresses and for increasing release of predators in greenhouses

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Abstract: Release methods of predatory mites have been developed to enhance their effectiveness in spider mite control. A popular method is the use of predators kept in bottles with wheat bran or vermiculite carriers: one advantage is that predator dispersal throughout plants can occur quickly after release. Another popular method is "slow-release sachets" that contain predators, prey mites and their food, along with wheat bran: many predators can be released from sachets for several weeks. However, predator release using these methods is sometimes inhibited by environmental stresses such as pesticide sprays and severe wet conditions. To resolve these problems, we developed plant-attached shelters made of waterproof paper that hold the sachets ("sheltered sachets"). We conducted laboratory experiments to determine whether sheltered sachets can protect *Neoseiulus californicus* against drenching and pesticides. Predators in

unsheltered sachets (i.e. sachets alone) were decreased after continuous spraying with water or after pesticide spraying, whereas sheltered sachets were not seriously affected. Furthermore, we found that more predators were released from sheltered sachets moisturized with a humidifier than from unsheltered sachets under dry conditions. These results indicated that sheltered sachets were potentially useful in protecting the predatory mites against environmental stresses and enhancing their release to crops.

O3.2

Feeding and Survival of *Eriopis connexa* (Coleoptera: Coccinellidae) on broad mites

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Abstract: The Coccinellidae predator *Eriopis connexa* feeds mainly on aphids. It has been found in chili pepper fields co-occurring with broad mites in the absence of aphids. We tested whether *E. connexa* larvae can feed and survive on a diet of broad mites. First instar larvae fed actively on broad mites. Larvae survive for some period feeding only broad mites, but did not complete pre-imaginal development. Broad mites may be used by *E. connexa* as alternative food, allowing their survival until essential food is available.

O3.3

Biological control of the tomato russet mite *Aculops lycopersici* (Acari: Eriophyidae) in greenhouse grown tomatoes

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Abstract: The efficiency of nine species of Phytoseiidae in controlling the tomato russet mite *Aculops lycopersici* Massee (Eriophyidae) was evaluated on tomato plants in an experimental greenhouse. Five hundred mites of the species *Neoseiulus andersoni*, *Neoseiulus califonicus*, *Neoseiulus fallacis*, *Galendromus occidentalis*, *Amblyseius swirskii* and *Amblydromalus limonicus* were released four times on lightly infested plants. *Amblyseius andersoni*, *N. californicus* and *N. fallacis* showed the strongest pest reduction. Even though these species did not display good survival and the curative strategy did not totally eliminate the pest, the plants remained healthy. Only two species (*A. swirskii* and *A. limonicus*) succeeded to develop and reproduce on the plants, but only once the plants were damaged to the extent that the trichomes had collapsed and no longer interfered with the development of the predators. Possibilities for an

adequate biocontrol strategy are discussed. *Amblyseius andersoni*, *N. californicus* and *N. fallacis* could be used in waterproof breeding sachets or with dribble introductions in a preventative biological control strategy.

O3.4

Improved UV-Resistance by pollen feeding in Phytoseiid mite

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Abstract: Pollen, which many phytoseiid mite species feed on, is frequently exposed to solar radiation which includes deleterious ultraviolet-B (UVB) fractions, so that pollen should comprise protective materials to protect a germ cell from ultraviolet radiation. Phytoseiid mites are vulnerable to (UVB) radiation. If phytoseiid mites can obtain the protective materials from pollen, significance of pollen-feeding is not restricted to the nutrition but also important for adaptation to solar UVB radiation. Survival rates after UVB irradiation were higher in adult *Neoseiulus californicus* females fed on tea pollen than that fed on *Tetranychus urticae*. *N. californicus* females fed on tea pollen produced more eggs than that fed on *T. urticae* after UVB irradiation. The protective effects were also observed in eggs laid by females fed on tea pollen. We also compared the protective effects of tea pollen, peach pollen and *T. urticae* on *N. californicus*. In both egg hatchability and survival of adult females after UVB irradiation, tea pollen showed largest protective effects, followed in order by peach pollen and *T. urticae*. Then, UVB absorbance and antioxidant activity of methanol extracts from tea pollen, peach pollen and *T. urticae* were analyzed. The UVB absorbance was largest in peach pollen, followed in order by tea pollen and *T. urticae*. Antioxidant activity was highest in tea pollen, followed in order by peach pollen and *T. urticae*. Finally, we identified antioxidant components in tea pollen and peach pollen. Our findings suggest that antioxidant activity (and UVB absorbance) by pollen components contributes to improve UVB resistance in *N. californicus*.

O4.1

Identification and evaluation of soil borne predatory mites for root knot nematode control in protected organic cropping systems

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Abstract: Root knot nematodes (RKN), *Meloidogyne* spp. are endo-parasitic nematodes that attack roots and are important pests in organic and conventional agriculture. Our general hypothesis was that soil predatory mites will prey on mobile stages of RKN, thereby reducing nematode density and plant damage. Our objectives were: 1) Collect and identify indigenous acarine species as potential candidates of predators of phyto-parasitic nematodes, using morphological and molecular tools. 2) Evaluate predation by these mites on mobiles stages of the RKN *Meloidogyne javanica* in a simple no choice system. 3) Identify and assess the potential of alternative prey for the conservation of soil predatory mites. 4) Evaluate predator control of RKN in potted plants and assess the effect of soil structure on predatory mite efficacy. For morphological and molecular identification of predatory mites, soil samples were collected and mites were extracted with Berlese funnels. Mites were sent to the Canadian Center for DNA Barcoding for sequencing. To test the prey suitability of free living non-parasitic nematodes (FLNPN) as alternative prey, we used the nematode *Panagrellus redivivus* as prey, and observed and recorded predation behavior of *Gaeolaelaps aculeifer, Stratiolaelaps scimitus* and *Lasioseius floridensis*. Predation and control of RKN were evaluated in 48 hour no choice experiments and 6-8 week potted plant experiments. Twenty species of mites belonging to the suborder Gamasina, were identified molecularly and morphologically, of which we have assessed 6 species in small arenas in no choice tests and 3 in potted plant trials. In our short-term experiments, nematode survival was significantly lower than the no release control in all species of predators evaluated. Our potted plant trials demonstrated that predatory mites can significantly reduce plant damage. Our direct recording of *S. scimitus*, *G. aculeifer*, and *L. floridensis* showed their ability to feed on the FLNPN *P. redivivus.* In summary, we have uncovered numerous indigenous potential candidates for nematode control. To improve and develop the biological control of plant parasitic nematodes we suggest that further research focus on the manipulation of soil structure and nutrients to conserve FLNPN and soil predatory mite populations.

O4.2

Susceptibility of the bulb mite, *Rhizoglyphus robini* (Acari: Acaridae), to entomopathogenic fungi

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Abstract: The bulb mite, *Rhizoglyphus robini*, is a serious pest of garlic, onion and other crops and its control is difficult due to its ability to develop resistance to acaricides. The aim of our study is to assess the possibility of biological control of *R. robini* using natural pathogens. For this purpose we conducted field collections of native entomopathogenic fungi (EPF), followed by laboratory evaluations to find the most effective EPF strains/species. Methods for recovery of new strains/species of EPF was based on *Galleria* trap baiting and elution of soil samples by water and cultivation using selective medium with dodine. Several strains of *Isaria* sp., *Purpureocillium lilacinum*, *Metarhizium* sp. and *Beauveria* sp. were isolated from garlic and onion fields in Israel. Their efficacy against *R. robini* is now evaluated under laboratory conditions. Preliminary results indicate that *Isaria fumosorosea* applied at concentration of 1×10^8 blastospores per ml of suspension does not cause any mortality in this pest.

O4.3

Entomopathogenic nematodes as natural enemies for control of *Rhizoglyphus robini* Claparede (Acari: Astigmata)

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Abstract: Bulb mites of the genus *Rhizoglyphus* are among the most serious pests of onion and garlic but also other plants, ornamentals as tulips or hyacints included (Díaz *et al.*, 2000). Females of these soil dwelling mites lay their eggs into the underground parts of many plants and their imature and adult stages cause damage to plant tissues that are, consequently, more sensitive to bacterial and fungal pathogens. Some of these pathogens (e.g. *Fusarium* sp.) are then transmitted by these mites to other healthy plants. As the females of *Rhizoglyphus echinopus* and the less common *R. robini* have relatively large bodies and live in the soil environment, entomopathogenic nematodes, especially the small species, could invade them and affect their survival having significant impact on their population.

P1

ITS Sequences of the predatory mites; *Iphiseius degenerans* (Berlese) and *Phytoseius ibrahimi* Döker & Kazak (Acari: Phytoseiidae)

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Abstract: In this study, molecular characterization of the natural populations of *Iphiseius degenerans* and *Phytoseius ibrahimi* collected from Turkey are presented, as well as detailed morphological description of the former. Morphological examinations showed no indication of presence of any variations between this Turkish population of *I. degenerans* and the other re-descriptions. This result was confirmed with PCR techniques and it was concluded that there were no genetic divergence between an Italian, a commercial (Koppert®) and the Turkish populations based on ITS sequences. *P. ibrahimi* was compared with *P. finitimus* which is a common predatory mite in Turkey and a morphologically close species to the former. The results showed that the genetic divergence between these two species is 10% which supported their species status in the genus *Phytoseius*. Results of this study would be useful to support classical taxonomy and may also help the non-expert phytoseiid taxonomist for proper species identification.

P2

***Phytonemus pallidus* (Acari: Tarsonemidae): a new potential pest in strawberry production and associated phytoseiid predators (Acari: Mesostigmata) in Silifke, Turkey**

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Abstract: This study was aimed to determine abundance of phytoseiid mite species in association with *Phytonemus pallidus* (Acari: Tarsonemidae) and *Tetranychus urticae* (Acari: Tetranychidae) in strawberry fields of Silifke county, Turkey. *P. pallidus* were detected in all samples with high infestations (mixed stages >10 individuals/leaflet). A total of 11 phytoseiid species belonging to six genera and two sub-genera were determined in association with the pest. Among them *Neoseiulus barkeri* Hughes (29.07%) was the most abundant species followed by *Proprioseiopsis messor* (Wainstein), *Amblyseius swirskii* Athias-Henriot and *Typhlodromus* (*Anthoseius*) *recki* Wainstein. The existence of *P. pallidus* and abundance of the associated phytoseiid predators in strawberry fields of Silifke, Turkey were revealed for the first time in this study. Results of this study will be the first step in establishment of IPM programs in these strawberry fields.

P3

Detecting acaricide resistance in *Tetranychus urticae* (Acari: Tetranychidae) collected from strawberry fields in Silifke, Turkey

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Abstract: The resistance status of different *Tetranychus urticae* (red form) populations collected from strawberry fields in Silifke, Turkey, were determined against abamectin, etoxazole, spiromesifen and tebufenpyrad by bioassay and biochemical methods. According to LC_{50} values of field and susceptible populations, resistance ratios were found to be 2.39-7.86, 6.80-15.39, 4.61-9.73 and 5.51-12.47-fold for the same acaricide order given above, respectively. The resistance status of *T. urticae* populations varied based on the location due to different spray history of each field. Results of the photometric enzyme assay showed that the esterase and the GST enzymes may play an important role in detoxification of these four acaricides in different *T. urticae* populations.

P4

Three plant protection agents compared in their efficacy against *Aculops lycopersici* on tomato

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Abstract: In recent years, *Aculops lycopersici* (Tryon, 1917) (Acari: Eriophyoidea) has occurred more frequently in tomato cultivation throughout Germany. If infestation of tomato greenhouses occurs *A. lycopersici* can cause devastating damage. At present, there are no biological control agents available that show satisfying results when used against *A. lycopersici* on tomato and also there are only a few acaricides available against this mite. In order to investigate plant protection agents which potentially could be used against *A. lycopersici* in tomato, a greenhouse trial will be conducted between May and August 2017. In this trial the acaricide "Vertimec Pro" (Abamectin, Syngenta), "PREV-AM" (orange oil, OroAgri) and the entomopathogenic fungus *Beauveria bassiana* formulated as "Naturalis" (e-nema) will be compared in their efficacy against *A. lycopersici* on tomato. After inoculation with *A. lycopersici* the population densities and the symptoms caused by *A. lycopersici* on tomato plants will be monitored frequently throughout the whole experiment. This will allow assessment of the direct and lasting effects of all three plant protection agents.

P5

Compatibility of *Neoseiulus californicus* and *Orius insidiosus* for two-spotted spider mite control in roses

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Abstract:We evaluated the compatibility of *Orius insidiosus* and *Neoseiulus californicus* for *Tetranychus urticae* control in roses in laboratory behavioral studies. On rose leaflets, we observed that *O. insidiosus* was more active than the predatory mite. The presence of *T. urticae* did not refrain predation of *O. insidiosus* on *N. californicus*. Even though, when both predators were combined, there was an additive response in the consumption of nymphs and adults of *T. urticae*, but not of eggs.

P6

Intraguild predation among exotic and native phytoseiids as influenced by pollen provisioning

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Abstract: *Amblydromalus limonicus* and *Transeius montdorensis* are two exotic phytoseiid species recently imported in Europe as biological control agents of thrips in greenhouses. Both species are generalist predators and the climatic conditions in the Mediterranean do not exclude the possibility of their dispersion and successful establishment from greenhouse crops to orchards. Nevertheless, the ecological risks and the possible effects associated with exotic species on native phytoseiids have not been evaluated so far. The present work focused on the study of intraguild predation between *A. limonicus* and *T. montdorensis* and three native orchard inhabiting phytoseiid mites (i.e. *Euseius stipulatus*, *E. finlandicus* and *Iphiseius degenerans*). We show that both exotic species were superior intraguild predators to *E. finlandicus* and *E. stipulatus* but not *I. degenerans*. In addition, pollen provisioning reduced intraguild predation among the exotic and native phytoseiids but this effect was expressed in a species-specific manner. Nevertheless, this reduction was shown to be stronger for the *Euseius* compared to the exotic species or the native *I. degenerans*. Our study highlight the risk of releasing exotic biological control agents without previously assessing their interactions with native natural enemies of pests. Such interactions may be differentially affected by various factors among them the availability of alternative food sources.

P7

An integrative approach to the molecular and morphological identification of mites associated with the red poultry mite

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Abstract: Predatory mites are widely used for the control of plant feeding mites. However, information on the ecology of acarine predators and alternative prey found in association with mites attacking poultry and their potential for biological control is very limited. In addition, the identification of acarine predators rely on morphological characters that can be very difficult to discern. These ambiguities could be resolved if reliable molecular markers would be available. Recent studies demonstrated that mites of the families Cheyletidae and Laelapidae prey on the red poultry mite (RPM), *Dermanyssus gallinae* and small scale production of these biocontrol agents is currently being performed. As these were pioneering studies, it can be expected that additional generalist predator soil species from these families and others will be identified as biocontrol agents of *D. gallinae*. Within the frame work of the COREMI COST action FA1404, we sampled mites associated with RPM. Using molecular and morphological tools we identified 34 species belonging to 9 families.

P8

Effects of commercial beneficial fungi and a plant strengthener on the two-spotted spider mite *Tetranychus urticae*

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Abstract: The two-spotted spider mite *Tetranychus urticae* is a polyphagous phytophagous mite with a worldwide distribution, and a serious pest in tomato and several other crops. Besides chemical treatments, predatory mite releases represent an effective biological control method. However, predatory mites are not effective in all crops. Other biological control agents such as beneficial microorganisms, as well as plant strengtheners known to confer resistance against plant pests and pathogens may prove to be alternative biological solutions for controlling spider mites. Here, we assessed this hypothesis by recording the effects of two endophytic and an

entomopathogenic fungi as well as one plant strengthener on the performance of *T. urticae*. We found that all products significantly affected spider mites. Our results highlight the potential of these products in herbivore suppression in addition to plant disease control.

P9

Developing strategies for controlling tarsonemid and eriophyoid mites with phytoseiid predatory mites in flower bulbs, Bromeliaceae, gerbera and blackberry

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Abstract: Small phytophagous mites of the families Eriophyidae and Tarsonemidae are increasingly causing serious crop damage in various ornamental and fruit crops in the Netherlands. The reduced use of broad spectrum pesticides is probably one of the reasons for this observed increase. A major pest in tulip bulbs is the eriophyid *Aceria tulipae*. This so-called dry bulb mite is particularly a problem after harvest when tulip bulbs are stored for several months. Another eriophyoid mite, *Acalitus essigi*, is a serious pest in the culture of blackberry. The mites hide in the buds, leaf axils and bracts. Economic losses occur when they attack the fruit during drupelet ripening. The affected drupelets become hard, inedible and bright red. Tarsonemid mites give serious problems in various ornamental greenhouse crops. A major pest in amaryllis is the bulb scale mite *Steneotarsonemus laticeps*. Similar to the dry bulb mite, this mite hides deep into the bulbs and is thereby very hard to control with pesticides or biological control agents. Bromeliaceae are mainly attacked by the tarsonemid *Steneotarsonemus ananas* , whereas the most abundant tarsonemids in gerbera are *Tarsonemus violae* and the broad mite *Polyphagotarsonemus latus* . These mites live deep in flower microhabitats and cause flower deformation. Although these various small phytophagous mites all require a specific approach for biological control, there might also be similarities in ways to optimize control. Here we present shortly our plans to enhance biological control of the above mentioned phytophagous mites with phytoseiid predatory mites.

O5.1 *Plenary talk*

The elucidation of adaptation mechanisms in spider mites: recent progress and future perspectives

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Abstract: Generalist (polyphagous) herbivores can feed and reproduce on many different plant species and include some of the most pesticide resistant and notorious pests in agriculture. With experimental advances and new tools developed for Tetranychus urticae, we are now poised for fundamental advances in understanding the molecular genetic make-up of adaption in generalist pests. Some spider mites species are extremely polyphagous crop pests with a remarkable evolutionary potential to adapt to acaricides. However, acaricide resistance is traditionally much less studied and understood compared to insecticide resistance. We will show here how the genome sequence of the two-spotted spider mite *T. urticae* has provided an invaluable resource to study adaptation mechanisms. Protocols for high resolution mapping of resistance genes by bulk segregant analyses have allowed studying acaricide resistance mechanisms free from prior hypothesis, with remarkable results. We will give an overview of recent successes in genetic mapping and report on the progress made in functional validation of resistance mechanisms.

O5.2

Functional characterization of insecticide resistance in *Tetranychus urticae*

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Abstract: The spider mite *Tetranychus urticae* is one of the most important agricultural pests world-wide and it displays a striking ability to develop resistance to pesticides used for its control. By using a variety of approaches, including functional expression and characterization of recombinant enzymes, immunohistochemical stainings, as well as in vivo ectopic expression and CRISPR-mediated genome modification in drosophila we aim to better understand the role of individual genes and pathways in the development of resistance. We have functionally characterized detoxification genes that have been implicated in acaricide/insecticide resistance and identified specific enzymes that are capable to metabolise certain chemicals, to less toxic metabolites. We have also employed the GAL4/UAS system for ectopic expression of cytochrome P450s and the CRISPR system for the introduction of several resistance mutations in

Drosophila, and assay phenotypes with predicted resistance to different pesticides. Our most recent work also involves immunohistochemical staining of detoxification enzymes, aiming to identify the insecticide update routes and physiology of detoxification.

O5.3

Acaricide resistance status of *Panonychus citri* (Acari: Tetranychidae) collected from citrus orchards in Adana, Turkey

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Abstract: In this study, resistance status of ten different *Panonychus citri* populations collected from citrus orchards in Adana, Turkey, were determined against etoxazole, spirodiclofen and spirotetramat using bioassay and biochemical tests. A leaf-disc method was used to determine LC_{50} and LC_{90} values of different *P. citri* populations. According to the results, resistance status of *P. citri* populations varied based on the location due to different spray frequency. Based on LC_{50} values of the tested populations, 1.22-18.35, 1.23-40.43 and 1.76-27.50-fold resistance were determined against etoxazole, spirodiclofen and spirotetramat, respectively. Results of photometric enzyme assays showed that esterase and GST enzymes may be involved in detoxification of etoxazole, spirodiclofen and spirotetramat in *P. citri*.

O5.4

Efficacy of chemical and bio-pesticides on the tomato russet mite *Aculops lycopersici* (Acari: Eriophyidae)

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Abstract: In our study several products were tested against the tomato russet mite, *Aculops lycopersici* (Acari: Eriophyidae) on tomato plants. Several chemical as well as physical and botanical insecticide and acaricide compounds were tested on a high population of the TRM. The majority of the chemical compounds were effective against this mite. On the other hand, only the appliance of thyme oil reduced the population of the mite, while some physical compounds, such as Kinetic, Agritrap and Eradicoat were estimated to be moderately to highly effective, according to EPPO guidelines.

O6.1

Comparison of sprays from a fixed overhead spray boom with overall air-assisted knapsack spraying for control of *Tetranychus urticae* and the effects on phytoseiids in raspberry.

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Abstract: Spotted wing drosophila (SWD), *Drosophila suzukii*, has established in the UK and this fruit pest is currently controlled with insecticide spray programmes, coupled with good farm hygiene. Given that much of the control for other pests in raspberry crops, such as the two-spotted spider mite, *Tetranychus urticae*, relies on biological control it is important to develop compatibility strategies for biocontrol by predatory mites with insecticide sprays for control of SWD. To determine whether the method of spraying could be important, experiments were done in small purpose-built poly-tunnels to compare the same insecticide spray programme applied by two different spraying methods, overall canopy spraying using an air-assisted knapsack sprayer and a system of overhead spraying to give spray deposits mainly on the upper leaf surface only. Populations of *T. urticae* and the predatory mite complex were recorded throughout the raspberry growing season and compared to an untreated control, over two seasons. The numbers of SWD emerging from picked raspberries were counted. The numbers of *T. urticae* were higher in the sprayed plots. In 2016, the natural phytoseiids were affected by the spray treatments, but the effect was mitigated by spraying from above, where there was markedly less spray on the underside of the leaves in the overhead spray treatment. Introduced *Phytoseiulus persimilis* was less affected by the spray programme than anticipated. In both years the numbers of SWD were lower in the treated plots compared to the untreated control, the overhead spraying performing as well as the overall spray.

O6.2

Pesticide toxicity in a pyrethroid resistant strain of *Phytoseiulus macropilis* (Acari: Phytoseiidae)

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Abstract: *Phytoseiulus macropilis* Banks is one of the most important predatory mites used for the control of the two-spotted spider mite in Brazil. The objective of this research was to evaluate the toxicity of pesticides of different chemical groups in a pyrethroid resistant strain of *P. macropilis*, under laboratory conditions. The LC_{50} (medium lethal concentration) values of the pyrethroids fenpropathrin, bifenthrin and deltamethrin, for the adult females of this strain of *P. macropilis*, were at least ten times higher than the field recommended concentrations of these strain, mortalities above 90% (in adult females) were observed for the recommended concentrations of acephate, abamectin, milbemectin, diafenthiuron, chlorfenapyr, fenpyroximate

and etoxazole. Intermediate toxicity was verified for propargite, which caused mortality of approximately 40% in adult mites at the recommended concentration. Spiromesifen did not cause significant mortality to the eggs of the predatory mite.

O6.3

Side effects of five pesticides on different stages of *Amblyseius swirskii* (Acari: Phytoseiidae) under laboratory conditions

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Abstract: In this study, the side effects of five pesticides (ametoctradin, isopyrazam, mandipropamid, propamocarb-HCL+fluopicolide and sulfaxoflor) were determined on eggs, larvae and adult females of *A. swirskii*. According to the results, none of the pesticides was toxic to the eggs, however, ametoctradin, propamocarb+fluopicolide and sulfoxaflor were toxic to the larvae and adult females. In addition, only mandiopramapid and sulfoxaflor significantly reduced egg production of the predatory mite. Inconclusion isopyrazam may be compatible with *A. swirskii* in IPM programs, without further field or semi-field experiments.

O7.1

Population structure of the phytoseiid mite, *Neoseiulus womersleyi*, in an experimental organic tea field

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Abstract: In order to control spider mites in tea plantations following reductions in chemical pesticide applications, it is necessary to use natural enemies such as the phytoseiid mite *Neoseiulus womersleyi*. Banker plants, which encourage proliferation of phytoseiid mites, can enhance the biological control characteristics of *N. womersleyi*; however, the optimum number and distribution of banker plants are uncertain. In this study, in order to provide insights into use of banker plants, we analyzed the population structure of *N. womersleyi* in an experimental organic tea field using microsatellite DNA markers. The results suggested mites migrated on several occasions into the field during the early summer. Nevertheless, the mites did not reach

the centre of the field. Microsatellite analysis also suggests that movement in the field was strictly limited, indicating that the artificial spread of phytoseiid mites from banker plants to tea plants would be required to control spider mites effectively.

O7.2

Field evaluation of sixspotted thrips, *Scolothrips sexmaculatus* (Pergande), as a predator of Pacific spider mite, *Tetranychus pacificus* (McGregor), in California almonds

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Abstract: Spider mites (Acari: Prostigmata: Tetranychidae: *Tetranychus* sp.) are significant pests of the more than 400,000 hectares of almonds grown in California, USA. Historically, the most commonly recognized predator of spider mites has been the phytoseiid *Galendromus occidentalis* (Nesbitt) (Acari: Mesostigmata: Phytoseiidae). However, over the past decade populations of this predator have diminished while populations of sixspotted thrips, *Scolothrips sexmaculatus* (Pergande) (Thysanoptera: Thripidae), have increased. During 2016 and 2017 we conducted a series of experiments to develop methods to monitor sixspotted thrips with sticky traps, evaluate the field biology of thrips, and measure the impact on spider mite populations. Sixspotted thrips was shown to be capable of providing complete biological control of Pacific spider mite, *Tetranychus pacificus* (McGregor), under field conditions in commercial almond orchards where thrips population doubling times were calculated to be 4.2 days. Data suggest that conservation biological control programs that avoid broad-spectrum insecticides for lepidopteran and heteropteran pests, in combination with the use of treatment thresholds that tolerate low mite populations as food for thrips, can result in excellent biological control of spider mites.

O7.3

In preparation for the potential incursion and spread of citrus leprosis in Florida

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Abstract: Citrus leprosis (CiLV) is considered one of the most destructive diseases of citrus, causing blemishing, fruit drop and die-back that can kill the tree if not controlled. The disease is spreading north from South America and has been reported in Mexico. The disease is caused by five distinct viruses (and possible more) that are vectored by *Brevipalpus* mites. *Brevipalpus yothersi* (syn. phoenicis) is associated with the most damaging virus CiLV-C in Brazil, Colombia, and Mexico. Both CiLV and *B. yothersi* have a broad host range. All regions recently infected with CiLV had non-virulent *B. yothersi* mites prior to disease emerging, and Florida has non-virulent *B. yothersi* populations. In preparation for a potential incursion of CiLV in Florida, CiLV infected areas in Colombia and Mexico were surveyed to determine the incidence of viruliferous mites on citrus and non-citrus hosts. Surveys were also conducted in south Florida to determine the host plant range of *Brevipalpus* spp. and their prevalence and distribution in citrus orchards. In Colombia, viruliferous mites were found on four plants including citrus. In Mexico, viruliferous mites were found only on citrus plants. In Florida, *B. yothersi* and an unidentified *Brevipalpus* sp. were found on 20 plant species: Five plants had both species, three plants had only the unidentified *Brevipalpus* sp, and 12 species had only *B. yothersi*. We report 7 new host records for *B. yothersi*. Three species of predatory mites were found associated with *Brevipalpus* spp. in Florida. Our study suggests that *B. yothersi* has a broad host range in South Florida and is a common resident of citrus groves which could increase the spread of CiLV if the disease reaches the U.S.A. Mitigation tactics and the potential use of existing natural enemies to control *Brevipalpus* spp. are discussed.

O7.4

Resurgence of phytophagous mites in papaya: can natural enemies provide a lasting solution to the increasing mite problem in papaya in the Americas?

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Abstract: Papaya, *Carica papaya* is a tropical fruit crop with 3 major key pests (fruit flies, aphids and leafhoppers) and several secondary pests, i.e., scales, mealybugs and mites i.e., *Tetranychus* spp., and *Eutetranychus* spp. Chemical control practices aimed at controlling one of the key pests disrupt the beneficial fauna of the secondary pests, causing continuous resurgences. Through preliminary surveys and literature search, we verified that mites are now one of the major problems affecting papaya production in North and Central America (USA, Belize, Mexico). We concluded that the lack of natural enemies in these plantations was the major reason for mite severity. The first goal of the present study was to determine under Florida conditions, the efficacy and interactions of natural or resident predators, i.e., *Neoseiulus longispinosus* (Acari: Phytoseiidae), *Neoseiulus umbraticus*, *Amblyseius largoensis* inhabiting papaya and exotic predators, i.e., *Amblyseius swirskii* and *Phytoseiulus persimilis*. From this study we determined that the natural predator, *N. longispinosus* was a key predator; intraguild predation of introduced species, may affect its effectiveness. The second goal was to determine the best sampling unit to be used in the field to assess mite infestation and predator levels in papaya.

O7.5

Mite-spotting - approaches for detection and quantification of *Aculops lycopersici* on tomato and a few findings along the way

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Abstract: In recent years, *Aculops lycopersici* (Tryon, 1917) (Acari: Eriophyoidea) has occurred more frequently in tomato cultivation throughout Germany. Despite its devastating damage potential when infesting tomato greenhouses, usually no regular monitoring is conducted for this mite in practise. There are two main reasons for this. Growers have no convenient monitoring methods at hand, and secondly *A. lycopersici* does not occur as frequently as other pests as for instance *Trialeurodes vaporariorum*. In order to be put into practise, monitoring methods must be very efficient and easy to handle. This study aims to provide solutions for early detection suitable for tomato growers as well as detection and quantification methods for monitoring of population dynamics and spatial distribution on plants and within greenhouses for research purposes. Different methods are under investigation and will be presented. In a greenhouse trial it was shown that it was possible to detect *A. lycopersici* infestations with non-destructive fluorescence and reflectance measurements on plants. Also a sampling method with sticky stamps delivered promising results. Quantification was possible even at low infestation rates. A good correlation between counts on stamps and actual counts on plants was shown. Parallel to these methods plants were scored for *A. lycopersici* symptoms visible to the bare eye as a reference, a method typically used at first place by growers and advisors. The suitability of each method for detection and monitoring of the pest will be discussed. The effects of drought stress on *A. lycopersici* quantity and on the development of *A. lycopersici* induced plant symptoms were investigated in the same experiment.

O8.1 *Plenary talk*

Why multidisciplinary approaches for controlling mite pests?

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Abstract: Mite pests are essentially controlled with other mites, the predators of the family Phytoseiidae. They are used in the three main biological control modalities: augmentative, classical and conservation even if more examples are documented for the former strategy with 12 species currently sold in Europe. The presentation aims to list where we are for all these strategies and what are the lacks / tracks to go further. These tracks are divided in three main categories: (i) predator/prey interactions, (ii) the plant traits and their impact on this latter couple and (iii) agronomic practices at plant level (i.e. fertilisation, weed management, water stress, biological soil community) and their direct or indirect impacts on predator prey interactions. The communication lists the challenges for these three main categories with illustrations and examples. The topics presented are the importance of taxonomical knowledge, phylogeny, predator life traits modelling, population genetics studies and implications for knowledge of interaction between preys and predators. Plant defence / plant appetence knowledge are also discussed to determine how these features can be used for various biocontrol applications and situations (direct defences, molecules involved, beetle bank for predatory mites). Finally, a synthesis on what we know on soil management and impact on mite community is proposed to determine how the plant physiology can affect the interaction between prey and predators and further biological control. After listing what we know and what we should know, a conclusion adresses the disciplinary collaboration (i.e. as genetics, ecology, agronomy and ecophysiology) needed to reach mite control within a new agroecological context.

O8.2

Phytoseiid (Acari: Mesostigmata) mite abundance and diversity in Belgian apple orchards

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Abstract: Due to *Typhlodromus pyri* (Acari: Phytoseiidae) being resistant against the formerly used organophosphates and carbamates, it was for several decades the only phytoseiid in Belgian commercial apple orchards. The hypothesis that shifting from organophosphates to more selective pesticides changed phytoseiid mite diversity, is investigated. This study examines the mite species complexes in Integrated Pest Management (IPM) orchards, organic and unsprayed

abandoned orchards in 2016 and 2017. A total of four phytoseiid species was observed: *T. pyri*, *Amblyseius andersoni*, *Euseius finlandicus* and *Phytoseius horridus*. *T. pyri* was the most dominant species: it was recorded in 23 IPM and organic orchards, and was dominant in 20. The total abundance of Tetranychidae and Phytoseiidae did not differ between different pest management systems. However, species composition did differ: significantly less *T. pyri* and more A. *andersoni*, *E. finlandicus* and *P. horridus* were found to unsprayed orchards compared to IPM and organic orchards, respectively. Apart from pest management, no other effect of the orchard factors on mite populations was found.

O8.3

Assessing uncertainties related to vine damage by *Eotetranychus carpini* via machine learning technique

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Abstract: The control of the yellow spider mite *Eotetranychus carpini* (Oudemans) remains an important challenge on grapevine (*Vitis vinifera* L.) in Southern Europe, especially in Tuscan viticulture. The frequency of damage due to *E. carpini* has escalated by the lack and/or unsuitable timing in control interventions. This is largely attributable to the difficulty in correlating the onset of damage with *E. carpini* populations. Here, we apply a non-parametric machine learning technique, i.e., Random Forest (RF), to quantify the variability of leaf area damage as affected by the abundance and structure of populations of tetranychids and phytoseiids, and by vine cultivar and phenological stage. The highest predictive power was achieved by the RF built considering the damage class 0 (healthy leaf) and 1 (< 20% leaf area affected), with 86.73% of matched observations in the out-of-bag dataset. The performances of the RFs decreased when considering the other damage classes. The number of immature tetranychids was the top-ranked variable explaining leaf damage variability, followed by vine phenology, cultivar and phytoseiids. These results confirm the high correlation between *E. carpini* abundance and early leaf damage, suggesting the need of its timely detection on vine leaves, as well as the relevance of both cultivar and natural antagonists in modulating the impact of the yellow spider mite.

O8.4

Metabarcoding for rapidly identifying Phytoseiidae predatory mite species

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Abstract: The identification of Phytoseiidae mites is mainly based on morphological characters. Sometimes, this identification is cumbersome because the characters that allow separating species are difficult to observe and/or their diagnostic value is not totally accepted. Recently, molecular markers were developed for a barcoding purpose. This approach successfully differentiates closely related species where morphology fails and provides support for testing the validity of morphological characters. However, barcoding implies that each specimen is sequenced individually hence, each mite from a sample should be analysed individually, with obvious consequences for cost and working time. This study aims to determine how high-throughput sequencing could be used to identify multiple species of Phytoseiidae mites in environmental samples. Several females from five species important for biological control (*Kampimodromus aberrans*, *Typhlodromus exhilaratus*, *T. phialatus*, *Euseius gallicus*, *E. stipulatus*) were mixed in a single tube. DNA extraction of all mites was carried out, as well as PCR using the 12S rRNA fragment. This procedure proved efficient for identifying Phytoseiidae species. Three technical replicates were carried out for a total of 1.2 millions of illumina reads. All the species initially present in the sample were retrieved using BLAST against our local taxonomy database. It is however impossible at the time being to relate the number of reads obtained to the proportion of each species in the sample analysed as multiple biases would affect the interpretation. This methodological advances open new doors for rapid identification of predators and potentially give access to food webs, identifying prey species eaten by the predators.

O9.1

Mite species of cultivated mushrooms in Turkey

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Abstract: Mushroom cultivation is an important agricultural industry worldwide. Mushroom production has greatly increased in the last three decades in Turkey. The mushroom cultivation environment provides optimal conditions for many organisms, including mites. Some species feed on mushrooms, fungi and bacteria, and some species feed on small insects and mites, acting as biological control agents. In this paper, mite species associated with cultivated mushrooms in Turkey are summarized in a literature review.

O9.2

Species composition of spider mites and predatory mites (Acari:Tetranychidae, Phytoseiidae) on *Rubus* spp. in Serbia

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Abstract: This study presents data on spider mites (Tetranychidae) and predatory mites (Phytoseiidae) hosted by cultivated red raspberry and wild blackberry species (*Rubus* spp.), which were collected in various growing regions in Serbia over the period 1983-2016. Seven *Rubus* species were found to host ten spider mite species: *Amphitetranychus viennensis*, *Bryobia rubrioculus*, *Eotetranychus deflexus*, *E. perplexus*, *E. rubiphilus*, *E. uncatus*, *Neotetranychus rubi*, *Schizotetranychus parasemus*, *Tetranychus turkestani* and *T. urticae*. Twenty one phytoseiid species were also found: *Amblyseius andersoni, A. bryophilus, A. fraterculus*, *Euseius finlandicus, Graminaseius graminis*, *Neoseiulella tilliarum*, *Neoseiulus umbraticus, Paraseiulus soleiger, P. talbii, Phytoseius canadensis, P. corniger, P. echinus, P. juvenis, P. macropilis, P. maltshenkovae, P. ribagai, Proprioseiopsis okanagensis, Transeius wainsteini, Typhlodromus bakeri, T. pyri* and *T. rhenanus.* An analysis of the Tetranychidae/Phytoseiidae complex on the *Rubus* species in Serbia revealed a predominance of a combination of four tetranychid species (*T. urticae, N. rubi, E. rubiphilus* and *T. turkestani*) and five phytoseiid species (*T. rhenanus, E. finlandicus, P. juvenis, N.umbraticus* and *A. andersoni*). A positive and significant association for *E. finlandicus-N. tilliarum*, a negative and significant association for *N. rubi-P. juvenis*, and a negative and very significant association for *E. finlandicus-P. maltshenkovae* were found.

O9.3

Occurrence of phytoseiid species on vegetables in Samsun province, Turkey

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Abstract: Phytoseiidae (Acari: Mesostigmata) are the most common, plant-inhabiting predatory mites and play an important role in the natural control of certain important agricultural pests. Turkey is one of the world's biggest vegetable producers and Samsun is one of the most important vegetable growing provinces. The aim of this study was to identify the phytoseiid species and their abundance on vegetables in Samsun Province. The study was conducted in 2015 and 2016, with leaf samples of summer and winter vegetables collected during different vegetative periods. A total of nine phytoseiid species were collected. *Phytoseius finitimus* was the most common species, followed by *Amblyseius andersoni*. *Neoseiulus aristotelisi* was *recorded* for the *first time* in Turkey.

Spider mites in protected natural areas of Serbia

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Abstract: This study presents the data regarding species diversity of spider mites (Acari: Tetranychidae) which were collected over four growing seasons at 80 locations in 20 various protected natural areas of Serbia. A total of 21 tetranychid species were found: *Bryobia angustisetis*, *B. graminum*, *B. kissophila*, *B. longisetis*, *B. praetiosa*, *B. rubrioculus*, *Tetranycopsis horridus*, *Amphitetranychus viennensis*, *Eotetranychus aceri*, *E. carpini*, *E. coryli*, *E. fraxini*, *E. pruni*, *E. rubiphilus*, *E. tiliarium*, *Neotetranychus rubi*, *Panonychus citri*, *P. ulmi*, *Schizotetranychus garmani*, *Tetranychus turkestani* and *T. urticae*. Spider mites were found on 59 host plant species belonging to 21 plant families. Seven tetranychid species (*B. praetiosa*, *E. aceri*, *E. carpini*, *E. fraxini*, *E. pruni*, *E. rubiphilus* and *P. citri*), 37 host plant species and six plant families were new records for Serbia. The records of *E. aceri*, *E. fraxini* and *E. rubiphilus* were the first in the Balkans. Twelve plant species found in this survey were identified for the first time as spider mite hosts.

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