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Contents

Host selection behavior of broad mite, *Polyphagotarsonemus latus* (Acari: Tarsonemidae)

Jeyasankar Alagarmalai [1] , Mor Grinberg[1,2], Saadia Reneh[1] Lital Sharon[1], Rafael Perl-Treves[2] , Victoria Soroker[1]

[1] Dept. of Entomology, Agricultural Research Organization, Bet Dagan 50250, Israel; [2]The Mina and Everard Goodman Faculty of Life Science, Bar-Ilan University, Ramat-Gan 52900 Israel, sorokerv@volcani.agri.gov.il

Abstract: This study presents evidence for host selection ability of broad mites, *Polyphagotarsonemus latus* (Banks) (Acari: Tarsonemidae)**,** by both free-moving and phoretic individuals. Host selection by free-moving mites was monitored in two or four choice set up of young leaves (3rd leaf from the apex). Host choice between several plants was tested: cucumber (*Cucumis sativus* L.) cv Kfir, tomato (*Solanum lycopersicon*) cv. M82, two isogenic lines, cv Moneymaker and Motelle, that differ in resistance to whiteflies, and the cucurbits *Lagenaria siceraria* cv Sus and *Cucurbita pepo* cv Orangetti, previously shown to differ in resistance to *Tetranychus urticae*. A tomato mutant derived from cv Castlemart, *def-1* (defenseless-1), and its wild-type isogenic line were also compared. Response of phoretic mites to the plants was tested in non choice bioassay. Performance on the hosts was determined by counting the progeny after one week. Our data indicate that broad mites are able to actively choose between host plants and usually successfully discriminate between susceptible and non-susceptible hosts.

Augmentation and conservation of indigenous generalist acarine predators for the control of citrus rust mite, *Phyllocoptruta oleivora,* in Israel

Yael Argov[1], Sylvi Domeratzky, Uri Gerson[2], Shimon Steinberg[3] Eric Palevsky[4]

[1]Israel Cohen Institute for Biological Control, Plant Production and Marketing Board, Citrus Division, POB 80 Bet Dagan, 50250, Israel, yael@jaffa.co.il;[2]Department of Entomology, Faculty of Agricultural, Food and Environmental Quality Sciences, Rehovot 76100, ISRAEL, Gerson@agri.huji.ac.il; [3]Bio-Bee Biological System, Kibbutz Sdeh Eliyahu, Beit Shean Valley 10810, Israel, s_stein@bio-bee.com; [4]Agricultural Research Organization (ARO), Newe-Ya'ar Research Center, Ramat Yishay, 30095, Israel, palevsky@volcani.agri.gov.il.

Abstract: The key acarine citrus pest in Israel is the citrus rust mite (CRM), Phyllocoptruta oleivora, which is probably the most cosmopolitan citrus pest. In this study we focused on the conservation and augmentation of two indigenous phytoseiids, found to be potential predators of CRM, namely Amblyseius swirskii and Iphiseius degenerans. In order to identify a chemical suitable for Medfly control that is also more selective for these acarine predators we compared the field effects of spinosad to malathion, and found the former to be more selective to A. swirskii than the latter. Field augmentation trials with A. swirskii and I. degenerans yielded significantly higher levels of predators in some of the trials, but had no effect on CRM populations. In unsprayed groves where CRM is under control, these predators subsist on a diet composed of alternate food sources, such as other mites and insect prey, pollen, honeydew and various fungi. We thus believe that habitat management and conservation should become part and parcel of an indigenous predator augmentative program.

The genetic variability of the spider mites of Israel

Tselila Ben-David[1], Sarah Melamed[2], Uri Gerson[2] and Shai Morin[2]

[1]*PPIS Ministry of Agriculture and Rural Development, Bet Dagan 50250, Israel; zlilabd@int.gov.il;* [2]*Department of Entomology, Faculty of Agriculture, The Hebrew University of Jerusalem, Rehovot 76100, Israel*

Abstract: Forty-three sequences of the second internal transcribed spacer (ITS2) of nuclear ribosomal DNA were obtained from 16 Israeli species of spider mites (Acari: Tetranychidae). The length of the ITS2 region was species-specific and ranged from 368-542 bp. Two species, *Eutetranychus orientalis* and *Panonychus ulmi,* showed extensive polymorphism in their ITS2 base composition (eleven and seven sequences, respectively), while eight species had only one ITS2 sequence. The interspecific variation ranged from 4.4-54.8%, and the intraspecific variation from 0.2 to 2%. Using a 2% threshold for species diagnosis in our data set, 14 out of 16 (87%) species, recognized by morphological criteria, would have been accurately identified. The only exceptions involved the low divergence, 0.011-0.015 (1.1-1.5%), between the closely related *Tetranychus urticae* and *Tetranychus turkestani*. Still, these species had fixed alternative rDNA-ITS2 variants, with five diagnostic nucleotide substitutions separating them. The maximum parsimony phylogenetic trees supported the monophyly of the Bryobiinae and the Tetranychinae and that of their genera, with the exception of *Oligonychus*, where monophyly was rejected.

Interplay between omnivory and intraguild predation: thrips spatial dynamics and damage to strawberry

Moshe Coll[1], Sulochana Shakya[1] and Phyllis Weintraub[2]

[1]*Department of Entomology, The Hebrew University of Jerusalem, Rehovot, Israel;* [2]*Department of Entomology, Agricultural Research Organization, Gilat, Israel*

Abstract: Omnivory, the feeding on both plant and prey material, and intraguild predation (IGP) are common in ecological systems. For the most part, these complex trophic interactions have been studied separately. Yet some predators are often involved in both omnivory and IGP. We therefore tested these interactions together, in a system that consisted of strawberry plants, western flower thrips (WFT) and two of its predators, the mite *Neoseiulus cucumeris* and the bug *Orius laevigatus*. All three are omnivorous consumers that feed on strawberry pollen; WFT damages strawberry fruit, the mite preys on first instar WFT, and the bug feeds on WFT and the mites. We asked: (i) what is the effect of pollen feeding on intensity of IGP? (ii) what is the combined effect of omnivory and IGP on WFT suppression? and (iii) what is the importance of the within-plant distribution of the predators in relation to prey feeding site, for pest-inflicted damage to strawberry fruit? Results show that (i) predation on *N. cucumeris* by *O. laevigatus* was significantly lower in the presence of pollen than in its absence; (ii) significantly fewer WFT were killed by the predators in the presence of pollen than in its absence; (iii) in the presence of pollen, WFT and both predators primarily reside in flowers rather than fruit and leaves; (iv) in the absence of pollen, WFT were recorded primarily on fruits; (v) in the presence of pollen, *N. cucumeris* is found in the flowers only when *O. laevigatus* is absent; else, the mites are found on the fruits or leaves; and (vi) when both predators are present, significantly lower fruit damage was observed in the absence of pollen than in its presence. Taken together, results show that omnivorous feeding and differential response to heterogeneously distributed resources buffer herbivory and IG predatory interactions. This may allow for complex trophic interactions, such as omnivory and IGP, to persist and be common in nature.

Tetranychus evansi Baker & Pritchard control in European solanaceous greenhouses: facts and perspectives

Maxime Ferrero[1], Marie-Stéphane Tixier[1], Karel Bolckmans[2], Serge Kreiter[1]

[1] *Montpellier Sup Agro, Laboratoire d'Acarologie, Unité Mixte de Recherche Centre de Biologie et de Gestion des Populations, Bâtiment 16, 2 Place Viala, 34060, Montpellier cedex 01, France;*
[2] Koppert BV, Veilingweg 17, P.O. Box 155, 2650 AD Berkel en Rodenrijs, The Netherlands

Abstract: *Tetranychus evansi*, a pest of several garden market crops, especially solanaceous ones, is being of great matter for growers for years in Africa and now in southern Europe. The authors discuss here which methods were considered to control *T. evansi*, and what may be the best path to follow to get this severe pest out of economically important crops. Chemical control is the only possibility to control by now this spider mite, but it has a low efficiency due to some resistances developed by the mite, and lead to environmental and health problems. In European solanaceous greenhouse crops, biological control is widely use and thus the route of finding a biological agent to control *T. evansi* has been privileged by researchers, without success until recently. Plant resistances, fungi, generalist predators and predatory mites have been tested for more than 25 years but did not lead to field applications. In 2005, a predatory mite, *Phytoseiulus longipes* has been found to be efficient against the pest populations. *Phytoseiulus longipes* is a very promising predator and is currently being studied, but may not be the only way to protect solanaceous crops from *T. evansi* injuries.

Interaction of the mango bud mite, *Aceria mangiferae*, with *Fusarium mangiferae*, the causal agent of mango malformation disease

Efrat Gamliel-Atinsky[1,2], Stanley Freeman[1], Abraham Sztejnberg[2], Marcel Maymon[1], Eduard Belausov[3] and Eric Palevsky[4]

[1]Dept. of Plant Pathology, ARO, The Volcani Center, Bet Dagan 50250, Israel e-mail: efrat@volcani.agri.gov.il; [2]Dept. of Plant Pathology and Microbiology, The Hebrew University of Jerusalem, Faculty of Agricultural, Food and Environmental Quality Science, Rehovot 76100; [3]Microscopy Unit, ARO, The Volcani Center; and [4]Dept. of Entomology, Newe-Ya'ar Research Center, ARO, Ramat Yishay 30095, Israel

Abstract: It has been suggested in the literature that the mango bud mite, *Aceria mangiferae*, plays an important role in epidemiology of mango malformation caused by *Fusarium mangiferae*. Current work was designed to study the role of the mites in carrying fungal conidia, vectoring them into the primary penetration sites and possibly assisting fungal penetration and dissemination. Carrying: bud mites were exposed to a gfp-marked fungal isolate. After 24 hours the mites were removed and mounted for microscopic observation. The gfp fluorescing conidia were observed on the examined mites and did not seem to cling to any particular part of the mite's body. Vectoring: agar plugs bearing either bud mites and/or gfp-marked pathogen were placed on a leaf near an apical bud on potted mango plants according to the following treatment design: 1. bearing bud mites and gfp-marked pathogen; 2. bearing bud mites; 3. bearing the gfp isolate; 4. untreated control. Bud mites were found only in apical buds of treatments 1 and 2 and gfp conidia were found in bud bracts only in treatment 1. Penetration: potted mango plants were inoculated with gfp-marked conidia in two treatments with or without the presence of bud mites. The frequency of infected apical buds was higher in the presence of bud mites. Dissemination: spore and mite traps were placed in a diseased orchard for one year in order to trace possible association between windborne bud mites and windborne conidia. No windborne bud mite bearing conidia was found on the traps, although high numbers of windborne conidia were trapped. These results suggest that the mango bud mite can carry the pathogen conidia on its body, vector it to the apical bud and improve fungal penetration. It also appears that the bud mites do not play a role in aerial dissemination of conidia.

A Tribute to the late Professor Eliahu Swirski, our foremost agricultural acarologist

Uri Gerson
Department of Entomology, Faculty of Agriculture, Hebrew University of Jerusalem, Rehovot 76000, Israel

Abstract: The late Professor Eliahu Swirski studied the aphids of the Middle East, the local pests of subtropical fruit (date palms, avocado and citrus), and pestiferous mites along with their predators. He followed the biology of the citrus rust mite in the orchard and in the laboratory and looked for its natural enemies. He collected and described many predatory mites of the family Phytoseiidae from Israel, Italy, Greece, Turkey and Kenya. The biology of several indigenous predators (including *Amblyseius swirskii*) and their susceptibility to pesticides were also studied.

Acaricides and the integrated control of plant feeding mites

Richard M. GreatRex
Syngenta Bioline Ltd., Telstar Nurseries, Holland Road, Little Clacton, Essex, CO16 9QG UK

Abstract: In discussing compatibility of acaricides or other pest control products within Integrated Pest Management, we need first to understand how to interpret the information which is available. Laboratory and field results often differ, and many things can contribute to this difference. The interaction between the product and the plant, leaf expansion and degradation, application technique and equipment, and application timing can all affect compatibility. Examples of how these various parameters influence compatibility are given for abamectin. Details are given of some of the most recently registered products, and also some products which are still in the developmental pipeline.

The use of products is not only driven by efficacy: politics and public opinion are all driving a change in their use. Government policy throughout Europe is to reduce pesticide use. Supermarkets react to public opinion and perceived risk by restricting use of products on the fruit and vegetables which they will sell: even registered products can be excluded. The rate of registration of new active ingredients is also low: there are relatively few new chemical classes and modes of action in development. In this situation, it is critically important that we maintain the viability of the few products which are available. Careful use and management of these products within IPM systems is one way to do this.

The interaction between *Rhizoglyphus robini* and plant pathogens on onion

Tal Hanuny[1], Moshe Inbar[1], Leah Tsror[2] and Eric Palevsky[3]
[1]Department of Evolutionary and Environmental Biology, University of Haifa, Mount Carmel, Haifa 31905, Israel thanuny@study.haifa.ac.il; [2]Agricultural Research Organization (ARO), Gilat Research Center, D.N. Negev, 85280, Israel tsror@volcani.agri.gov.il; [3]ARO, Newe-Ya'ar Research Center, Ramat Yishay, 30095, Israel palevsky@volcani.agri.gov.il

Abstract: We determined the pest status of the bulb mite, *Rhizoglyphus robini*, on young onion plants with and without the presence of different fungal species. First, we analyzed the degree of attraction of the mite to various fungi found on onion. We then assessed the effects of selected fungi and the mite on the germination and subsequent survival of young onion seedlings. Finally, we examined how the interactions between a weakly pathogenic fungus and the mite would affect the onion seedlings. The mites were always more attracted to colonized PDA plugs versus non-colonized PDA (except in the case of bi-nucleate *Rhizoctonia* AG-A). Onion seedling survival was significantly reduced by the fungi; the most pathogenic being the *Fusarium moniliformae* white strain and the least being *F. moniliformae* purple strain. Onion sprouts colonized by this fungus were significantly more attractive to the mites than healthy sprouts. At two days post-mite infestation, the effects on onion sprout length of the mites and the *F. moniliformae* purple strain and their interaction were significant. Mites had no effect on sprout length in the absence of this fungus, in contrast, in its presence, mites significantly reduced sprout length, more than the fungus alone. The importance of host-plant, fungi and mite interactions are discussed.

The beneficial fungus *Neozygites floridana* for the control of *Tetranychus urticae*

Ingeborg Klingen, Karin Westrum, Silje Stenstad Nilsen, Nina Trandem, Gunnar Wærsted
Bioforsk, Norwegian Institute for Agricultural and Environmental Research, Plant Health and Plant Protection Division, Høgskoleveien 7, 1432 Ås, Norway. E-mail: ingeborg.klingen@bioforsk.no

Abstract: *Neozygites floridana* is a fungus in the order Entomophthorales that infects and kills the two-spotted spider mite, *Tetranychus urticae*. The fungus is therefore of interest for the biological control of *T. urticae*. To obtain information that might help in the use of this fungus under practical conditions in strawberries and cucumbers we have tried to answer the following questions in a series of studies[*)]: 1) When, and at what infection levels does *N. floridana* occur in *T. urticae* populations in field grown strawberries? 2) How and where does *N. floridana* survive harsh climatic conditions (i.e winter) in Norway? 3) How and where does *N. floridana* infected *T. urticae* move and sporulate on a plant? 4) How do commonly used pesticides in strawberries affect *N. floridana* and *T. urticae*? 5) How can *N. floridana* be inoculated in augmentative microbial control of *T. urticae*? Results show that *N. floridana* infected and killed *T. urticae* in 12 out of 12 Norwegian strawberry fields studied. Infection levels up to 90% were observed, and the highest levels were observed late in the season. The infection levels throughout a season varied considerably. *N. floridana* was observed to over winter as both hyphal bodies in hibernating *T. urticae* females from October to at least February at temperatures as low as -20^{o} C. Cadavers with resting spores were found from October to the end of January. Cadavers then probably disintegrated, and resting spores were left on leaves, soil, etc. In a bioassay where a Norwegian *N. floridana* isolate was tested for numbers and distance of spores thrown at three different temperatures (13^{o}, 18^{o}, 23^{o} C), preliminary results show that high numbers of spores (ca 1300-1900 per cadaver) were thrown at all three temperatures. Further, spores were thrown about the same distance (up to about 6 mm) at all three temperatures. The effects of pesticides used in strawberries on the *N. floridana* infection level were studied to evaluate factors that might be important for conservation biological control. The pesticides tested were three fungicides; Euparen (tolylfluanid), Teldor (fenhexamid), Switch (cyprodinil + fludioxonil) and one acaricide/ insecticide: Mesurol (methiocarb). The experiment indicated that all three fungicides affect *N. floridana* negatively but that Euparen might be the least harmful. Mesurol did not affect *N. floridana*. Our attempts to inoculate *N. floridana* artificially in a strawberry field has not yet been successful, but we now work on promising methods for inoculation of *N. floridana* in *T. urticae* populations in greenhouse cucumbers. More detailed results from the studies referred to in this abstract will soon be published elsewhere.

Exploration and evaluation of natural enemies for the invasive spider mite *Tetranychus evansi*

Markus Knapp
Icipe – African Insect Science for Food and Health, P.O. Box 30772, 00100 Nairobi, Kenya, mknapp@icipe.org

Abstract: The spider mite *Tetranychus evansi* is an invasive pest of tomatoes in East and Southern Africa probably originating from South America. It is causing severe yield losses in small-holder tomato systems. No effective natural enemies are present in the region. Initial surveys for natural enemies in northeastern Brazil, from where the mite had been reported as a pest, did no reveal any potential biocontrol agent. Areas in South America, that are climatically similar to areas in Kenya and Zimbabwe where *T. evansi* is a problem, were identified using Desktop-GARP (Genetic Algorithm for Rule-set Production). Several natural enemies were found during extensive surveys in these areas. Evaluation of several natural enemies collected revealed a Brazilian strain of the phytoseiid mite *Phytoseiulus longipes* to be the only promising candidate for classical biological control in Africa so far. This predatory mite was imported into Kenya and a permit for experimental released was granted in December 2006.

Predatory mites associated with the coconut mite *Aceria guerreronis* in Brazil

L.M. Lawson-Balagbo[1,4], M.G.C. Gondim Jr[2], G.J. de Moraes[3], R. Hanna[1], P. Schausberger[4]
[1]International Institute of Tropical Agriculture, Biological Control Centre for Africa, Cotonou, Benin; [2]Universidade Federal Rural de Pernambuco, Departamento de Agronomia, Recife-PE, Brazil; [3]ESALQ-Universidade de São Paulo, Dept. Ent., Fitop.e Zool. Agrícola, Piracicaba, SP, Brazil; [4]Institute of Plant Protection, Department of Applied Plant Sciences and Plant Biotechnology, University of Natural Resources and Applied Life Sciences, Vienna, Austria, Email: late_emile.lawson-balagbo@boku.ac.at

Abstract: Coconut is an important crop in tropical and subtropical regions. Among the mites that infest coconut trees, *Aceria guerreronis* Keifer is economically the most important. We conducted surveys throughout the coconut growing areas of Brazil. Samples were taken from hanging nuts of coconut palms in 163 sites with the aim of determining the predatory mites associated with *A. guerreronis*. About 78% of all predatory mites belonged to the family Phytoseiidae, mainly represented by *Neoseiulus paspalivorus* De Leon, *Neoseiulus baraki* Athias-Henriot *Amblyseius largoensis* Muma and *Neoseiulus recifensis* Gondim Jr. & Moraes; 15% were Ascidae, mainly *Proctolaelaps bickleyi* Bram, *Proctolaelaps* sp nov and *Lasioseius aff. queenslandicus* Womersley. *Bdella distincta* Baker & Balogh (Bdellidae) was also common under the bracts of the nuts as well as few species of the family Cheyletidae. Six species are reported for the first time in Brazil. *Neoseiulus paspalivorus*, *N. baraki* and *P. bickleyi* were the most frequent and most abundant predators associated with *A. guerreronis.* These three predators seem promising candidates for future biocontrol efforts.

Biological control in vineyards by means of a laboratory phytoseiid strain: a small scale experiment in Tuscany (Italy)

Marialivia Liguori[1], Giuseppino Sabbatini Peverieri[1], Sauro Simoni[1], Laura Ferré[2]
[1]*Istituto Sperimentale per la Zoologia Agraria, via Lanciola 12/A, 50125 Firenze, Italy,*[2] *Azienda agricola Podere Forte, Loc. Petrucci 13, 53023 Castiglione d'Orcia (Si), Italy*

Abstract: *Eotetranychus carpini* (Oud.) outbreaks frequently occurred in a small vineyard of cv Petit Verdot in Val d'Orcia (Siena, Italy); during 2004, samples showed that phytoseiids were not present. To re-establish their presence, the release of *Typhlodromus exhilaratus* Ragusa from laboratory rearing was made by performing a small scale experiment. In 2005, from mid-May to mid-August, 2,250 mites/plant were released. On the release plants the phytophagous population was significantly lower, especially till the end of July; in this period, damage level was positively correlated to *E. carpini* population density.

Biological control of the newly introduced persea mite with indigenous and exotic predators

Yonattan Maoz[1], Shira Gal[1], Yael Argov[2], Martin Berkeley[2], Miriam Zilberstein[3], Mickey Noy[3], Yehonatan Izhar[4], Jonathan Abrahams[5], Moshe Coll[6] and Eric Palevsky[1]

[1]Agricultural Research Organization (ARO), Newe-Ya'ar Research Center, Ramat Yishay, 30095, Israel, palevsky@volcani.agri.gov.il; [2]Israel Cohen Institute for Biological Control, Plant Production and Marketing Board, Citrus Division, POB 80 Bet Dagan, 50250, Israel; [3]Extension Service, Ministry of Agriculture and Rural Development, POB 30 Bet Dagan, 50250, Israel; [4]Western Galilee R&D, MP Oshrat, 25212, Israel;. [5]Soil Conservation and Drainage Unit, Upper Galilee Ministry of Agriculture, Sefad, Israel. [6]Department of Entomology, The Hebrew University of Jerusalem, POB 12, Rehovot 76100, Israel,

Abstract: *Oligonychus perseae* was first discovered in Israel on avocado trees in the autumn of 2001; by 2004 it spread to most of the important avocado growing regions. While field monitoring for persea mite we observed *Euseius scutalis* (Phytoseiidae) feeding on *O. perseae* within torn nests and outside of the nests. Subsequently, laboratory studies were performed to evaluate the efficacy of this predator. To improve persea mite control, the exotic predatory mite *Neoseiulus californicus* was released in 2004 and 2005. To determine whether other generalist predators can feed upon and tear the nests of persea mite, insect and arachnid predators were collected from avocado trees using a beating tray technique placed individually on newly infested leaf discs and monitored for several days. Although *E. scutalis* reduced adult persea mite populations in the lab (on leaf discs) with or without torn nests, egg predation was improved by tearing the nests. Seasonal CMDs following *N. californicus* releases were reduced by 30%, but leaf damage was still considerable and similar to control trees. Furthermore Phytoseiid predators recovered from all release plots were mostly of the species *E. scutalis* ranging from 78-95%. In our no-choice bioassays on leaf discs we observed nest tearing and predation by green lace wing *Chrysoperla carnea*, dusty wing *Conwentzia* sp. and others. Developing methods for augmentation and conservation of *E. scutalis* and nest-tearing predators may prove valuable for enhancing persea mite control.

Biological control of the bulb scale mite *Steneotarsonemus laticeps* (Acari: Tarsonemidae) with *Neoseiulus barkeri* (Acari: Phytoseiidae) in amaryllis

G.J. Messelink, R. van Holstein-Saj
Wageningen UR Greenhouse Horticulture, P.O. Box 20, 2265 ZG Bleiswijk, The Netherlands; E-mail: Gerben.Messelink@wur.nl

Abstract: The bulb scale mite *Steneotarsonemus laticeps* is a serious pest in the culture of amaryllis and some other flower bulbs. Earlier results indicated *Neoseiulus barkeri* to be a promising candidate for biological control of this pest. In this study we assessed the ability of *N. barkeri* and *Amblyseius andersoni* to control or restrict the bulb scale mite in amaryllis in a greenhouse experiment. The pest was introduced by interplanting infested bulbs, and the predators originated from laboratory rearing. Populations of bulb scale mites were monitored over a period of 15 weeks. Both phytoseiid mites reduced pest injury significantly, with *N. barkeri* being the more effective predator. Unlike *A. andersoni*, *N. barkeri* established a permanent population, although in low numbers.

Additivity versus interactions in mite-plant and predator-mite interactions

Jay Rosenheim, Valerie Fournier
Department of Entomology and Center for Population Biology, University of California, Davis, 95616, USA; jarosenheim@ucdavis.edu

Abstract: A general question in ecology is whether the dynamics observed in communities of multiple interacting species can be predicted from an understanding of pairwise interactions among the component species. That is: can we predict the behavior of the 'whole' by examining the function of the 'parts'. Here we address this question by examining two case studies. In the first case study, we examined how a plant, papaya (*Carica payayae*) responds to attack by three organisms, a rust mite *Calacarus flagelliseta*, a foliar pathogen, powdery mildew *Oidium caricae*, and a root pathogen, *Phytophthora palmivora*. Because a plant's ability to resist infection or compensate for herbivory may be non-linear, we expected that interactions might be important. When all three antagonists were present simultaneously, the plant appeared to be overwhelmed and plant death was observed. In the absence of the root pathogen, however, rust mites and powdery mildew had largely additive effects on plant performance. In the second case study, we examined how an herbivore, the spider mite *Tetranychus cinnabarinus*, responded to attack by three organisms, a coccinellid beetle *Stethorus siphonulus*, a predatory mite *Phytoseiulus macropilis*, and a web-building spider *Nesticodes rufipes*. Because the web-spider eats both *Tetranychus* and the other predators, theory suggests that interactions may be important. Experiments demonstrated that the web-spider caused spider mite population growth rates to increase, apparently by suppressing populations of *Stethorus*. Populations of *Phytoseiulus*, however, appeared to be insensitive to the presence of the web-spider, and produced robust spider mite control. Thus, both of our case studies suggest that important multi-species interactions can occur, and that the emergent behavior of speciose communities may not be readily inferred from a study of its component parts.

The history of the predacious Phytoseiidae mites in Israel

Amos Rubin
14, Rahavat Ilan, Givat Shmuel 54056 Israel e-mail: frubin@netvision.net.il

Abstract: In the mid-1950's he successful biological control of the Florida red scale, *Chrysomphalus aonidum,* by the imported parasitic wasp *Aphytis holoxanthus* left only the citrus rust mite *Phyllocptruta oleivora* as a main pest in citrus orchards. The need for research on this pest and its natural enemies, lead to research on Phytoseiidae that started in 1959 by the late Professor Eliahu Swirski (1921-2002). Until 1966 six Phtoseiidae were imported from Hong Kong, Chile, USA, Italy and India. Nine Israeli species were exported in these years to USA, Switzerland and USSR. In the 1990's five species were introduced from Australia, and two from USA, Italy and Spain. Mass produced of *Euseius victoriensis* was established in the north of Israel on citrus.

The biology of Israeli phytoseiids: *Amblyseius swirskii, A. rubini=scutalis, Iphiseius degenerans, Typhlodromus athiasae* and the imported *Phytoseiulus persimilis, T. occidentalis* and *Phytoseius finitimus* were studied intensively. Some other factors such as over-wintering and chromosome numbers were also researched. Few of these species were mass produced and released (for example, 200,000 specimens of *P. persimilis* were released in 200 locations, with good recovery). Thirty-four Phytoseiidae were found on wild vegetation. A rare phenomenon of female viviparous was observed in one phytoseiid species*: Paragigagnathus tamaricus.*

Some Israeli Entomologists who have been involved in phytoseiid mite research are (in alphabetical order): Shlomo Amitai, Yael Argov, Natan Dorzia, Uri Gerson, Tova Grinberg, Yonatan Maoz, Eric Palevski, Chaim Reuveni, Amos Rubin, Eliahu Swirski, Carmit Tal, Phyllis Weintraub and Manes Wysoki. In 1998 a key of 51 phytoseiid mites of Israel was published by E. Swirski, S. Ragusa and H. Tsolakis.

The research of Israeli Phytoseiidae was important to understand their role as a control factor in rust, bud and red mite pests, and also as a control measure of whiteflies and thrips in several vegetable and orchard crops. They are mass produced and released in glasshouses, to control pests instead of pesticides. As a result healthy food products are sold in the markets.

A tritrophic perspective to the biological control of eriophyoid mites

Maurice W. Sabelis, Izabela Lesna & Nayanie S. Aratchige
Section Population Biology, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Kruislaan 320, 1098 SM Amsterdam, The Netherlands

Abstract: Vagrant eriophyoid mites are so small that they can move into narrow plant structures. Here, they would normally be safeguarded from attack by predators, such as phytoseiid mites, because these are much larger than the eriophyoid mites. Recent experimental evidence has been obtained that plants do not passively undergo the attack by these plant parasites, but respond by altering the relevant plant structure so as to promote access of phytoseiid predators. Not all species of phytoseiid mites can take advantage of this plant response, but some species can. This suggests particular morphological and behavioural traits that enable these phytsoseiid species to get access to the sites where eriophyoid mites hide. These new insights may provide a new tritrophic perspective to the biological control of eriophyoid mites.

The effects of varieties and agronomic practices on acarine populations in Italian vineyards

Sauro Simoni, Marisa Castagnoli
C.R.A., Istituto Sperimentale per la Zoologia Agraria, lab. Acarology, via di Lanciola 12/a, 50125 Florence Italy, email: sauro.simoni@isza.it

Abstract: The effects of the varieties, Nero d'Avola, Verdicchio, Fiano, Refosco and management practices (conventional, organic, no pesticides) on acarine species colonization and abundance were assessed in vineyards in different growing regions from Northern to Southern Italy. Verdicchio was the most inhabited variety by phytoseiids, Refosco by tetranychids and tydeids while Fiano was the less colonized by eriophyids. Phytoseiid mites showed significantly higher densities per leaf in untreated vineyards, while no difference was detected between biological and conventional vineyards. On the contrary, tydeids and tetranychids had the highest density in conventional vineyards.

Seasonal quality assessment of mass-produced *Phytoseiulus persimilis*

Shimon Steinberg, Hadassa Cain
Bio-Bee Sde Eliyahu Ltd. Kibbutz Sde Eliyahu, Bet Shean Valley 10810, Israel

Abstract: A life-time fecundity test was conducted with the commercially-produced predatory mite *Phytoseiulus persimilis* in order to assess its intrinsic quality in light of a new concept that categorizes egg laying females to young and old individuals according to the duration of their ovipositional period. *Phytoseiulus persimilis* females from two standard production batches were sampled for the test. Within each batch the fecundity of freshly harvested females (control treatment) was compared with that of stored predators, the latter simulating the logistic chain of the commercial product exported to Europe. Total egg production and duration of ovipositional period were closely related both in the control and storage treatments within the two batches. The distribution of reproductive age categories showed in the two batches ca. 50% non-reproducing and old 5-day ovipositing females in the freshly harvested material and ca. 40% of the same categories from the stored mites. Around 20-30% of the freshly harvested predators belonged to the young >20-day ovipositing females, whereas the stored individuals in this category consisted ca. 40% of the tested population. The average number of eggs per reproductive category increased gradually from old to young reproductive ages, both in the freshly harvested and stored mites, reaching a maximum of ca. 90 eggs at 25 oviposition days in the two batches. The reproductive rate of a female predator in each reproductive category met the IOBC standard of 2 eggs/female/day in all reproductive categories at both batches and in the stored and non-stored predators. The calculated potential yield of eggs from 2,000-female predators in a commercial product was 66,000 and 51,000 eggs for freshly harvested *P. persimilis* in batches A and B, respectively and ca. 82,000 eggs for the commercial product of stored material. The results of this study show that reproductively young females survived cold storage better than the old ones. Furthermore, they indicate good intrinsic quality and high colony vigor of the mass produced *P. persimilis*.

Biological control of *Polyphagotarsonemus latus* by the predaceous mite *Amblyseius swirskii*

Carmit Tal[1, 2], Moshe Coll[2], Phyllis G. Weintraub[1]
[1]Agricultural Research Organization (ARO), Gilat Research Center, DN Negev, 85280, Israel; e-mail: phyllisw@volcani.agri.gov.il; Hebrew University, Department of Entomology, Rehovot, Israel

Abstract: The broad mite, *Polyphagotarsonemus latus*, is a major pest on many crops in tropical and subtropical regions and in greenhouses world-wide. The phytoseiid predatory mite, *Amblyseius swirskii*, is able to feed on a wide range of plants and arthropods. However, its ability to control populations of *P. latus* is yet unknown. The object of this research was to determine the ability of *A. swirskii* to feed on broad mites in the laboratory on leaf discs and in the field on covered sweet pepper. Female *A. swirskii* were starved for 24 hours before being allowed to feed individually on different densities of broad mites. After 24 hours, broad mite mortality was assessed. Each broad mite density was replicated 15 times. We found that *A. swirskii* demonstrates a type II functional response to varying densities of *P. latus*. Based on these positive results we explored *A. swirskii* as a biological control agent against broad mites by determining their ability to control them on covered sweet pepper. Predators were released at two rates, 50 and 100/m^2, and were compared to non-treated and acaricide-treated controls. The higher release rate was comparable to acaricide treatment.

Field evaluation of cotton seed treatments and a granular soil insecticide in controlling spider mites and other early-season cotton pests in Texas

Noel Troxclair
Texas Cooperative Extension, Texas A&M Research and Extension Center, P.O. Box 1849, Uvalde, Texas 78802-1849

Abstract: This on-farm, large-plot study involved a comparison of untreated control plots versus thiamethoxam and imidacloprid cotton seed-treatment insecticides and in-furrow aldicarb in controlling in early-season cotton arthropods. Early-season cotton arthropods were monitored on three dates and significant differences among treatments were detected for thrips, aphids, red imported fire ants and spider mites, on one or more dates.

Spider mite control by four phytoseiid species with different degrees of polyphagy

Yvonne M. van Houten, Hans Hoogerbrugge & Karel J.F. Bolckmans
Koppert Biological Systems, P.O. Box 155, 2650 AD Berkel en Rodenrijs, The Netherlands

Abstract: Four commercially available phytoseiid mite species with different life-styles; *Phytoseiulus persimilis, Neoseiulus californicus, Amblyseius swirskii* and *Amblyseius andersoni* are all predators of two-spotted spider mite. These species were compared with respect to the following features: oviposition rate on *T. urticae*, incidence of reproductive diapause under short day conditions and their performance as biological control agent of *T. urticae* on sweet pepper. The results showed that *P. persimilis* exhibited the highest oviposition rate followed by *N. californicus, A. swirskii* and *A. andersoni* in descending order. *A. andersoni* was the only species to enter diapause under short day conditions. In a cage experiment *A. swirskii* and *A. andersoni* strongly slowed down the population growth of *T. urticae* on sweet pepper, whereas *P. persimilis* and *N. californicus* were able to control *T. urticae* successfully.

The influence of *Amblyseius swirskii* on biological control of two-spotted spider mites with the specialist predator *Phytoseiulus persimilis* (Acari: Phytoseiidae)

Yvonne M. van Houten, Hans Hoogerbrugge & Karel J.F. Bolckmans
Koppert Biological Systems, P.O. Box 155, 2650 AD Berkel en Rodenrijs, The Netherlands

Abstract: The biological control of *Tetranychus urticae* with *Phytoseiulus persimilis* was examined on sweet pepper plants in presence of the generalist phytoseiid mite *Amblyseius swirskii.* At a moderate density of *T. urticae, A. swirskii* had a negative effect on the population increase of *P. persimilis.* At a high density of *T. urticae*, no effect of *A. swirskii* on the *P. persimilis* population was found. Both at high and low densities of *T. urticae, P. persimilis* was able to control two-spotted spider mites when *A. swirskii* was present on the plants.

Antibiosis of kidney bean cultivars to the carmine spider mite, *Tetranychus cinnabarinus* (Boisduval) (Acari: Tetranychidae)

Carlos Vásquez[1], Mariela Colmenárez[1], Neicy Valera[1], Lisbeth Diaz[2]
Universidad Centroccidental Lisandro Alvarado, Decanato de Agronomía. [1]Departamento de Ciecnias Biológicas. [2]Departamento de Ingeniería Agrícola. Núcleo Tarabana. Via Agua Viva, Municipio Palavecino, Estado Lara, Venezuela. E-mail: carlosvasquez@ucla.edu.ve.

Abstract: The antibiosis of three *Phaseolus vulgaris* L. cultivars to the carmine spider mite, *Tetranychus cinnabarinus* (Boisduval), was evaluated under laboratory conditions in Venezuela. Oviposition and survival of the carmine spider mite were evaluated on 22 or 55 day-old-leaf disks. Results showed that lower oviposition was observed in 22-day-old leaf disks, while on 55-day-old leaf disks oviposition increased in 43.1, 58.9 and 95.9% in Tacarigua, Coche and ICA-Pijao cultivars, respectively. On the other hand, survival was significantly lowered in 55-day-old leaf-disks from ICA-Pijao, thus suggesting that this cultivar produces feeding deterrent. Our results showed that ICA-Pijao could be used in developing of resistance programs to obtain inbred elite lines in Venezuela.

Spatiotemporal within-plant distribution of the spider mite *Tetranychus urticae* confronted with specialist and generalist predators

Andreas Walzer[1], Karl Moder[2], Peter Schausberger[1]
[1]Institute of Plant Protection, Department of Applied Plant Sciences and Plant Biotechnology, University of Natural Resources and Applied Life Sciences, Peter Jordanstrasse 82, Vienna, Austria; E-mail: andreas.walzer@boku.ac.at; peter.schausberger@boku.ac.at; [2]Institute of Applied Statistics and Computing, Department of Landscape, Spatial and Infrastructure Sciences, University of Natural Resources and Applied Life Sciences, Peter Jordanstrasse 82, Vienna, Austria; E-mail: karl.moder@boku.ac.at

Abstract: The single and combined effects of the predatory mites *Phytoseiulus persimilis* and *Neoseiulus californicus* on the spatiotemporal of *Tetranychus urticae* on bean plants were investigated in separate greenhouse compartments. Four treatments were conducted: (1) *T. urticae*, (2) *T. urticae* + *P. persimilis*, (3) *T. urticae* + *N. californicus*, (4) *T. urticae* + both phytoseiid mites. Population development and distribution of the spider mites were compared among treatments. The spider mites were suppressed to zero density in the predator combination treatment but not in the single predator treatments. The predators determined the spatiotemporal distribution of the spider mites through density-mediated effects (density reduction) and behavior-mediated effects (triggering anti-predation behavior) and these effects were linked to diet specialization. The specialist *P. persimilis* exerted stronger density-mediated effects on the spider mite distribution than the generalist *N. californicus*. Both predators triggered similar anti-predation behavior in the spider mites, which was manifest in earlier bottom-up migration when predators were present. In combination the predators were somewhat more dispersed than when alone reducing the predator-free space on the plant and leading to local extinction of *T. urticae*.

Symbionts in mites and their relevance for pest control

Einat Zchori-Fein[1], Monika Enigl[2], Peter Schusberger[2], Netta Mozes-Daube[1], Yuval Gottlieb[1], Tal Hanuny[1] and Eric Palevsky[1]
[1]Department of Entomology, Newe Ya'ar Research Center, ARO, Israel; [2]Institute of Plant Protection, Department of Applied Plant Sciences and Plant Biotechnology, University of Natural Resources & Applied Life Sciences, Peter Jordanstrasse 82, A-1190 Vienna, Austria

Abstract: Maternally-inherited symbionts of arthropods are known to influence many aspects of their host's biology. With the advance of the field, enough data has been collected to be of applied value and a novel approach, termed symbiont-based protection (SyBaP) or "symbiotic control", is being considered for combating economically and medically important pests. In an effort to assess the possible use of SyBaP methods against mite pests, one predatory mite - *Neoseiulus californicus* - and one phytophagous mite - *Rhizoglyphus robini* - was chosen, and their symbiotic complex was determined. Molecular fingerprinting techniques revealed *Spiroplasma* in *N. californicus*, but no significant influence on fitness was found. Similarly, *Defluvibacter* and another unnamed α-Proteobacterium were found in *R. robini*, and both were observed concentrated in the same areas of *R. robini* eggs using confocal microscopy. This study will serve as the first step toward the application SyBaP methods in mites.

Transgenic crop-mite interactions

Rostislav Zemek
Institute of Entomology, Biology Centre AS CR, Branisovska 31, CZ-370 05 Ceske Budejovice, Czech Republic, rosta@acarus.entu.cas.cz

Abstract: Transgenic crops that are resistant to insect pests are grown on an increasing percentage of the global agricultural area. Understanding of the interactions between these crops and plant-feeding mites and their natural enemies is very important from both integrated pest control and risk assessment research point of view. So far, only a few laboratory and greenhouse studies on the effects of transgenic plants with insecticidal activity on mites have been reported. They used plants expressing lepidopteran- or coleopteran-active *Bacillus thuringiensis* toxins (maize, eggplants, potatoes), *Galanthus nivalis* agglutinin (potatoes) or proteinase inhibitor (tomato). *Tetranychus urticae* Koch was selected as a model herbivorous mite while *Neoseiulus cucumeris* (Oudemans), *Phytoseiulus persimilis* A.-H. and *Typhlodromus pyri* Scheuten were selected as predatory mites in these studies. Although no acute toxic effects of transgenic plants on any mites were reported, the obtained data revealed both positive and negative effects of these plants on mites. Whether the observed effects are due to the insecticidal proteins, or due to other changes in primary or secondary metabolites in transgenic plants, is unclear and remains to be elucidated.