Potential Invasive Pests Workshop

UF-CTA

October 10-14, 2010
Mayfair Hotel
Miami (Coconut Grove), Florida USA

www.conference.ifas.ufl.edu/tstar

T-STAR A Special Grant of the USDA, NIFA
Tropical & Subtropical Agriculture Research

Project No. 1009
Welcome to the “Potential Invasive Pest Workshop” in Coconut Grove, Miami!

The Workshop’s organizing committee hope that you will be stimulated by the presentations of the invited speakers and participants and by the discussions. This symposium addresses those pests that might become invasive, and we anticipate that the discussions will identify areas for future research and international collaboration.

We also welcome you to the Workshop social events at the Palm Terrace, beginning with the Welcome Networking Social on Sunday evening and the Closing Reception and Dinner Banquet on Thursday evening.

The Mayfair Hotel is centrally located within Miami, and is south of downtown and southwest of Miami Beach. The city of Coral Gables is nearby. There are several major shopping malls, including The Village of Merrick Park, Dadeland Mall and The Falls and downtown Coral Gables. Fairchild Tropical Botanic Garden, one of the great world collections of palms and cycad species is nearby; the garden is open from 12:00PM to 10:00PM daily.

Your Workshop hosts and the Workshop coordinator, Holly Paszko, will attempt to make the week enjoyable and rewarding for all of you. If you need assistance, please do not hesitate to contact us.

A special thanks to the sponsors of this Workshop, the University of Florida’s Institute for Agricultural Sciences Center for Tropical Agriculture, the USDA CSREES Program in Tropical and Subtropical Agricultural Research and USDA APHIS PPQ.

Jorge E. Pena
Professor, Entomology of Tropical Fruit Crops and Associate Director
UF IFAS Center for Tropical Agriculture

Richard E. Litz
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UF IFAS Center for Tropical Agriculture
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Agenda

Sunday, October 10, 2010
5:00pm-7:30pm  REGISTRATION OPEN (Crystal Foyer)
6:30pm-7:30pm  WELCOME NETWORKING SOCIAL (Palm Terrace)

Monday, October 11, 2010
7:00am-6:15pm  REGISTRATION OPEN (Crystal Foyer)
7:00am-8:00am  MORNING REFRESHMENTS
LITE CONTINENTAL BREAKFAST (Palm Terrace)
8:00am-8:30am  WELCOME ADDRESS (Crystal Ballroom)
8:00am-8:15am  John Capinera, Chair, Entomology & Nematology, University of Florida
8:15am-8:25am  R. E. Litz, Director, University of Florida Center for Tropical Agriculture
8:25am-8:30am  Welcome by Organizers, Housekeeping Remarks and Introduction on Sessions with Invited Speakers

8:30am-12:10pm  SESSION 1: Coleoptera: Leader: R. Giblin Davis (Crystal Ballroom)

The Red Palm Weevil:
8:30am-8:50am  Romeno Faleiro: Biology and Management of the Red Palm Weevil: India
8:50am-9:10am  R. Giblin-Davis: Biology and Management of Palm Weevils
9:10am-9:30am  P. Vidyasagar: Biology and Management of the Red Palm Weevil: Saudi Arabia
9:30am-9:50am  Josep A. Jacas: Infestation Levels and Management of the Red Palm Weevil: Spain
9:50am-10:05am  Li Ren: Occurrence and Damage of the Red Palm Weevil, Rhynchophorus ferrugineus (Olivier) in China
10:05am-10:30am  AM REFRESHMENT BREAK (Kentia I & II)

The Red Palm Weevil (continued):
10:30am-10:45am  A. Ajlan: www.redpalmweevil.com - First Global Portal for the Red Palm Weevil
10:45am-11:00am  Amy Roda: Red Palm Weevil Rhynchophorus ferrugineus, an Invasive Pest Recently Found in the Caribbean that Threatens the U.S. Nursery and Palm Industry
11:00am-11:15am  Hassan Al-Ayied: First Phase of the National Project for Red Date Palm Weevil Rhynchophorus ferrugineus (Olivier)-Early Detection of Infestation
11:15am-11:35am  Discussion
### Monday, October 11, 2010 (continued)

#### Heilipus Weevils:

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Topic</th>
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<tbody>
<tr>
<td>11:35am-11:55am</td>
<td>Armando Equihua-Martinez</td>
<td>Avocado Weevils of the Genus <em>Heilipus</em></td>
</tr>
<tr>
<td>11:55am-12:10pm</td>
<td>Teresa Cooper</td>
<td>Bromeliad Weevils as Pests of Bromeliads</td>
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#### GROUP LUNCHEON (*Palm Terrace*)

1:15pm-6:10pm  
**SESSION 2: Coleoptera: Leader: R. Haack**  
(*Crystal Ballroom*)

#### Ambrosia Beetles and Other Beetle Species:

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<th>Time</th>
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<tr>
<td>1:20pm-1:40pm</td>
<td>R. Haack</td>
<td>Exotic Bark and Ambrosia Beetles (Coleoptera: Curculionidae: Scolytinidae) in the United States: Current and Potential Invaders</td>
</tr>
<tr>
<td>1:40pm-2:00pm</td>
<td>Crebio Avila</td>
<td><em>Diabrotica speciosa</em>: Important Soil Pest in South America</td>
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<tr>
<td>2:00pm-2:15pm</td>
<td>Runzhi Zhang</td>
<td>Introduction, Dispersal and Potential Impacts of the Colorado Potato Beetle, <em>Leptinotarsa decemlineata</em> in China</td>
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<tr>
<td>2:15pm-2:40pm</td>
<td>Discussion</td>
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<tr>
<td>2:40pm-3:00pm</td>
<td>PM REFRESHMENT BREAK (Kentia I &amp; II)</td>
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#### Strategies to Follow for Potentially Invasive Pests:  
Leader: R. Balaam

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<th>Time</th>
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<tr>
<td>3:00pm-3:20pm</td>
<td>Anne Sophie Roy</td>
<td>EPPO Activities on Potential Invasive Pests</td>
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<tr>
<td>3:20pm-3:40pm</td>
<td>George Roderick</td>
<td>Next Generation Invasion Biology: Origins, Pathways, Demography and Future Spread</td>
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<tr>
<td>3:40pm-4:00pm</td>
<td>Bob Balaam</td>
<td>USDA APHIS Greater Caribbean Safeguarding Initiative</td>
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<td>4:00pm-4:20pm</td>
<td>Ana Isabel Gonzalez</td>
<td>Activities of the NAPPO Invasive Pest Panel</td>
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<tr>
<td>4:20pm-4:40pm</td>
<td>Osama El-Lissy</td>
<td>A National Perspective of the Detection and Response to Exotic Plant Pests</td>
</tr>
<tr>
<td>4:40pm-5:00pm</td>
<td>Jurgen Kroschel</td>
<td>Application and Use of Insect Phenology Modeling for Invasive Species for Regional and Global Risk Assessments under Future Climate Change Scenarios</td>
</tr>
<tr>
<td>5:00pm-5:20pm</td>
<td>Lance Osborne</td>
<td>Managing the Invasive Species Risk in the Ornamental Industry</td>
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<tr>
<td>5:20pm-5:40pm</td>
<td>Leroy Whilby</td>
<td>Preparing for Potentially Invasive Pests: Strategies from the Florida Department of Agriculture Division of Plant Industry</td>
</tr>
<tr>
<td>5:40pm-6:10pm</td>
<td>Discussion</td>
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Tuesday, October 12, 2010

7:00am-5:30pm   REGISTRATION OPEN (Crystal Foyer)
7:00am-8:00am   MORNING REFRESHMENTS / LITE CONTINENTAL BREAKFAST (Palm Terrace)

8:00am-12:15pm SESSION 3: Lepidoptera: Leader: M. Hoddle (Crystal Ballroom)

8:00am-8:20am   J. R. Postali-Parra: Bioecology and Biological control of Stenoma catenifer
8:20am-8:40am   M. Hoddle: Surveys for Potentially Invasive Lepidoptera Associated with Avocado Fruit
8:40am-9:00am   J. R. Postali-Parra: Bioecology and Biological Control of Tuta absoluta
9:00am-9:20am   A. Urbaneja: Basis for Integrating Bacillus thuringiensis and Nesidiocoris tenuis for Biological Control of Tuta absoluta
9:20am-9:40am   A. Mafra-Neto: Sex Pheromone Tools for Detection, Management and Control of the Tomato Leafminer Tuta absoluta in South America, Europe and Mediterranean Countries
9:40am-10:00am  Ana E Diaz Montilla: The Fruit Borer, Neolucinodes elegantalis (Guéneé) (Lepidoptera: Crambidae), an Insect Pest of Neotropical Solanaceous Fruits
10:00am-10:20am AM REFRESHMENT BREAK (Kentia I & II)
10:20am-10:50am Juli Gould and Rebecca Simmons: Copitarsia spp.: Biology and Risk Posed by a Potentially Invasive Lepidoptera from South America
10:50am-11:10am Daniel Carrillo: Biology and Management of Tecla solanivora (Lepidoptera: Gelechiidae), an Important Pest of Potatoes in the Colombian Andes
11:10am-11:30am Arnold Hara: Host Range of the Nettle Caterpillar, Darna pallivitta (Lepidoptera: Limacodidae) in Hawaii
11:30am-11:50am H. Zhu: The Distribution and Threat of Invasive Codling Mothm Cydia pomonella (L.) in China
11:50am-12:15pm Discussion
12:15pm-1:15pm   GROUP LUNCHEON (Palm Terrace)
1:15pm-5:20pm   SESSION 4: Diptera: Leader: Nancy Epsky, USDA ARS, Miami (Crystal Ballroom)

Fruit Flies Anastrepha ludens, A. obliqua and Bactrocera carambolae:

1:15pm-1:35pm   A. Birke Biewendt: Monitoring, Control Mechanism and Quarantine Treatment for Anastrepha obliqua and Anastrepha ludens
1:35pm-1:55pm   L. Guillén Conde: Biology, Distribution, Hosts and Population Dynamics of Anastrepha obliqua and Anastrepha ludens
1:55pm-2:30pm   Aldo Malavasi: Three Tephritid Fruit Fly Species that Pose a Threat to Florida: Bactrocera carambolae, B. invadens and Anastrepha grandis
**Tuesday, October 12, 2010** (continued)

2:30pm-2:50pm  **P. Kendra:** Gas Chromatography for Detection of Citrus Infestation by Tephritid Fruit Flies

2:50pm-3:10pm  **R. Faleiro:** Ecology and Sustainable Management of Major Bactrocera Fruit Flies in Goa, India

3:10pm-3:40pm  **PM REFRESHMENT BREAK (Kentia I & II)**

3:40pm-4:00pm  **Gall Midges and other Diptera Affecting Asparagus, Tomatoes, Peppers, orchids:**

3:40pm-4:00pm  **R. Gagne:** Two Generalist Gall Midge (Diptera: Cecidomyiidae) Pests of Agricultural Crops in the American Tropics

4:00pm-4:20pm  **Juliet Goldsmith:** The Hot Pepper Gall Midge in Jamaica: Strategies Towards Risk Management

4:20pm-4:40pm  **Jorge Castillo-Valiente:** *Prodiplosis longifila* Gagné in Perú

4:40pm-5:00pm  **Juliette Pijnakker:** *Lyprauta* spp. (Diptera: Keroplatidae) in Orchid Greenhouses in the Netherlands

5:00pm-5:20pm  Discussion

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**Wednesday, October 13, 2010**

7:00am-12:15pm  **REGISTRATION OPEN (Crystal Foyer)**

7:00am-8:00am  **MORNING REFRESHMENTS / LITE CONTINENTAL BREAKFAST (Palm Terrace)**

8:00am-12:00pm  **SESSION 5: Acarina and Fire Ants Control: Leader: J. C. Rodrigues (Crystal Ballroom)**

8:00am-8:20am  **J. C. Verle Rodrigues:** *Brevipalpus* Mites (Acari: Tenuipalpidae) Pests and Virus Vectors

8:20am-8:40am  **C. Welbourn:** The Hibiscus Erineum Mite *Aceria hibisci* (Acari: *Eriophyidae*) a Threat to Malvaceae

8:40am-9:00am  **Denise Navia:** Recent Mite Invasions in South America

9:00am-9:20am  **J. E. Pena:** Dispersal Patterns of *Brevipalpus phoenicis* from Citrus Fruits

9:20am-9:40am  **Josep Jacas:** Dynamics of *Eutetranychus banksi* and *E. orientalis* in Citrus in Spain

9:40am-10:00am  **Tanjim Hossain:** *Solenopsis invicta* as Potential Biocontrol for *Aedes aegypti*

10:00am-10:20am  **Jaeson Clayborn:** Are Coastal Populations of Fire Ants, *Solenopsis invicta* Preying on or Scavenging on Sea Turtle Nests?

10:20am-10:50am  **AM REFRESHMENT BREAK (Kentia I & II)**

10:20am-12:00pm  **POSTER SESSION (Kentia I & II)**

12:00pm  **REMAINDER OF DAY ON OWN**
Thursday, October 14, 2010

7:00am-5:30pm  REGISTRATION OPEN  (Crystal Foyer)
7:00am-8:00am  MORNING REFRESHMENTS / LITE CONTINENTAL BREAKFAST  (Palm Terrace)

8:00am-12:00pm  SESSION 6  Hemiptera:  
Leader: Ian Stocks  (Crystal Ballroom)

- **Pseudococcidae, Ortheziidae, Psyllidae & Derbidae:**
  - 8:00am-8:20am  Amy Roda: Developing Survey and Mitigation Strategies for the Passionvive Mealybug *Planococcus minor*
  - 8:20am-8:40am  Mark Culik: Experiences with *Planococcus minor*  (*Hemiptera: Pseudococcidae*) in Espiritu Santo, Brazil, with Respect to Potential Invasive Pests
  - 8:40am-9:00am  Ian Stocks: Recent and Potentially Imminent Introductions of Coccoidea and Aleyrodidae to Florida and the Caribbean Area
  - 9:00am-9:20am  K. Wyckhuys: Invasion of Exotic Arthropods in South America’s Biodiversity Hotspots and Agro-Production Systems: Prospects for Classical Biological Control
  - 9:40am-10:00am  R. Shatters: Phylogeography of *Diaphorina citri* Kuwayama mtCOI: Two Old World Lineages and a New World Invasion
  - 10:00am-10:20am  Jawwad Qureshi: Biological Control of *Diaphorina citri*  (*Hemiptera: Psyllidae*) with the Parasitic Wasp *Tamarixia radiata*  (*Hymenoptera: Eulophidae*) in Florida
  - 10:20am-10:40am  AM REFRESHMENT BREAK  (Kentia I & II)
  - 10:40am-11:00am  Wayne Hunter: Emerging Psyllid Genome, RNA Interference and Insect Biology
  - 11:00am-11:20am  Aziz Ajlan: Two Forms of Citrus Greening Disease and their Psyllid Vectors in Saudi Arabia
  - 11:40am-12:00pm  Discussion
  - 12:00pm-1:15pm  GROUP LUNCHEON  (Palm Terrace)

1:15pm-5:30pm  SESSION 7  Hemiptera: Diaspidid Scales and Whiteflies: 
Leader: C. Mannion, UF TREC, Homestead  (Crystal Ballroom)

- 1:15pm-1:35pm  G. Evans: Recent and Potential Invasive Species of Armored Scales to the U.S. and Caribbean Basin
- 1:35pm-1:55pm  Richard Stouthamer: Diaspidid Scale Insects on Imported Fruit are a Substantial Risk
Thursday, October 14, 2010 (continued)

1:55pm-2:15pm  M. Hennessey: Likelihood of Establishment of Diaspidid Scales Legally Entering the U.S. via Commercial Fresh Fruit for Consumption Pathway

2:15pm-2:35pm  David Bartels: Efficacy of Packinghouse Procedures on Mitigation of Armored on Hass Avocado

2:35pm-2:55pm  Catharine Mannion: Biology and Population Dynamics of the Ficus Whitefly, Shinghiella simplex

2:55pm-3:15pm  Jesusa Legaspi: Fecundity of Ficus Whitefly, Shinghiella simplex (Hemiptera: Aleyrodidae), and Its Predation by Delphastus catalinae (Coleoptera: Coccinellidae)

3:15pm-3:35pm  PM REFRESHMENT BREAK (Kentia I & II)

3:35pm-5:30pm  Discussion: Wrap up session

6:30pm-7:30pm  RECEPTION (Rooftop Pool)

7:30pm-10:30pm  CLOSING DINNER BANQUET (Palm Terrace)
Poster Directory

1. A Simplified and Efficient Technique for Rearing the Exotic Pest *Diaphorina citri* (Homoptera: Psyllidae) and its Parasitoid, *Tamarixia radiata* (Hymenoptera: eulophidae) -- Jose Castillo, University of Florida, Immokalee, FL, United States

2. Enhancing Corn Productivity through Integrated Pest Management in Rainfed Areas -- Myleen Corpuz, Isabela State University, Philippines

3. Development of Agricultural Quarantine Inspection and Port Technology to Prevent Invasive Pests from Entering on Imported Commodities -- Mike Hennessey, USDA, APHIS, Raleigh, NC, United States

4. New Whiteflies in the Landscape of South Florida -- Catherine Mannion, University of Florida, Tropical Research and Education Center, Homestead, FL, United States

5. Olfactory Responses of Male Medflies to Plant Material Containing the Parapheromone a-Copaene -- Jerome Niogret, USDA, Miami, FL, United States

6. The African Fig Fly: Surveys to Ascertain the Status of an Invasive Pest in the US -- Jorge E. Peña, University of Florida, Tropical Research and Education Center, Homestead, FL, United States

7. Off-Shore and On-Shore Biological Control Programs to Mitigate the Impacts of Invasive Arthropods and Weeds -- Amy Roda, USDA-APHIS-PPQ-CPHST, Miami, FL, United States

8. The Critical Role of IR-4 in Speciality Crop Pest Management -- Michelle Samuel-Foo, University of Florida, Food and Environmental Toxicology Lab, Gainesville, FL, United States

9. Pests of Tamil Nadu, India -- S. Suresh, Tamil Nadu Agricultural University, India

10. Mealybugs Present in Grand Cayman -- Joan Steer, Department of Agriculture, Grand Cayman, Cayman Islands

11. Discovery of a New Invasive Mealybug, *Phenacoccus solenopsis Tinsley* (Hemiptera: Pseudococcidae) in China -- Runzhi Zhang, Institute of Zoology, Chinese Academy of Sciences, Beijing, China

12. Update on Heteroptera of Concern as Potential Agricultural Pests in the Southeastern United States -- Julieta Brambila, USDA-APHIS-PPQ, Entomology, Gainesville, FL, United States

ABSTRACTS
Listed alphabetically by presenter’s last name
Date palm, Phoenix dactylifera L., and 19 other palm species are under the threat in several countries from infestation by red palm weevil (RPW), Rhynchophorus ferrugineus, the most dangerous pest of palms. During the mid nineteen eighties, it gained foothold in the date plantations of the arid Middle-Eastern region from where it moved into Africa (Egypt) in the early nineteen nineties; subsequently into Europe (Spain) due to transportation of infested offshoots. Currently it is devastating Phoenix canariensis in the Mediterranean region. In 2008 and 2009, RPW was reported from, Morocco, Libya, Caribbean (Curacao island/ Netherland Antilles), Republic of Georgia and Albania.

RPW mostly infests young date and coconut palms less than 20 years old with a single female laying about 300 eggs, which hatch into damage inflicting grubs. All stages (egg, larva, pupa and adult) are spent inside the palm itself, with adults flying out of infested palms in search of mates or sites to oviposit. Palms in the early stage of attack are difficult to detect, as neither the damage symptoms nor the hidden larva can be seen.

In order to facilitate sharing of information on RPW and develop a global net work of researchers, farmers and administrators the first worldwide website on RPW (www.redpalmweevil.com) was established in Arabic and English languages during 1998. Besides the world-wide distribution of this pest the site also contains latest information on the management of RPW, resource persons working on this pest, important publication titles/abstracts on RPW, information on seminars/ symposia/workshops related to RPW and is a global link for scientists, researches and people interested in RPW. The RPW site along with the Entomological Society of America (ESA) hosted the RPW symposium via teleconference during EAS 56th annual meeting at Nevada, USA. This presentation gives an overview on the management of RPW and the global portal – (www.redpalmweevil.com).

Contact Information: Aziz Ajlan, King Faisal University, PO Box 55009 Hofuf, Al Hassa 31982, Saudi Arabia, Phone: 966555675888, Email: aajlan@hotmail.com
Two Forms of Citrus Greening Disease and their Psyllid Vectors in Saudi Arabia

Aziz Ajlan and Khalid Alhudaib
Department of Arid Land Agriculture, College of Agricultural and Food Sciences, King Faisal University, Hofuf, Al Hassa, Saudi Arabia

Citrus is one of the most economically important crops in Saudi Arabia. The two forms of citrus greening disease, a heat-tolerant form (Asian) and a heat-sensitive form (African), are threat to citrus orchards in Saudi Arabia. Citrus greening disease is caused by a bacterium, Candidatus Liberibacter (fastidious, phloem-limited bacterium) infects all types of citrus species and spread by the Asian citrus psyllid (Diaphorina citri Kuwayama) and the African citrus psyllid (Trioza erytreae (del Guercio)). When Diaphorina citri was discovered in Saudi Arabia in early nineteen seventy, intensive spraying of insecticides used. However, in early nineteen ninety, biological control of Diaphorina citri as part of the IPM program was initiated in a small Mexican lime orchard consisting of 45 seven-year old trees in Hadda ash Sham, about 120 km northeast of Jeddah, by releasing the endoparasite, Diaphorencyrtus aligarhensis, which is found parasitizing on psyllid nymphs on citrus trees in Jeddah. At the beginning of the program two releases of the parasite in the orchard were carried out in August and September, 1991. The procedure involved placing several small lime twigs, having many parasitized nymphs, in flasks containing water and transporting them to the small Mexican live orchard. In few days, adult parasites were seen flying around in search of the psyllid nymphs to lay their eggs. Continuing releasing of the parasites at intervals, the psyllid population increased in numbers, which required intervention with limited chemical control of the psyllids on October, 1991 and March 1992. In between these two treatments, citrus mites infested the trees to a high level, which sprayed on January, 1992 with an acaricide that had no harmful effect on the psyllid parasites. The releases of the parasites would require full cooperation of growers to insure proper implementation of the program.

Contact Information: Aziz Ajlan, King Faisal University, PO Box 55009 Hofuf, Al Hassa 31982, Saudi Arabia, Phone: 966555675888, Email: aajlan@hotmail.com
First Phase of the National Project for Red Date Palm Weevil 
*Rhynchophorus ferrugineus* (Olivier) - Early Detection of Infestation

**Hassan Y. Al-Ayied**
Natural Resources and Environment Research Institute (NRERI), King Abdulaziz City for Science and Technology (KACST), Riyadh, Kingdom of Saudi Arabia

Red date palm weevil (RPW) *Rhynchophorus ferrugineus* (Olivier) is the most important destructive economic insect pest of date palm *Phoenix dactylifera* L in Saudi Arabia. King Abdulaziz City for Science and Technology (KACST) has established a national project for RPW control which were divided into three phases. First phase is concern with infestation early detection methods and biological studies, the second phase is evaluation of infestation and distribution and the third phase will deal with control methods. The first phase consists of number of research teams. First team was working on the use of RPW aquestic characters to be used as indicator of early infestation. Second team was using the plant physiological indicator to determine the insect infestation. Third team is using the biotechnology for distinguish between the infested and non infested date palm trees. The fourth team is utilizing a thermal camera and the fifth team is using the ground penetrating radar (GPR) to see the internal cavity of the infested date palm trees. Beside these teams there were other team studying some other aspects such as insect biological studies. Positive indications were observed from the above studies. For example, the insect's noises were recognized using small aquestic device. Some SIT methods were evaluated and the relationship of the RPW and some other insects were studied.

**Contact Information:** Hassan Y. Al-Ayied, Natural Resources and Environment Research Institute (NRERI), King Abdulaziz City for Science and Technology (KACST), P. O. Box 6086 Riyadh 11442, Kingdom of Saudi Arabia, Phone: 1352273396935280000000, Email: alayedh@kacst.edu.sa
Diabrotica speciosa: Important Soil Pest in South America

Crébio José Ávila\textsuperscript{1} and Viviane Santos\textsuperscript{2}
\textsuperscript{1}Embrapa Agropecuária Oeste, Dourados, MS, Brazil  
\textsuperscript{2}Department of Entomology, Phytopathology and Zoology, University of São Paulo, Piracicaba, SP, Brazil

The objective of this review is to present some biological and behavioral aspects of \textit{D. speciosa}, as well as the strategies used to control this pest in Brazil. \textit{Diabrotica speciosa} is a multivoltine crisomelid that has wide geographic distribution, occurring almost everywhere in South America, probably because of its polyphagous habit and the ability to adapt to different environments.

Studies conducted in Brazil showed that this insect could be easily reared in laboratory conditions with natural diet, using bean leaves as food for adults and corn seedlings for the larvae. Both, the type and quality of food available for the adult greatly affects the fecundity and adult longevity of the insect.

Both adults and larvae of \textit{D. speciosa} cause crop damage. Adults feed on leaves, new shoots, pods and fruits of various species of plants, causing defoliation or acting as vectors of pathogens, especially viruses. The main crops attacked by adults are beans, soybeans and potatoes. The larvae that live in soil can attack roots or tuber crops, especially in corn and potato crops.

In Brazil, the control of adults and larvae of \textit{D. speciosa} is done almost exclusively by using chemical insecticides. Often, for adults, is necessary multiple sprays of insecticides in the crops in order to obtain good control, since this beetle, due to its flight ability and polyphagia, can migrate easily between cultures, favoring frequent re-infestations. Applications of granular or spray insecticide on the sowing furrow, showed an effective control of \textit{D. speciosa} larvae on corn and potato crop. Insecticides applied on seeds are an ineffective strategy for controlling larvae of this insect. The microbial control of \textit{D. speciosa} larvae with entomopathogenic nematodes has also shown promising.

Baits containing the allelochemical cucurbitacin (kairomone) plus insecticides can be used for controlling or monitoring adults of \textit{D. speciosa} in crops where this pest causes damage. Recent studies revealed the existence of the sex pheromone produced by adult \textit{D. speciosa}. The identification and synthesis of these compounds will be an important strategy for the management of this pest on cropping systems.

Contact Information: Crébio José Ávila, Laboratory of Entomology, Embrapa Agropecuária Oeste, PO Box 661, Dourados, MS, Brazil, Phone: 55-67 34169778, Fax: 55-67 34169721, Email: crebio@cpao.embrapa.br
Session 2 (B): Strategies to Follow for Potentially Invasive Pests: USDA APHIS Greater Caribbean Safeguarding Initiative

Bob Balaam
USDA APHIS PPQ GCSI, CSI Florida Program Manager, Homestead, Florida USA

The United States Department of Agriculture’s Animal and Plant Health Inspection Service recognizes the threat posed to US plant health by invasive plant pests which may become established in the Greater Caribbean Region, including the West Indies, Central America, Florida, Puerto Rico, and the US Virgin Islands. To meet this threat and to assist the entities in that region with similar plant health safeguarding efforts, APHIS has established the Greater Caribbean Safeguarding Initiative. This program, as well as the Offshore Pest Information Program, are designed to establish and maintain partnerships and networks that will identify key pest targets and pathways that could threaten the Region and in cooperation with multiple programs within the Agency and with the NPPOs, Universities, and other institutions in the Region to conduct pest detection programs, initiate pest mitigation programs, conduct the necessary research and outreach, and formulate national and regional policy that will enhance the harmonization of plant protection in the Region according to international standards.

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Efficacy of Packinghouse Procedures on Mitigation of Armored Scales on ‘Hass’ Avocado

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The armored scale on avocado fruit is an important issue with the 2007 ruling opening all 50 United States to the importation of ‘Hass’ avocados (*Persea americana* Mill. var. ‘Hass’). Current pest risk assessments do not consider armored scales as regulated pests. However, grade standards of no more than 10% infested fruit per shipment should be met in order to comply with the Florida avocado quality market standard (USDA 1959) and the avocado import grade regulation (CFR 944.28, 2007). In addition, Morse et al. 2009 (J. Econ. Entomol. 102: 855-867) contends that the volume of shipments and the levels of live scales observed on these shipments present a significant risk to the California avocado industry. There are 26 packinghouse approved to export avocados to the U.S. under the USDA APHIS Avocado Export Program in the state of Michoacán, México. Packinghouses use brushing equipment in their packing lines to clean the avocado fruit as it comes in from the field. The objectives of these experiments were to determine which types of brushing equipment in the packing line are most efficacious in removing armored scale from the fruit and evaluate the efficacy of culling armored scale infested avocado fruits on the packing line.

The brushing experiment was run October 2009, in 8 packinghouses representing a combination of 8 different brush types and combinations. Brush types include plastic, horse hair, and sponge rollers. A total of 360 avocados similar in size and scale infestation were collected from a single load at one packinghouse. The avocados were taken to a lab where the scales were counted and the avocados were marked with 3 2-cm circles. After processing, scales within the circles would be examined for live and dead individuals. The avocados were randomly divided into 9 groups of 40, one group for each packinghouse and 40 as the untreated control. The avocados were then run through the brushing equipment at each packinghouse. Twenty avocados were set aside in cold storage for 24 hours and the remaining 20 avocados were processed immediately. All the avocado sub-samples (2-cm circles) were examined under microscopes in the lab to count live and dead scales.

The average number of scales per fruit was 68.1 ± 41.4 before treatment and 45.7 ± 28.4 after brushing (33% removal). The level of removal ranged from 52.1% on equipment with 33 horse hair rollers to 18.5% on equipment with 20 horse hair and 10 sponge rollers. The percentage of live scales on the fruit average 6.7% with a range from 3.1 to 14.0%. Fruit held in cold storage for 24 hours averaged 4.8% live scale compared with 8.6% live scale on fruit immediately after brushing.

Brushing equipment on the packing line alone removes, at the most, 52% of the armored scale on avocados. However, significant mortality occurs during the cold storage of the fruit. An additional study to examine the combined effects of the brushing equipment and culling by workers is planned for May 2010.

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Anastrepha ludens and Anastrepha obliqua (Diptera: Tephritidae): Two Pestiferous Tropical Fruit Flies that Could Potentially Invade Temperate Areas under a Global Warming Scenario

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The family Tephritidae (Diptera) comprises over 4000 species of which ca. 209 belong to the genus Anastrepha. Of these, less than 10 species are of significant economic importance. Here we dwell on two pestiferous Anastrepha species identified as potential exotic invaders under a global warming scenario: Anastrepha ludens (Mexican fly) and A. obliqua (West Indian fruit fly). Anastrepha ludens, known as the Mexican fruit fly, is a feared pest of citrus, but also causes economic damage to mango. Anastrepha obliqua, known as the West Indies or mango fruit fly, causes significant economic damage to mango and tropical plums (Spondias spp.). We provide a comprehensive overview of the published information on these two species to aid further research efforts and to facilitate decision-making processes in the areas of management and regulatory entomology. We place emphasis on recent studies on behavior, especially those related to oviposition and host-selection (and use), life history (including variation on the duration of larval development according to type of host), ecology and population dynamics. We also discuss traditional control methods (e.g., field sanitation, chemical and biological control, SIT), more recent efforts on biorational management and use of new tools like barcoding and geographical information systems to monitor Anastrepha populations. Finally, we discuss short- and long-term research needs.
Update on Heteroptera of Concern as Potential Agricultural Pests in the Southeastern United States

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This work addresses 35 heteropteran species of concern to the southeastern states because of their potential to become pests in this area. We list the species with their latest distribution and illustrate select species. Some are not found in the United States while others occur in western states or have recently entered the North American continent. All these species are agricultural pests, with some being nuisance pests in urban settings as well.

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Invasion by 6-legged Aliens

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The biota of the world is becoming increasingly homogeneous as aggressive invasives become redistributed. Among the most important invasive organisms are insects. Unlike some other organisms (such as plants and vertebrates) that are (inadvisably) moved deliberately, insects almost always are hitchhikers or stowaways. Although tourism is sometimes implicated in the movement of insects, commerce is most often the underlying factor facilitating redistribution. Movement of live plant materials is the principal issue in tropical climates but dunnage plays a major role in cooler climates. The economic impact of invading organisms exceeds $100 billion annually in the United States but it is difficult to ascribe environmental impacts.

Regulatory services throughout the world seek to eliminate the movement and establishment of unwanted alien organisms. The sources of alien organisms reflect the origin of items in commerce, with Florida’s invasives heavily weighted to Latin America and Asia, whereas the invasives affecting most of North America originate in Europe. From the perspective of USA, the rate of introduction continues undiminished. A more positive perspective is that despite the growth in international trade, the rate of introduction has not greatly increased.

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Biology and Management of *Tecia solanivora* (Lepidoptera: Gelechiidae), an Important Pest of Potatoes *Solanum tuberosum* in the Colombian Andes

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*Tecia solanivora* Povolny causes serious problems in potato crops in various regions of South America, Central America and the Canary Islands (Spain). Larvae feed exclusively on potato tubers making galleries that are filled with excrement favoring secondary rot. Infested tubers can no longer be used for human or animal consumption and serve as inoculums for secondary infestations. This paper reviews the biology, life history and seasonality of this pest in different regions of Colombia, where potato production has been severely affected because of the presence of this pest. Management of *T. solanivora*, including sampling and monitoring techniques, and the different control tactics (Chemical, biological, cultural and quarantine methods) that have been developed for this pest in Colombia are also discussed here.

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A Simplified and Efficient Technique for Rearing the Exotic Pest *Diaphorina citri* (Homoptera: psyllidae) and its Parasitoid, *Tamarixia radiata* (Hymenoptera: eulophidae)

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The Asian citrus psyllid *Diaphorina citri* Kuwayama is the vector of bacteria *Liberobacter asiaticus* the causal agent citrus greening disease or Huanlongbing, now spread throughout the citrus-growing area of Florida. Biological control using the parasitic wasp *Tamarixia radiata* (Hymenoptera: Eulophidae) is being adopted as a tool to combat the psyllid. We describe a method for mass rearing *Tamarixia radiata* (Waterston) presently utilized in our insectary at the University of Florida/IFAS Center in Immokalee.

Freshly flushing plants are exposed for oviposition to a constant number of caged psyllid adults for 3 days. Plants are removed, cleaned of psyllids, and held until nymphs have reached 4th instar. Infested plants are then placed for 3 days inside another “parental cage” containing a constant population of the wasp continuously renewed. After exposed to the wasps, plants are removed, held in an incubation cage for 4 days (10 days before the emergence), then pruned of infested branches containing the parasitized nymphs (mummies) and placed inside a ventilated acrylic box for emergence. The wasps are then counted and removed easily from the cage using an aspirator connected to a vacuum pump.

The production takes place in a controlled environment room under optimal temperature and humidity (25-27 °C, 60-80% RH, 14 h. light). This system maintained for over 15 generations and a production of 133770 and 69668 individuals of *D. citri* and *T. radiata* respectively.

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**Prodiplosis longifila Gagne: Cecidomyiidae in Peru**

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*Prodiplosis longifila* Gagne belongs to the family *Cecidomyiidae* and is known as “la Prodi”, “la caracha” o “la mosquilla de los brotes”. It is considered a key pest in most of the attacked crops such as asparagus, tomato, potato, marigold, legumes, cucurbits and so on. The level of damage depends on the crop and it can affect yields by up to 100%. It has been also reported in some others hosts, such as weeds.

Prodiplosis is distributed throughout the central and northern coast of Peru. The first time that its presence was reported as a pest was in the 80s decade, initially infecting both tomato and potato crops. Before the 80s, it has been reported but without causing economic damage in the crops.

The insect’s biological cycle is on average 10 to 14 days depending on environmental conditions, being the autumn and spring seasons that most encourages its presence. There are no artificial diets for their rearing so far, consequently studies of its biology are made directly on their hosts.

The damage is produced by the larvae, scraping the epidermal tissue of buds, flower buds, flowers and fruits, but it will depend on the crop attacked. It causes atrophy and deformation in buds which affects the appearance of harvesting fruits.

The way to assess the insect presence of the pest in the field is by counting the number of buds affected or the number of adult insect caught in intersection traps. It has been established in some crops the damage response thresholds for both infected organs and for number of captured insects.

With the help of many technicians, especially in the Chavimochic irrigation (La Libertad, Peru), different control methods such us pressure wash, light traps, sulfur, extracts of garlic and chili, toxic baits, flavorings traps, among others for adult insects and for the larvae chemical controls with clornicotinilos insecticides were developed.

Avoiding soil moisture helps in the control of insect adults since prepupaes falling on the ground are sensitive to lack of moisture, during asparagus cultivation.

The use of foliar fertilizers, to produce the premature fall of flowers, reduces infestive populations since adults oviposit on male inflorescences. By handling homogeneous phenology in representative areas, which have more than 100 hectares, helps with the insect management. As a result it has no place to shelter and then restart a new infestation.

Biological control can be done with the insect *Synopeas spp*: Platygasteridae which is an egg-larvae parasitoid, with 16 to 20% of parasitism. Predators of both larvae and adults are also used but with a minor percentage of efficiency. It has been evaluated that some Entomopathogenics show a low control level.

The insect attacks in most of the crops is devastating, because it has many hosts, overlapping generations and the weather does not represses the insect. Its attacks is very aggressive due to the amount of populations which are generated along the crop phenology.

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Are Coastal Populations of Fire Ants (*Solenopsis invicta*) Preying on or Scavenging Sea Turtle Nests?

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Most coastal ecosystems in Florida have been altered by humans with potentially significant impacts on the success of sea turtle nests and survival of hatchlings. A large number of studies have been conducted on the abundance and distribution of sea turtle nests during their breeding season to determine the extent of damage caused by human encroachment into coastal habitats. These studies point to predators such as canines, raccoons, and fire ants. My two working hypotheses are: (1) fire ant abundance should be higher on private beaches because of reduced human activity and denser vegetation with watered lawns (an intermediate anthropogenic influence) than on natural beaches with sparse native vegetation; (2) sea turtle nests near private beaches are more prone to predation by fire ants than sea turtle nests near natural beaches. Four beaches were selected with public, private or natural habitats (Anna Maria Island, Downtown Saint Petersburg beach, Fort DeSoto park, and Manasota Key). Fire ants were collected and counted using bait traps in transects along the beach from the wrack line to the vegetation zone. Data on sea turtle nests from Manasota Key were analyzed to deduce which predators were major threats to sea turtle nests. The fire ant study showed a significantly higher number of fire ants were captured in natural area beaches compared to public and private beaches. The sea turtle study showed that canines were the top predator of sea turtle nests at Manasota Key; and fire ants had a minimal impact. Contrary to my hypotheses, these studies suggest a higher abundance of fire ants does not necessarily result in a higher predation/scavenging rate on sea turtle nests. Additional data on fire ants and sea turtle predation are needed to support or refute these preliminary results. (Project supported in part by the STREAMS program, USFSP).

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Bromeliad-eating Weevils as Pests of Bromeliads

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Bromeliad-eating weevils (Coleoptera: Curculionidae) are native to the Neotropics. The larvae mine the stems, inflorescences, or fruits of bromeliads. Bromeliad-eating weevils observed in their native habitats on their adapted host bromeliads have not been found to be pests. However, bromeliad-eating weevils can become pests on pineapple plants and ornamental bromeliads as well as on wild bromeliad populations in new lands. One species (Metamasius callizona), originally from Mexico and Guatemala, is an invasive pest on native bromeliads in Florida. Pest situations have arisen either because a bromeliad-eating weevil hitchhiked to a new land on ornamental shipments of bromeliads and became established on wild or cultivated bromeliad populations or because land used for the cultivation of pineapple plants or ornamental bromeliads is located near bromeliad populations that support bromeliad-eating weevils. There are 10 known genera and 42 species of bromeliad-eating weevils distributed throughout the Neotropics. With the continued movement of ornamental bromeliads between countries and insufficient inspection of plants at borders, the potential exists for the movement and establishment of pest bromeliad-eating weevils on indigenous bromeliad populations or on cultivated pineapple plantations and ornamental bromeliads.

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Enhancing Corn Productivity through Integrated Pest Management (IPM) in Rainfed Areas

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In the Philippines, research in rainfed areas (corn) has been very limited and there is an urgent need to increase farm profitability for poverty alleviation without jeopardizing the environment. To address the present dilemma, a field experiment was conducted to enhance further the existing pest management practices in corn production by way of introducing the use of trichogramma, earwigs or the combination of the latter, applied at the right growth stage of corn plants. An alternative mechanical control (light trapping) was also established, to identify other corn pests associated in infesting corn plants during vegetative stage.

On the duration of the study, five treatments were used namely: Treatment 1 – No pest management done, Treatment 2 – Trichogramma (Trichogramma evanescens), Treatment 3 – Earwigs (Euborellia annulata), Treatment 4 – Light trapping, and Treatment 5 – Trichogramma + Earwigs; replicated three times. Specifically it aimed to evaluate the economics and effectiveness of Trichogramma and earwigs in the suppression of corn borers to sustain the production of IES-8906 OPV glutinous corn.

Results revealed that releases of Trichogramma alone or in combination with earwigs obtained the highest number of parasitized egg mass of corn borers at 35 and 45 days after planting. In terms of yield (green glutinous corn) per sampling area it showed highly significant among the different treatments.

Moreover, the results showed that the most effective pest management without jeopardizing the ecosystem is the combination of Trichogramma and earwigs because it revealed high effectivity in the field by exhibiting the lowest number of unparasitized egg mass of corn borers.

Highest return of investment was attained in the combination of Trichogramma and earwigs with a monetary amount of Php 1.78 per peso invested. Remarkably, the use of Trichogramma alone or in combination with earwigs, are as effective as insecticides in controlling corn borer and have greater economic benefit to farmers.

Considering that the typical Filipino farmers are resource-poor the technology on the use of trichogramma and earwigs is recommended. It could help the farmers to produce safer food at a lesser cost of production and even enhance the environment.

Key words: Trichogramma, earwigs, light trapping IPM, predators, parasitized and unparasitized egg mass, biological control, corn borers.

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Experiences with *Planococcus minor* (Hemiptera: Pseudococcidae) etc. in Espírito Santo, Brazil, with Respect to Potential Invasive Pests in General

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*Planococcus minor* is a scale insect belonging to the family Pseudococcidae, members of which are commonly known as mealybugs. As a plant feeding insect not currently known to occur in the United States, *P. minor* is considered to be a potential invasive pest for this country because it is widely distributed and commonly intercepted at US ports-of-entry, it is polyphagous and has been recorded from many economically important crop plants, environmental conditions in the US may be suitable for survival and development of the species, and related species have previously become serious pests after entering this country. *Planococcus minor* is very similar morphologically to the species *Planococcus citri*, a very common and well-known pest, and the difficulty in distinguishing these two species has led to confusion regarding *P. minor*. *Planococcus minor* was initially described in 1897. However, because of its similarity to *P. citri*, *P. minor* was synonymized with *P. citri* in 1925. In 1981, Cox described the species *Planococcus pacificus* and noted morphological characteristics to help distinguish *P. pacificus* from *P. citri*. Subsequently, in 1989, Cox recognized that *P. pacificus* was a synonym of *P. minor*, therefore making *P. minor* the valid name for the species. Thus, *P. minor* has only been known as a distinct species for relatively a short period of time. Because for many years (i.e. 1925-1981) mealybugs with characteristics of *P. minor* were considered to be *P. citri*, many past records of *P. citri* may actually refer to *P. minor*. *Planococcus minor* has been recorded from more than 250 species of plants. However, relatively little is known of *P. minor* as a pest (compared to, for example, *P. citri*). Lack of information of *P. minor* as a pest suggests that *P. minor* rarely causes notable economic damage to crops and is at most an occasional or secondary pest. *Planococcus minor* does occur in Brazil but there are few published records of this species in this country and, as in other parts of the world, little information of this species as a pest in this country. There is a recent report of *P. minor* as a pest of cotton in Brazil but it is noted that specimens identified as *P. minor* in a photograph in the report are apparently a different species. In any case, *P. minor* is known to occur on important crops in Brazil and additional research is needed to study *P. minor* and document its pest status (and natural enemies) in this country as well as in other areas where the species is currently known to occur. Natural enemies are commonly associated with scale insects in the Brazilian State of Espírito Santo, thus contributing to control of these pests, and parasitoids and predators found associated with *P. minor* and other scale insects in this area, including several new species recently described, are noted, as well as the need in areas such as this to avoid inducing outbreaks of pests such as *P. minor* by pesticide misuse or other cultural practices that favor development of pests. Because it is difficult to predict which potential invasive pests will enter the US or other countries, the most efficient way to prepare for such pests may be to support development of international scientific cooperation and collaboration between scientists where potential invasive species occur, including support for research to study specific potential invasive pests where they actually currently occur, so that basic information on specific species will be available if the potential pest does enter a new region, and equally importantly, so that mutually beneficial relationships will be established and appropriate foundations will be in place so that whichever invasive pest enters a new region we will be better able to rapidly develop research where the pest has previously been established to obtain information needed for its management in the new area.

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The Fruit Borer, *Neoleucinodes elegantalis* (Guenée) (Lepidoptera: Crambidae), an Insect Pest of Neotropical Solanaceous Fruits

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*Neoleucinodes elegantalis* is an insect of tropical origin that is distributed from Central to South America (Capps, 1948). It attacks solanaceous fruits such as tomato (*Solanum lycopersicum* Lam.), eggplant (*S. melongena* L.), green pepper (*Capsicum annuum* L.) and some exotic fruits like the tree tomato (*S. betaceum* Cav.) and naranjilla (*S. quitoense* Lam.). In South America, this insect causes losses between 6–70% (Restrepo et al., 2007; Picanço et al., 1999; Marcano, 1990), where nine wild solanaceous hosts have been recorded (Capps, 1948; Picanço et al., 1997, Medal et al., 1996; Diaz, 2009). To control this insect pest, common pesticide applications are made with organophosphate and carbamate insecticides ranked as category IA and IB (Vallejo, 1999). The natural behaviour of the insect makes chemical control inefficient, because the larva is protected by the fruit (Costa Lima, 1949). Its life cycle is 34 days, under 27ºC and 68% relative humidity (Fernandez & Salas, 1985). Initial populations of the insect can be detected with pheromone traps (Cabrera et al., 2001; Badji, 2003; Jaffe et al., 2007) and by the presence of eggs on the fruit sepals (Serrano et al., 1992). The initial damage is recognized by the presence of pimples or orifices on the skin of the fruit, once the larva finishes its life cycle within the fruit, it exits the damaged fruit to pupate on the nearby leaves (Viáfara et al., 1999). The damage by the larvae causes the fruits to fall rendering the fruit unmarketable. The insect’s natural enemies are diverse, abundant and dominant depending on its solanaceous host (Diaz and Brochero, 2009). Several control strategies have been evaluated. Pruning methods achieved a 50% reduction in insect infestation (Silva Júnior and Vizzotto 1986) and sorghum barriers reduce their incidence (Paula et al., 2004). Bagging of flowers and fruits, as a mechanical control practice has been demonstrated to be efficient against this pest (Rodrigues Filho et al., 2001; Jordão & Nakano, 2002, Diaz et al., 2003). Some active ingredients have also been identified, which used in proper dosages during economic threshold levels are known to control the insect populations (Lima et al., 2001, Martinelli et al., 2003, Miranda et al., 2005, Motta et al., 2005). Furthermore, the behavior of the insect has been studied in order to determine the most suitable hours for carrying out insecticide applications (Eiras and Blackmer, 2003). de França et al. (2009) proposed the use of toxic traps with 1% sucrose used in combination with insecticides as a strategy to reduce insect populations. In Colombia, research on genetic resistance through gene introgression from grown wild tomato materials have began (Parra et al., 1997, Restrepo et al., 2007, Salinas et al., 1993). In Brazil, selections have been made to identify tomato materials that are resistant and susceptible to *N. elegantalis* (Lyra & Lima, 1998; & Lara Moreira, 1982, Moreira et al., 1985).

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A National Perspective of the Detection of and Response to Exotic Plant Pests

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USDA APHIS Plant Protection and Quarantine (PPQ) works with Federal agencies, State, tribal and local governments, industries, and stakeholders to implement coordinated actions designed to contain, control, or eradicate invasive plant pests newly introduced into the United States.

In addition to biological and ecological considerations, PPQ and cooperators evaluate several other key factors, including environmental, economic, and international trade implications, in selecting the most appropriate response strategies.

This report summarizes the emergency management framework currently being used in the prevention, preparedness, response, and recovery from invasive pest outbreaks in the United States.

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Avocado Weevils of the Genus *Heilipus*

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Mexico is considered the largest avocado (*Persea americana* Mill) producer in the world, with an annual yield of more than 1 million T per year). Besides, Mexico and Central America are the considered center of origin for avocados as well as the area of origin of several herbivorous insects associated with this tree species. The increasing interest on avocado production, has made an impact on the build up of several of the species of herbivores associated with this crop.

The genus *Heilipus*, is represented by 92 species in the Americas, with 39 recorded from North and Central America and 53 registered in south America. Currently, 8 species of *Heilipus* attack *Persea americana* Mill. In FL, USA, *H. apiatus* Oliver, bore into avocado stems and kill young trees. In México, the large avocado borers, *H. albopictus* Champion and *H. lauri* cause damage to stem and fruits, the first species restricted to a small region of the State of Mexico. In Central America, the stem borer *H. elegans* Guerin is known from en Costa Rica; the fruit borers *H. trifasciatus* Fabricius (=*H. perseae* Barber) and *H. pittieri* Barber af registered in Nicaragua, Costa Rica and Panamá. In Colombia, there are reports of the presence of the fruit borers *H. trifasciatus* and *H. lauri*. However, since *H. lauri*, was not reported by Wibmer & O’Brien (1986) in their catalog of Curculionidae. in South America, it is believed that the insect was introduced into Colombia and that *H. lauri* is a Mexican native species. The species *H. elegans* Guerin, *H. rufipes* Perty and *H. catagraphus* Germar are reported from Brazil. Taking these facts into consideration, the genus *Heilipus* appears to be one of the most common groups affecting avocado orchards in the Americas.

Aspects about description, distribution, biology, damage and control are mentioned.

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Armored scales (Diaspididae) are the largest and most diverse group of scale insects and are found on terrestrial plants on every continent of the world (including Antarctica). They include many economically important pest species of forest, fruit and ornamental crops throughout the world, and are among the most common species found on imported plant products. In their native areas, their population is usually maintained below economic injury levels by their natural enemies; however when the scale is separated from its natural enemies, primarily due to human effort (transported to a new area or by the non-selective use of chemical pesticides), then high infestations of the scale often occur resulting in economic damage. Virtually all of the major armored scale pests in the U.S. and Caribbean Basin are non-native species.

The increase in the diversity and volume of agricultural products being shipped from throughout the world and their rapid movement on the world market has also increased the movement of these pests and the likelihood of their introduction and establishment in the region. A review of the armored species intercepted at U.S. ports of entry between 2007 and 2009 showed that a great majority of the interceptions consisted of a relatively small number of cosmopolitan species. However, several species not known to occur in the U.S and Caribbean Basin, or of limited distribution, were intercepted that could pose a threat to agricultural crops in the region. In addition, there are also other species that are not known to occur in the region but have been recorded on these imported products in their native country, which could also cause economic damage to crops if introduced.

History has shown that when an exotic pest enters and establishes in a country outside its native region, it often takes little time for the species to spread to other countries in the region. Therefore, it is mutually beneficial for those working in quarantine and crop protection in the region to work together to stop or at least slow down the movement of pests that threaten crops in the region. This requires that each country in the region dedicate the resources and train and employ the personnel necessary to inspect, detect and identify pests found on products entering their country, and immediately alert the other countries in the region when an exotic pest is found. The identification of scale insects is almost always based on the adult female and is complicated by the necessity to first clear and stain the specimen before mounting it on a microscope slide for examination under a compound microscope. It requires specialized training to see, understand and evaluate the characters used to distinguish between genera and species and access to identification tools, literature and/or reference a collection. Training, manuals, keys, illustrations, biological information and other tools need to be developed and made available, and communication lines established between crop protection workers in the region, so together we can thwart the introduction and establishment of invasive pests in our region.

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Ecology and Sustainable Management of Major *Bactrocera* Fruit Flies in Goa, India

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*Bactrocera* fruit flies (Diptera:Tephritidae) include some of the world’s most serious agricultural pests. In Goa, mango is an important host for *B. dorsalis* and *B. caryaeae* while, cucumber is an important host for *B. cucurbitae* and *B. tau*. The ecology and phylogenetic relationship of these *Bactrocera* fruit flies was studied in the coastal (15°29′53″ N; 73°54′59″ E), undulating mid land (15°27′16″ N; 73°59′49″ E) and upland (15°21′37″ N; 74°14′39″ E) regions of Goa in Western India. Besides, sustainable management technologies, using Bait Application Technique (BAT) for *B. cucurbitae* and *B. tau* and post harvest management of *B. dorsalis* and *B. caryaeae* using Hot Water Treatment (HWT) in mango to meet local and international plant quarantine standards were developed.

Studies on ecology revealed that *B. caryaeae* dominated the Goa region followed by *B. dorsalis, B. cucurbitae* and *B. tau*. Both in the upland and midland regions, *B. caryaeae* and *B. dorsalis* occupied top two ranks in their occurrence followed by *B. cucurbitae* in upland and *B. tau* in midland. In the coastal region, *B. cucurbitae* occupied the first rank followed by *B. dorsalis, B. caryaeae* and *B. tau*. Further, spatial distribution studies showed that the above fruit fly species were aggregated in nature and followed the negative binomial distribution pattern. Studies on seasonal incidence indicated that *B. dorsalis* and *B. tau* dominated during the monsoon season, where as *B. caryaeae* showed prominent density in the pre-monsoon season while, *B. cucurbitae* showed high incidence in the post-monsoon season. Phylogenetic relationship studies among these fruit flies based on mitochondrial 16s rRNA sequence indicated variations between these *Bactrocera* species in the three geographical regions.

Results on application of food baits to manage *B. cucurbitae* and *B. tau* in farmer’s fields revealed that a mixture of locally available banana and jaggery as bait spray effectively controlled the pest. Treating of *B. dorsalis* and *B. caryaeae* infested mangoes with hot water at 48°C for one hour controlled these flies and is recommended as a post harvest treatment protocol for export of mangoes from India.

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Two Generalist Gall Midge (Diptera: Cecidomyiidae) Pests of Agricultural Crops in the American Tropics

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Two widely distributed species of gall midges are known to infest flowers and buds of various agricultural commodities in the American tropics. The first, *Prodiplosis longifila* Gagné, appears to be native to South America and the Caribbean and has been reported also from Florida. The other, *Contarinia maculipennis* Felt, first discovered in Hawaii, is now known to be Southeast Asian in origin. It has spread to Pacific islands and the Western Hemisphere, including the Caribbean and Florida through commerce. These two species are distinct from one another and from other species in their genera. Pertinent characters used to distinguish between these species and among other species in both *Prodiplosis* and *Contarinia* are illustrated. Proper mounting and access to correctly identified voucher specimens are prerequisites for identification of these species. Their known distribution and hosts are outlined.

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Biology and Management Overview of the Red Palm Weevil, *Rhynchophorus ferrugineus*

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The red palm weevil (RPW), *Rhynchophorus ferrugineus* (Olivier) (Coleoptera: Curculionidae) is a palm borer native to South Asia which has spread mainly due to the movement of cryptically infested planting material to the Middle East, Africa and the Mediterranean during the last two decades. Globally, the pest has a wide geographical distribution in diverse agro-climates and extensive host range in Oceania, Asia, Africa and Europe. The RPW is reported to attack 20 palm species belonging to 16 different genera worldwide. Although it was first reported as a pest of coconut, *Cocos nucifera* in South Asia, it has become the major pest of date palm, *Phoenix dactylifera* and the Canary Island date palm, *P. canariensis* in the Middle East and Mediterranean Basin, respectively. Recent invasions suggest that it is a potential threat to *P. dactylifera* plantations in the Maghreb region of North Africa and a variety of palm species in the Caribbean and southern China. Strict pre- and post-entry quarantine regulations have been put in place by some countries to prevent further spread of this highly destructive pest. Early detection of RPW-infested palms is crucial to avoid death of palms and is the key to the success of any Integrated Pest Management (IPM) strategy adopted to combat this pest. Because signs and symptoms of RPW infestation are only visible during the later stages of attack, efforts to develop early-detection devices are being undertaken. Once infested by RPW, palms are difficult to manage and often die because of the cryptic habits of this pest. However, palms in the early stages of attack can recover after treatment with insecticides. IPM strategies, including field sanitation, agronomic practices, chemical and biological controls and the use of semiochemicals both for adult monitoring and mass trapping have been developed and implemented in several countries. This chapter summarizes the research developed during the last century on different aspects of the RPW including latest findings on its biology, geographic distribution, economic impact and management and prevention options.

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Gall midge infesting hot peppers was declared a pest of quarantine importance in Jamaica in 1998 when larvae were intercepted in shipments of hot peppers from Jamaica to the United States of America (USA). Persistent interception of the insect, identified as *Contarinia* sp., resulted in the imposition of a mandatory fumigation requirement for all peppers from Jamaica into the USA.

Fumigation resulted in additional expenses for exporters, a reduction in the shelf life as well as the quality of the peppers and led to a decline in the production and export of Jamaica’s hot peppers.

In order to regain its hot pepper market and realize the earning potential of this commodity, Jamaica undertook several activities to develop an integrated pest management strategy to prevent export of the pest on consignments. The components of the strategy included activities on: pest identification, surveillance, biology and epidemiology, control measures at the field level, inspection procedures at the ports and the conduct of a pest risk assessment. This paper presents an overview of these activities and an update on the status of the hot pepper gall midge issue in Jamaica.

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Activities of the NAPPO Invasive Species Panel

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The North American Plant Protection Organization (NAPPO) is a regional organization that provides a forum for public and private sectors in Canada, the United States and Mexico to collaborate in the development of science-based standards intended to protect agricultural, forest and other plant resources against regulated plant pests, while facilitating trade. In response to the increase of invasive species cases in North America, and the need to address the problem from a regional perspective, the Executive Committee decided in 2006 to set up an Alien Invasive Species (AIS) Panel to determine what the scope of NAPPO could be on the issue, under International Plant Protection Convention (IPPC) regulations, and to define what constitutes an invasive species on the part of NAPPO’s responsibilities. The panel has been working on the development of documents regarding the risk posed by invasive species to protect the region from AIS. The panel has finished a Regional Standard on Pest Risk Assessment for Plants for Planting as Quarantine Pests and is currently exploring the possibilities to include the potential effects of climate change in existing pest risk assessments and a new North American Standard to address pathway risk analysis alongside the Pest Risk Analysis (PRA) Panel.

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The genus *Copitarsia* (Lepidoptera: Noctuidae) is comprised of six to twenty-one species, depending on the taxonomic treatment. Of its species, only four of these are considered to be agricultural pests: *C. corruda*, *C. decolora*, *C. incommoda*, and *C. naeonoides*. The classification, composition and subfamily placement of *Copitarsia* are all controversial; for example, many publications use taxonomically invalid names for *C. incommoda* (*C. consueta*) and *C. decolora* (*C. turbata*), as well as mistaking one for the other. Further, members of *C. corruda* were originally described as *C. decolora*, and only recently found to be divergent based on DNA-based and morphological characters.

Larvae of *Copitarsia* are highly polyphagous, feeding on 39 crop plants in 19 families. *Copitarsia incommoda* have been documented on cut flowers, rapeseed, and alfalfa, while *C. decolora* have been found on cut flowers, lettuce, peas, beans, cabbage, and potatoes. *Copitarsia corruda* has been recorded on asparagus, asters, and irises. The three pest species overlap geographically in parts of central and South America. *Copitarsia incommoda* is found from Colombia to Southern Chile, eastward to Argentina; *C. decolora* is found in Southern Mexico to Ecuador. *Copitarsia corruda* is found in Colombia, Ecuador, and Peru, though its distribution is poorly known. We discuss the biology and seasonality of these species in their native range, as well as techniques for mass rearing on artificial diet.

In much of their native range, *Copitarsia* species would not be of economic concern to growers were it not for the quarantine treatment requirements imposed by the United States. Sampling these species can be challenging. Eggs and small larvae are difficult to detect, and it is often easier to scout for damage rather than the insects themselves. Pheromone traps have been developed for *C. decolora* and are used in Mexico, but have not yet been standardized for use in Columbia, nor do they capture *C. corruda*. Light traps are commonly used to capture adults; however growers do not have the ability to distinguish *Copitarsia* from the other noctuids also caught in the traps. Control strategies are varied, differ by country and crop, and include insecticides (especially pyrethroids), biocontrol, and the physical removal of eggs by high power water sprays. Results of a probabilistic assessment of the risk of *C. corruda* establishing in the United States when imported on asparagus from Peru are also presented in this chapter.

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Exotic Bark and Ambrosia Beetles (Coleoptera: Curculionidae: Scolytinae) in the United States: Current and Potential Invaders

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Bark and ambrosia beetles are among the most important insects affecting forests and forest products worldwide. The nearly 6000 species of scolytines worldwide infest hundreds of plant species, including conifers, dicotyledons (both woody and herbaceous), monocotyledons (including palms), and ferns. In the continental United States (US) there are about 600 native and 56 exotic species of scolytines.

The life histories and habits of scolytines are extremely diverse. For example, scolytines breed in seeds, cones, pith, phloem, and wood. Some breed in roots, others in trunks, and still others in twigs. Some species feed directly on the host tissues, while others feed on fungal symbionts that grow along the gallery walls (i.e., the ambrosia beetles). Most species complete one or more generations per year. Scolytine adults are somewhat unique in that they tunnel directly into the plant tissues to deposit eggs upon which the larvae usually feed. This paper will focus on tree-infesting scolytines, which usually breed in weakened, dying or dead trees. However, some species infest healthy trees, including some native species, which can lead to significant tree mortality and economic losses.

Except during the short period of dispersal flight, the entire life cycle of bark and ambrosia beetles is spent within the host tissues. This close affinity of scolytines to their hosts as well as the cryptic nature of their galleries has aided more than 100 species worldwide to become established outside their native ranges. Most exotic scolytines have been moved inadvertently through commerce by transporting infested logs, lumber, wood packaging materials, and dunnage as well as seeds, nuts and live plants.

The three exotic scolytines (along with their fungal associates) that have caused the greatest economic and environmental impacts in the continental US include Scolytus multistitius (smaller European elm bark beetle), Xyleborus glabratus (redbay ambrosia beetle), and Xylosandrus crassiusculus (granulate ambrosia beetle). Of the 56 exotic scolytids now established in the US, there is only one species that is the target of a US federal quarantine: Tomicus piniperda (pine shoot beetle).

Scolytines can be monitored with a wide variety of traps and lures, including both pheromones and host volatiles. Several methods have been used to manage scolytines, including chemical, biological, physical, cultural, and regulatory control.

This paper will address the above topics, highlight the current status of Xyleborus glabratus, and discuss the principal scolytines moving in international trade as well as current efforts to reduce human-mediated movement of scolytines and other associated pests.

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Host Range of the Nettle Caterpillar, *Darna pallivitta* (Moore) (Lepidoptera: Limacodidae) in Hawai'i

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The nettle caterpillar, *Darna pallivitta* Moore, of Asian origin, was first discovered on the island of Hawai'i in September 2001. *D. pallivitta* probably arrived as hitchhiking pupae on shipments of Rhapis palm seedlings from Taiwan. *D. pallivitta* evaded eradication efforts and has become an invasive agricultural and landscape pest as well as a human health issue due to its painful sting. Potential host plants in Hawai'i were determined by their ability to support development of larvae into adults. Of the 23 plant species tested, 11 species encompassing eight families were found to support larval development to adulthood; four host species were native plants. Host plant species was a significant variable in larval and pupal development time. In addition, based on field observations of *D. pallivitta* larvae, a feeding list of plant species was compiled, which included 57 species of plants representing 54 genera in 26 families. Feeding preference for monocots (63.2% of observed plants) was consistent with host plant preference for monocots (63.6% of plants offered). Six feeding plant species are native or endemic to Hawai'i. Palms and grasses had the highest representation among species on the feeding list. *D. pallivitta* is highly polyphagous with many common landscape plants serving as hosts, and has the potential to decimate native and endemic plant species in Hawai'i.

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Development of Agricultural Quarantine Inspection and Port Technology to Prevent invasive Pests from Entering on Imported Commodities

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Quarantine inspections and mitigating treatments represent the last line of defense against exotic invaders entering the U.S. in trade commodities. United States Department of Agriculture, Plant Protection and Quarantine, Center for Plant Health Science and Technology (CPHST), Agricultural Quarantine Inspection (AQI) and Port Technology (PT) Program provides the scientific basis upon which agricultural import inspections and treatment technologies are made in order to guarantee the safety of our agricultural imports and promote international trade. The basic responsibilities of the AQI&PT program include developing treatment manual support for ports of entry, certifying vessels and containers for transporting commodities, developing methyl bromide alternatives, maintaining a database for monitoring fumigant usage, certifying international commodity treatment facilities in preclearance programs and developing detection technologies for port deployment, such as chemical sensors, acoustical detectors, and agricultural x-ray technology. A new national CPHST laboratory is currently being developed in Miami, FL. Scientists, co-located at the USDA Agriculture Research Service Subtropical Horticulture Research Station, will develop new commodity treatments and associated technologies, validate AQI and PT developed externally, develop risk management strategies and assessments of risk relative to AQI and develop port inspection technologies.

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Likelihood of Establishment of Diaspidid Scales Legally Entering the United States via the Commercial Fresh Fruit for Consumption Pathway

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APHIS policy since 1985 has been to not mitigate fresh fruit for consumption as a pathway for establishment of armored scales. In 2004, APHIS began allowing entry of commercial ‘Hass’ avocados from Mexico into the US including California. In 2006, California scientists observed armored scales entering California on commercial ‘Hass’ avocados legally entering from Mexico. As a result, APHIS reviewed the armored scale policy and drafted an updated risk assessment which supported the existing policy. In 2007, APHIS convened an expert panel in Los Angeles to review the APHIS armored scale pest risk assessment based on the concerns of California. The expert panel generally supported the risk assessment but called for new studies to bridge knowledge gaps including possible pathways of introduction. APHIS then supported research at the University of Florida to elucidate some of those possible pathways.

The likelihood of armored scale dispersal from infested fruit into hosts located nearby was studied between 2007 and 2009 at the University of Florida, Tropical Research and Education Center, Homestead, FL. One pathway that was studied was the scenario simulating discarding into the orchard environment of infested fruit by consumers. Squash, oranges, tangerines and ‘Hass’ avocados were artificially infested with oriental red scale Aonidiella orientalis (Hemiptera: Diaspididae) and placed in an orchard of avocado trees. Infestation of the trees was observed if discarded fruit was heavily infested, especially if discarded right next to trees. A second pathway studied was the role of fruit handlers in dispersal of crawlers. Brushing of crawlers from heavily infested fruit resulted in an infestation of handler’s clothing.

The above results, along with recent published studies by California scientists, were evaluated by APHIS to determine their impact on elucidating the armored scale pathway for all types of imported commercial fruit, the ‘Hass’ avocado pathway in particular, and the impact on the APHIS armored scale policy. Outcomes of these evaluations will be reported and discussed.

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Surveys for Potentially Invasive Lepidoptera Associated with Avocado Fruit

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Exports of fresh fruit originating from countries where exported fruit are native or endemic typically have associated with them numerous species of insects that have evolved with the plant of interest. Some of these may be well known pests, others may be species new to science and previously unknown to attack the crop, while additional species may be named and known by the scientific community, but their host plant associations are unknown.

These three scenarios, known pests, undescribed pest species associated with an economically important crop, and named species with unknown host plants were encountered during surveys for avocado fruit feeding Lepidoptera in Guatemala. Simple survey work that involved collecting avocado fruit and holding them for the emergence of Lepidoptera species revealed eight species of Lepidoptera associated with fruit: (1) *Stenoma catenifer* (a described species and significant pest of avocados), (2) *Histura perseavora* ([Tortricidae] a previously undescribed and damaging pest species), (3) *Holcocera plagatola* ([Coleophoridae] a previously undescribed opportunistic exploiter of avocados), (4) *Cryptaspasma* sp. nr. *lugubris* ([Tortricidae] possibly a described species that attacks avocado seeds, pest status undetermined), (5) *Amorbia santamaria* ([Tortricidae] a known pest of avocado fruit), (6) *Euxoa sorella* and (7) *Micrathetis triplex* (both noctuids are described species, and opportunistic exploiters?), and (8) *Netechma pyrrhodelta* ([Tortricidae] described species, first record from avocados).

Rearing of moths also allowed the documentation of natural enemy species associated with pest larvae, in particular, parasitoids. This information could prove invaluable for the rapid development of classical biological control programs. Additionally, colonies of the key pest *S. catenifer*, a major avocado pest in Mexico, Central and South America, were established and the sex pheromone was extracted, analyzed, and field tested.

Fruit surveys from exporting countries, like those described here, yield information that is often lacking for pest species associated with fruit that pose incursion risks for importing nations. This problem is particularly acute when species are unknown, and there are no detection tools available, like sex pheromones, that can be used to monitor exporting orchards, and also to rapidly detect incursion events in importing countries.

It is recommended that thorough fruit surveys for lepidopteran pests be conducted by countries petitioning for export privileges to countries that have domestic plantings of the same crop. This is especially important in areas where the exported crop is native because of the likely high diversity of herbivores that have evolved with the crop. These survey data will provide an inventory of pest species (described and undescribed species), their associated natural enemies, and when possible, provide opportunities for the development of pheromone monitoring tools. Pheromones can be used in exporting orchards to certify pest-free status, and for incursion detection in importing nations for key pest species identified from field surveys.

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**Solenopsis invicta** as a Potential Biocontrol for *Aedes aegypti*

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*Solenopsis invicta*, more commonly known as the fire ant, is an omnipresent invasive species in Florida, and across much of the entire southern half of the United States. Control efforts throughout its history as an invasive pest have largely focused on pesticides, which not only are inefficient, but are also known to harm the environment. The most common of these chemicals is cypermethrin. It behaves as a fast-acting neurotoxin in insects. It is easily degraded on soil and plants but can be effective for weeks when applied to indoor inert surfaces. Cypermethrin is highly toxic to fish, bees and aquatic insects.

Bioaccumulation refers to the accumulation of substances, such as pesticides, or other organic chemicals in an organism which occurs when an organism absorbs a toxic substance at a rate greater than that at which the substance is lost. Thus, the longer the biological half-life of the substance the greater the risk of chronic poisoning, even if environmental levels of the toxin are not very high. Repeated exposure to very low levels of toxins in these environments can be lethal over time. In order to limit the potential for the abuse of chemicals, such as cypermethrin, which lead to these negative effects, this study probes implications from previous work which has shown that fire ants are capable of walking underwater and also that they prey on *Aedes aegypti* larvae, the adult mosquito of which is known for spreading yellow fever, dengue fever, and other diseases. The intent is to quantify the possibility that the fire ant is a potential biocontrol for mosquito populations. Building on a previous pilot study showing that fire ants are capable of aquatic predation behaviors, an experimental design was implemented in which mosquito larvae were placed in varying depths of water to serve as prey for a colony of fire ants. The results show that shallow depths of water do indeed induce the aquatic predation behaviors of fire ants. The conclusion drawn is that the fire ant could act as a cheap and effective biocontrol for mosquito populations and thus lower the need for the use of toxic chemicals in controlling the populations of fire ants, thereby saving both money and time spent on medical expenses treating chemical exposure. It is recommended that that further studies be pursued in regards to the aquatic predation behaviors of fire ants, particularly in that there is a potential for reduction in the use of another potentially harmful chemical, sumithrin, a synthetic pyrethroid used in mosquito control more commonly known as Anvil.

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Emerging Psyllid Genome, RNA-interference and Insect Biology

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Psyllids are major disease vectors of many fruit tree crops yet their genetics have remained poorly studied. Insect genomics has advanced insect management by examining gene function and biological pathways. Invasive pests are often subjected to genetic analysis which can identify species more accurately for classification, thus expediting the proper application of pest management regulations. Currently the invasive pest, Diaphorina citri (Hemiptera: Psyllidae), the Asian citrus psyllid, ACP, is a highly competent vector of the phloem-inhabiting bacterium Candidatus Liberibacter asiaticus, associated with Huanglongbing, HLB (aka. Citrus Greening Disease). HLB threatens the US citrus industry due to losses in fruit yield, palatability, and tree death. Research efforts underway on psyllid genomics are providing information to aid the development of strategies to suppress ACP populations. Some of this information is targeting immunity genes in psyllids. Production and mining of psyllid cDNA libraries identified several genes which function in psyllid responses to stress such as temperatures, insecticides, and disease (e.g. heat shock proteins, hsp70, hsp90, cytochrome P450’s, Glutathione-S Transferase, Cu-SOD, Toll and others). Data mining identified homologous genes and quantitative RT-PCR was used to further examine transcript expression in response to heat shock, wounding and insecticide (imidacloprid) treatments. The production and application of psyllid genomic data provides the means to rapidly analyze genetic responses of ACP to these and other biological stresses. Further applications of the psyllid genome are being applied to develop RNAi, gene disruption methods to more effectively suppress ACP populations to reduce the spread of HLB in citrus.

Gas Chromatography for Detection of Citrus Infestation by Tephritid Fruit Flies

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Tephritid fruit flies are serious economic pests worldwide. As larvae, they feed and develop within the pulp of host fruits, making infestation difficult to detect by visual inspection. At U.S. ports of entry, incoming produce shipments are checked for infestation by manually cutting open a small sample of fruit and searching for tephritid larvae. Consequently, there is a need for more sensitive, high-throughput screening methods. This study evaluated gas chromatography (GC) as a potential technology for improved detection of hidden infestation. Grapefruits (*Citrus x paradisi* Macfad.) infested with immature stages of the Caribbean fruit fly *Anastrepha suspensa* (Loew) (Diptera: Tephritidae) were examined to determine if infested fruit emitted a chemical profile distinct from that of non-infested fruit. Peaks identified by GC analysis were grouped into three classes. Chemicals detected in similar quantities in all samples, or slightly elevated in infested samples, were regarded as non-diagnostic background volatiles. Chemicals highly elevated after oviposition, during the last instar exit stage, and in experimentally-pierced fruit were interpreted to be indicators of citrus peel injury, and included D-limonene and β-ocimene. Chemicals elevated exclusively in the larval stages were considered indicators of feeding damage and potentially diagnostic of infestation, and included hexyl butanoate and an unidentified compound. The peaks associated with injury and feeding were also detectable with a portable ultra-fast GC analyzer that required less than 80 sec per sample. Further studies will investigate the potential application of these results for development of a rapid, non-destructive screening method for detection of tephritid infestation.

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The Citrus Orthezia, *Praelongorthezia praelonga* (Douglas) (Hemiptera: Ortheziidae), a Potential Invasive Species

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Information on the biology, taxonomy, geographical distribution, and methods of control of the citrus orthezia, *Praelongorthezia praelonga* (Douglas), is presented. The citrus orthezia belongs to the scale insect family Ortheziidae (order Hemiptera), in which species commonly are called ensign scales. Currently there are 202 species of ensign scales described, including eight fossil species. Adult females of Ortheziidae are defined by a distinctive long ovisac and waxy symmetrical plates on the dorsum and margin.

The citrus orthezia is likely of Neotropical origin, and occurs in the Caribbean, and in Central and South America. It is highly polyphagous, and has been recorded on more than 60 host plants in 30 plant families. *Praelongorthezia praelonga* can cause severe infestations associated with sooty molds and dieback of branches of its hosts. Most biological information on this insect has been published in Spanish in journals and reports that are not readily available in North America. The life cycle of *P. praelonga* was previously studied by Restrepo *et al.* (1991) under field conditions in Colombia. The eggs hatch about 7 days after they are laid, and the female goes through three immature stages, i.e., first-instar nymph or crawler, second- and third-instar nymph, with each stage lasting for 31, 35 and 64 days respectively. The male prepupa lasts for an average of 32 days. The male pupal stage lasts between 4 or 5 days. The winged adult males are small, grayish-blue in color, live up to 8 days and are quite active fliers. The females live for up to 90 days. An adult female can lay between 85 to 106 eggs. Due to its wide host range, *P. praelonga* may be considered an insect pest with a potential for becoming an invasive species outside its area of current distribution. However, in contrast to many invasive scale insect species, *P. praelonga* has a lengthy life cycle and is a relatively large insect (body about 2 mm long, with ovisac up to 6 mm long), making it easier to detect in quarantine inspections. Also it reproduces sexually, which means that single nymphs or unmated females are unable to start new infestations. In its native range, at least in Colombia, the citrus orthezia appears to be kept under control by various natural enemies, including *Hyperaspis* sp. (Coleoptera: Coccinellidae); *Ambracius dufouri* and *Proba vittiscutis* (Hemiptera: Miridae); *Chrysopa* sp. (Neuroptera: Chrysopidae) and a fly species identified as Drosophilidae of which the larvae feed on the ortheziid eggs (Velásquez *et al.*, 1992). The fungus *Colletotrichum* sp. also has been found causing natural death of the insect (Garcia 1995). However, the common use of chemical control often results in the breakdown of the ecological balance between *P. praelonga* and its natural enemies, resulting in outbreaks of this pest. For the control of the citrus orthezia, an integrated management strategy that combines the use of insecticidal soaps, oils, cultural and biological control methods is recommended.

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Many potato pests have evolved in the center of origin of potato (*Solanum* sp.) in the High Andes of South America and have become invasive worldwide. The potato tuber moth (*Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae)) is today reported from more than 90 countries and considered the most damaging potato pest in the developing world. The leafminer fly (*Liriomyza huidobrensis* Blanchard (Diptera: Agromyzidae)), which is highly polyphagous, is reported from 66 countries. Climate, especially temperature, has a strong and direct influence on insect development, reproduction and survival and is considered the dominant abiotic factor directly affecting herbivorous insects. Climate change might also dissociate predator-prey relationships, because of a higher sensitivity of higher trophic levels to climatic variability or of different temperature optima compared with pests. This might cause a disruption of the temporal or geographical synchronization of pests and its natural enemies, increasing the risk of host outbreaks.

Understanding future shifts in pest range and damage is crucial for any strategy to manage plant health. We apply temperature-driven pest phenology modeling and risk mapping in a Geographic Information Systems (GIS) environment as an innovative tool to assess and understand how pests may spread across regions. Process-based phenology models that include a number of experimentally established functions to describe temperature-driven processes such as development, mortality, reproduction, etc., in insect species, were used to simulate species’ population growth potentials (life-table parameters) for a locality (grid point) over time. For spatial analysis of pests’ risk generic risk indices (Establishment Index, Generation Number and Activity Index) can be mapped for an area/region of interest according to real or interpolated grid point-based or simulated temperature data. For the potato tuber moth, it could be predicted that temperature increases of 2-3°C will cause a northward expansion of about 400-800 km in the northern hemisphere and expansion to higher altitudes in tropical mountains. For Peru, i.e., that due to global warming, the pest could affect potato at higher elevations and thus increase the total area of infestation from 120,398 ha to 179,178 ha (67% of the total potato area) until the year 2050.

The approach used in these studies can be principally used to assess the potential distribution and risk of other insect species. CIP developed the software program “Insect Life Cycle Modeling” (ILCYM - version 2.0) that facilitates the development of further insect models using a “model builder” and provides analytical tools for model validation and pest risk mapping. Presently, CIP is leading a collaborative effort with its partners in Africa to assess the vulnerability of agricultural systems to major insect pest and to identify adaptation strategies to cope with future pest problems. The impact of increased temperature is also studied on selected pests’ natural enemies to provide clues for the future resilience of agricultural systems to cope with pest problems. The results should fill the current knowledge gaps about climate change effects on economically important insect pests, especially in the tropics.

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Fecundity of Ficus Whitefly, *Singhiella simplex* (Hemiptera: Aleyrodidae), and its Predation by *Delphastus catalinae* (Coleoptera: Coccinellidae)

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Ficus Whitefly (*Singhiella simplex*) was first reported in Miami-Dade County in August 2007. This invasive pest causes infested plants to exhibit leaf yellowing, followed by leaf drop. The pest has been recorded on multiple ficus hosts including *Ficus benjamina*, *F. altissima*, *F. bengalensis*, *F. microcarpa*, *F. aurea*, *F. lyrata*, and *F. maclandii*. Little information is known about ficus whitefly’s reproduction and development or its potential to be controlled by natural enemies currently present in Florida. We report on reproductive parameters measured under four different temperature regimes (15°, 25°, 27°, and 30°). In addition, predation rates of the predator *Delphastus catalinae* are presented for three lifestages of ficus whitefly [eggs, small nymphs (2nd-3rd instars), and large nymphs (4th instar-pupae)]. Results from these studies will be used to develop future management strategies.

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Sex Pheromone Tools for Detection, Management and Control of the Tomato Leafminer, *Tuta absoluta* in South America, Europe and Mediterranean Countries

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The tomato leafminer, *Tuta absoluta* (Lepidoptera: Gelechiidae) is a serious pest of tomato, potato and other solanaceous crops. Larvae feed on all parts of tomato plants and can cause severe crop damage. Larval mining activity extends to all portions of the plant including fruit, and spans the entire growing cycle of the plant. *T. absoluta* has an extremely high reproductive capacity and damage can reach 100% in severely infested areas, causing substantial losses for growers. Intensive use of insecticides to control this devastating pest of tomatoes has generated numerous cases of resistance including pyrethroids, methamidophos and cartap in South American countries. *T. absoluta* was first reported in 2006 on tomato crops in Spain. Since then *T. absoluta* has been spreading rapidly throughout Europe, especially in Mediterranean countries. In 2009 *T. absoluta* was officially reported in France, Italy, Tunisia, Malta, Libya, United Kingdom, Greece, and Switzerland. According to Animal and Plant Health Inspection Services (APHIS), *T. absoluta* poses a serious threat to U.S. agriculture. APHIS has imposed new restrictions to shipments of field-grown green tomatoes from Algeria, France, Morocco, and Spain to prevent the introduction and establishment of *T. absoluta*.

The major component of the sex pheromone of *T. absoluta*, (3E,8Z,11Z)-3,8,11-tetradecatrien-1-yl acetate, was identified by Attygalle et al. in 1995, which resulted in a patent that ISCA Technologies retains the exclusive rights to. Since then, it was found that the pheromone lures are essential tools for early detection of *T. absoluta* in new areas, as well as an essential component in the development of novel, effective, environmentally friendly tools and solutions to control and prevent further spread of this invasive pest into new areas.

Here we will present historical data on the development of tools for the early detection and monitoring of *T. absoluta* in South American tomato fields, as well as in Europe and Mediterranean countries. Over the years several semiochemical management strategies have been attempted to control *T. absoluta* in field situations including mass trapping, mating disruption and attract and kill techniques. The authors discuss the relative effectiveness of different formulations in controlling this insidious pest of solanaceous plants.

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Three Tephritid Fruit Fly Species that Pose a Threat to Florida:  
*Bactrocera carambolae*, *B. invadens*, and *Anastrepha grandis*

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Tephritid fruit flies include the most destructive pests of fruit and vegetables produced throughout the world. Many of the most important pest species are also notable for their proven ability to move to and colonize new geographic areas. Arguably the most destructive of these is the Oriental fruit fly (*Bactrocera dorsalis*). This species has, in recent decades, been found to be a species complex, and two members of this complex have become significant pests and are spreading to new areas. One, the Carambola fruit fly (*Bactrocera carambolae*) was detected in Suriname in 1985, with specimens later found dating from the 1970’s. It has since spread to Guyana, French Guiana, and northern Brazil and now threatens the other areas of Brazil as well as Venezuela, Colombia, the Caribbean, and Central America. Another, the Invasive fruit fly (*Bactrocera invadens*) was found in Kenya in 2003, and quickly spread throughout much of Africa and has been found in several Asian countries (Bhutan, India, and Sri Lanka), where it is likely native. It is a very aggressive pest of mango, citrus and with reports (now in some doubt) about its ability to infest green bananas. It is a very good colonizer and appears to be outcompeting previously established fruit fly pest species. Males of both *B. carambolae* and *B. invadens* are attracted by the methyl eugenol, a powerful sexual attractant, and can be effectively detected using any fruit fly trap, though Jackson traps are the most common. Methyl eugenol is also the basis for control of these species, using bait stations to conduct male annihilation.

Anastrepha is one of the most diverse genera of fruit flies in the new world, and many of the more than 200 described species are pests. *A. grandis* is a pest of the fruits Cucurbitaceae in many areas of South America and has recently been found in Panama (2008). It is considered a pest of quarantine significance by USDA-APHIS, and this large (thus its name) tephritid causes significant damage to squash, melons, and other cucurbit crops grown commercially in South American countries. There are also records of *A. grandis* attacking watermelon and cucumber. There are no sexual attractants for *A. grandis* (or any Anastrepha species) and experiments are planned for June, 2010 to study the typical attractants used in McPhail traps. Previous studies have found McPhail traps baited with protein hydrolysate to be the best trapping system.

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Biology and Population Dynamics of Ficus Whitefly, *Singhiella simplex*

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In 2007, a whitefly [*Singhiella simplex* (Singh) (Hemiptera: Aleyrodidae)], new to North American continent, was reported attacking ficus trees and hedges in Miami-Dade County, Florida. Currently, this pest can be found in 16 Florida counties. Feeding by this whitefly causes leaf yellowing and massive defoliation. Branch dieback can also occur, but the extent of dieback is highly variable. This pest has only been reported on ficus species and has been reported on many of the common landscape species in south Florida with *F. benjamina* being a particular favorite. Ficus species determined to not be hosts include *F. microcarpa* “Green Island”, *F. religiosa*, *F. carica* (edible fig), *F. lyrata*, *F. pumila* (= *F. repens*), and *F. elastica* “Burgundy”. The whitefly life cycle is approximately one month under laboratory conditions and is affected by colder temperatures. Cooler temperatures can double the time for eggs to hatch and extend the life cycle. The adults live for only a few days. Sticky traps placed at different locations and directions have been used to monitor populations for more than one year which show the populations to be somewhat cyclical on a monthly basis. Populations have not yet fully recovered since the freeze in the winter of 2010.

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New Whiteflies in the Landscape in South Florida

Catharine Mannion and Holly Glenn
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In recent years, two whiteflies new to the North American continent have been reported in south Florida; the ficus whitefly, \( \text{Singhiella simplex} \) (Singh) (Hemiptera: Aleyrodidae) and the gumbo limbo spiraling whitefly \( \text{Aleurodicus rugioperculatus} \) Martin (Hemiptera: Aleyrodidae). The ficus whitefly only attacks ficus species and can cause severe defoliation and branch dieback. The gumbo limbo spiraling whitefly has a wide host range of ornamental and tropical fruits and the host plant list continues to grow. It is most notable due to the excessive amount of wax production. Another newly described whitefly species, \( \text{Dialeurodes schefflerae} \) (Hemiptera: Aleyrodidae), was identified attacking schefflera and is consistently the most prevalent whitefly on dwarf schefflera grown in Florida. And, lastly, Cardin’s whitefly \( \text{Metaleurodicus cardini} \) (Back) (Hemiptera: Aleyrodidae) has been known in Florida since 1917, however, in recent years there have been numerous outbreaks of this whitefly on Duranta sp. in south Florida. An update on these whiteflies will be discussed in this poster.

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Potential Invasive Pests Workshop

Recent Mite Invasions in South America

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Phytophagous mites are prone to become invasive pests in agricultural systems because they may be harmful to host plants, may act as vectors of plant diseases, quickly develop resistance to pesticides, are difficult to detect, are able to survive adverse conditions, reproduce parthenogenetically, and may adapt to new host plants. During the last years, South America has been the scenery for several plant mite invasions that threat fruit, ornamental and extensive crops as well as native species in natural areas.

A recent example of an invasive plant mite in South America is \textit{Schizotetranychus hindustanicus} (Hirst), commonly known as Citrus Hindu Mite (CHM) or Citrus Nest-Webbing Mite. This species was originally described on citrus from South India, in 1924. For a long period its presence had not been reported in any other continent or even in other countries. However about 80 years later its description, this mite was found in Zulia, Northwest Venezuela, in 2002. After that in February 2008 atypical symptoms on leaves and fruits of \textit{Citrus latifolia} and \textit{C. lemon} trees were observed for small farmers or domiciliary orchards in urban areas in the municipality of Boa Vista, Roraima, North Brazilian State in the border with Venezuela. Numerous spider mite colonies, identifies as being the HCM were found in these plants, mainly on the upper leaf surface and fruits. Adults and immature stages are yellowish with dark internal spots along the body. Females are 400 to 500 \(\mu\)m long. The male is smaller, pear-shaped and paler than female, presenting distinct red eyes.

Symptoms due to CHM infestation in Brazil consisted in circular whitish spots on leaves and fruits, with 1-3 mm in diameter, uniformly distributed occupying the whole infested tissue, what results in a peculiar aspect. Sometimes the entire crown is affected. The common name “Nest-Webbing Mite” is related to the female behavior, which spin circular fine webs under which they lay eggs. The emerging larvae and nymphs feed upon the cells and tissue protected by the web, whereas the adults remain or not under the nest-webbing for feeding. Up to now there is no information on quantitative losses caused by \textit{S. hindustanicus}, however severe damage on citrus leaves and fruits have been reported in Venezuela. It is clear that the mite produces a reduction on the esthetic value of fresh fruits due to the conspicuous symptoms associated with the mite infestation. Right now the occurrence of CHM in Brazil is restricted to urban and rural areas of Boa Vista municipality, Roraima. Phytosanitary measures have been adopted to avoid CHM dissemination to the main citrus production areas that are in Southeast and Northeast Brazil. Evaluations of host plants and associated predatory mites have been initiated in Brazil. Studies on population dynamics on different citrus varieties and biology have been recently conducted in Venezuela.

Other examples of recent invasive plant mites in South America are the Red Palm Mite, \textit{Raoiella indica} Hirst, mainly on banana and coconut; the rice mite, \textit{Steneotarsonemus spinki} Smiley, on rice crops; the litchi erinose mite, \textit{Aceria litchii} (Keifer), on litchi; the hibiscus erinenum mite, \textit{Aceria hibisci} (Nalepa) on hibiscus; and the wheat curl mite, \textit{Aceria tosichella} Keifer on cereal and other grasses. Information on host plants, occurrence areas, damages and prevention or control measures of these invasive mites in South America are presented.

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Olfactory Responses of Male Medflies to Plant Material Containing the Parapheromone α-Copaene

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The Mediterranean fruit fly Ceratitis capitata (Wiedemann) (Diptera: Tephritidae) is a highly invasive species that is considered the most adaptable and polyphagous species of tephritid fruit fly due to its global distribution and its broad range of host plants, primarily tropical and subtropical fruits and vegetables. Ceratitis capitata is presently ranked first among economically important fruit fly pests, due to both damage to crops and costs of eradication. Trimedlure is a synthetic chemical that is highly attractive to male medflies and is the standard male-targeted lure used for this species. Medfly response to trimedlure is similar to response to the sesquiterpene α-copaene, a widely-distributed plant compound, and males respond to both host and non-host sources that contain α-copaene. Although α-copaene is reported to be 2 to 5 times more attractive than trimedlure, difficulties in obtaining synthetic α-copaene in sufficient quantities for large-scale trap deployment have prevented its use as a lure. Early research on substrates containing α-copaene has shown that different sources produce a wide array of responses, from arrestant behavior near the source, to short-range and long-range attraction. As part of a study on sesquiterpene content of tree cambial tissue, we found that cambial (cambium+bark layers) tissue from avocado, Persea americana, contained α-copaene, and that levels were highly variable among different genotypes. Therefore, studies were initiated to determine if these sources of α-copaene were biologically active for male medflies. For comparative purposes, results were compared with responses to cambial tissue from Litchi chinensis and Ficus benjamina, two substrates known to elicit behavioral responses in male medflies.

Behavioral bioassays and electroantennography (EAG) were used to evaluate responses of sterile male medflies; and GC-MS analysis was used to quantify the amounts of 13 sesquiterpenes, including α-copaene, in cambial tissue from four avocado genotypes, from Litchi and from Ficus. Litchi elicited the highest response and Ficus the lowest response, with cambial tissue from the avocado genotypes eliciting intermediate responses that varied significantly among the four types in both the bioassays and EAG experiments. These responses, however, were not correlated with the amount of α-copaene. Additional sesquiterpenes may be responsible for the high responses observed with the low α-copaene substrates. Identification of these chemicals may provide a new understanding of the biological basis for the response of male medflies to these wood sources, which could lead to development of new tools for improved detection and control.

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Managing the Invasive Species Risk in the Ornamental Industry

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Florida, California and Hawaii are on the front lines when it comes to the war with invasive species. One study documented the Florida invasion at more than one new arthropod species becoming established in the state each month with California estimated to be one every other month. This does not mean a pest was just detected in someone’s baggage or on produce from another country, but that the species is living and breeding in the state. Not all of the insects, mites or spiders become pests but many do and influence our daily lives.

We can think of IPM and the threat of invasive species by using a framework developed for the discipline of Risk Management. Wikipedia defines Risk management as “the human activity which integrates recognition of risk, risk assessment, developing strategies to manage it, and mitigation of risk using managerial resources.” The objective of Risk Management is to add maximum sustainable value to all the activities of an organization. If we tweak the definition and its objective we get a conceptual structure for the threat of invasive species and a new definition for IPM: IPM is an activity which integrates recognition of risk, risk assessment, developing strategies to manage it, and mitigation of risk using all available tools and resources with the objective of obtaining the maximum sustainable value from all the activities of the agricultural enterprise.

In this talk we will briefly discuss how this framework fits our response to a few recent invaders.

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Bioecology and Biological Control of *Stenoma catenifer*

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We will show a rearing technique used to provide a constant supply of *Stenoma catenifer* throughout the year under laboratory conditions, to support research into the bioecology, behavior and biological control of this insect pest, proving ground information required for setting up control strategies within the IPM concepts.

The avocado seed moth required the association of chemical (avocado fruit) and physical (paper towel with depressions) stimuli for egg-laying. The oviposition occurred during the scotophase, with 80% concentrating between 8 p.m. and 12 p.m.

The avocado seeds were the most suitable substrate for *S. catenifer* rearing, but a white bean, carrot and yeast-based artificial diet could replace the natural food (seeds). For adults, water or a 10% honey solution was required in the cage for higher longevity and fecundity.

The duration and viability of the different developmental stages of the avocado seed moth varied according to the temperature, with a decrease in viability and fecundity at high temperatures (30 and 32ºC). Male and female longevity was higher at 20ºC as compared to 25 and 30ºC. The temperature threshold (Tt) and the thermal constant (K) for the egg to adult stage were 8.9ºC and 644.5 GD, respectively, varying according to the development stage. Based on the thermal requirements, 7.8 annual generations and 5.1 generations per production cycle were estimated for the region of São Tomás de Aquino, MG. The dynamics of *S. catenifer* can be an indicator of the number of generations based on the pest’s thermal requirements.

Five Braconidae (*Dolichogenidea* sp., *Hypomicrogaster* sp., *Apanteles* sp., *Chelonus* sp. and *Hymenochaonia* sp.) and two Ichneumonidae (*Eudeleboea* sp. and *Pristomerus* sp.) parasitoids were found parasitizing *S. catenifer*, with *Dolichogenidea* sp. and *Apanteles* as the most frequent ones.

The parasitoid emergence peak was observed in August, when larval parasitization reached 30%. The population of *S. catenifer* increased from December through July, and a 60% fruit attack was recorded towards the harvest. The highest percentage of attacked fruits had one to four larvae. The losses caused by the borer varied towards to the late agricultural season may reach 27%. Bagging infested fruits was an adequate cultural method to reduce the population size of *S. catenifer*, and larval mortality in these fruits was proportional to the temperature at the time of bagging.

Strains of *Trichogrammatoidea annulata* and *Trichogramma atopovirilia* were selected due to their higher parasitization on *S. catenifer* eggs. Under semi-field conditions, the highest parasitism was verified with a ratio of 28 and 30 parasitoids per egg, respectively for *T. annulata* and *T. atopovirilia*.

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Bioecology and Biological Control of *Tuta absoluta*

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Several natural and artificial diets were evaluated as rearing substrates for *Tuta absoluta*. Tomato leaves of the ‘Santa Clara’ cultivar was the most adequate diet for rearing *T. absoluta*. Among the artificial diets tested, the best was the one containing wheat germ, casein, yeast, soybean and white common bean plus powdered-tomato leaves.

The diet showed a phagostimulant effect, low larval mortality and promoted higher total viabilities. The number of larval instars was constant and equal to 4, both on natural and artificial diets, indicating the artificial diets tested were nutritionally suitable for *T. absoluta* rearing.

Temperatures ranging from 18 to 25°C were the most suitable for rearing *T. absoluta*. Taking into consideration the thermal requirements of this insect on artificial diet, the number of annual generations was estimated to be 5.8 to 9.0 on regions with temperatures between 20 and 25°C. The egg to adult thermal constant for insects reared on an artificial diet was 575 degree days.

Parameters of fertility life table were compared using the “Jackknife method” estimates of variance. The natural diet (tomato leaves) was the most adequate diet for rearing *T. absoluta*. Among the artificial diets, the best one was composed of white common bean plus powdered tomato leaves, and the worst one of ‘Pintado’ common bean. Paper covered with visual (green polyethylene) and olfactory (liquid leaves extract) attractives was the most suitable oviposition surface and can replace tomato leaves normally used on laboratory rearing methods.

The feasibility of *T. absoluta* control has been shown in Brazil by using the egg parasitoid *Trichogramma pretiosum* in greenhouse, sprawling and staked tomatoes.

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The African Fig Fly: Surveys to Ascertaining the Status of an Invasive Pest in the US

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The African fig fly, Zaprionus indianus Gupta (Diptera: Drosophilidae) a native of Africa invaded Florida around 2005 where it was collected from longan Dimocarpus longan Lour., and Barbados cherry, Malphigia emarginata Sessé & Moc. During 2006 and 2007 a survey was conducted in Miami Dade County to assess levels of infestation of this pest on tropical fruits and a vegetable, i.e., Atemoya, sugar apple, avocado, banana, carambola, grapefruit, guava, litchi, longan, mango, orange, sapodilla, spondias, Surinam Cherry, tangerine, tomato, wampee, and wax jambu. The plant species tested that produced negative results as hosts of Z. indianus were, Atemoya, sugar apple, avocado, banana, carambola, grapefruit, litchi, and mango. Guava and longan showed infestation of the fly, but the infestation level appeared to be linked to fruit ripeness or to previous fruit injury. Z. indianus was also collected from Loquat, Surinam cherry, spondias, wampee and oranges, however, it was unknown if the infestation was secondary and caused after infestation by other pests, i.e., Caribbean fruit fly, Anastrepha suspensa. A more thorough investigation of the host status for all these fruit species needs to be conducted to ascertain Z. indianus pest category.

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Dispersal Patterns of *Brevipalpus phoenicis* from Citrus Fruits

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*Brevipalpus* mites, including *Brevipalpus phoenicis* infest citrus trees and can vector citrus leprosis virus. *Brevipalpus* that may vector this virus have a broad plant host range (e.g. citrus, grapes). Countries that wish to export their commodities to the United States, and have the mites as well as the virus, must have the commodity be mite-free before it is exported to the United States. During January 2010, *Brevipalpus* infested lemons were placed on the ground in a field the 4 compass directions and at different distances from citrus trees. The number of mites was drastically reduced within 14 days of placement of the infested fruit in the field. Less than one mite per lens on the fruit were observed during 21 and 28 of field exposure. This indicates that the focus of mite infestation in the field is reduced 14 days after fruit placement in the field. However, during repetitions of this experiment, the highest number of mites recorded on a tree that was on a tree that was directly in contact with an infested fruit. Height of the fruit as source of infestation did not appeared to play a role on dispersion patterns of the mite. Lab studies showed that the mite can be dispersed by wind currents. The role of fruit stage, i.e., fresh fruit vs. rotten fruit, presence/absence of phoretic vectors i.e., fruit flies, vinegar flies, whiteflies on discarded fruit is discussed.

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Lyprauta spp. (Diptera, Keroplatidae) in Orchid Greenhouses in The Netherlands

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Two Keroplatidae species, one of which not described earlier, were identified in greenhouse grown orchids in The Netherlands: Lyprauta cambria (Chandler) and Lyprauta chacoensis (Edwards). They were associated with root damage, leading to excessive ramification and rotting.

The broad spectrum insecticides carbofuran, deltamethrin, dimethoat, malathion, methiocarb, methomyl, oxamyl and pirimifos-methyl, were found effective against the larvae in a laboratory setting, while all selective compounds, preferably used in Integrated Pest Management, failed. The entomopathogenic nematodes Steinernema feltiae and Heterorhabditis bacteriophora reduced numbers in the laboratory, but not in greenhouse tests.

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Biological Control of *Diaphorina citri* (Hemiptera: Psyllidae) with the Parasitic Wasp *Tamarixia radiata* (Hymenoptera: Eulophidae) in Florida

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The Asian citrus psyllid (ACP), *Diaphorina citri* Kuwayama is an efficient vector of the bacterium *Candidatus Liberibacter asiaticus*, the causal organism of the Asian form of huanglongbing (HLB) also known as citrus greening disease. ACP and HLB were identified from Florida in 1998 and 2005, respectively. Biological control is an important component of integrated pest management and has been effective in controlling ACP in the islands of Reunion, Guadaloup and Puerto Rico. *Tamarixia radiata*, a species specific ectoparasitoid of *D. citri* was imported from Taiwan and Vietnam and released in Florida in 1999. Studies conducted during 2006-2007 showed that the parasitoid was established throughout the citrus growing region of the state, but parasitism rates were variable, averaging <20% during spring and summer and increasing to 39% in September and 56% in November in the central and southwest regions. However, 80-100% mortality was observed in the cohorts of psyllid immatures that were exposed to natural mortality factors and was attributed mainly to generalist predators particularly ladybeetles *Olla v-nigrum*, *Curinus coeruleus*, *Harmonia axyridis*, and *Cycloneda sanguinea*. A colony of the previously imported and established strain of *T. radiata* was maintained at the SWFREC Immokalee, FL, and 105,368 wasps were produced between March 2009 and April 2010 for field release, behavioral studies at SWFREC, Immokalee, and Citrus Research and Education Center, Lake Alfred, and to initiate and maintain a colony for a commercial citrus grower. We also imported *T. radiata* from South China, North Vietnam and Pakistan and established these colonies at Division of Plant Industry (DPI) quarantine and initiated releases in October 2009 after approval by USDA-APHIS and DPI. So far, 23,571 (S. China), 18,783 (N. Vietnam), and 11,294 (Pakistan) wasps have been released in Zolfo springs, Lake Wales, and Immokalee, respectively. During Oct-Nov, 4-5 instar ACP nymphs collected from release blocks were reared out in the laboratory. Based on the number of emerged wasps and psyllids, parasitism averaged 10, 2, and 60% at Zolfo springs, Lake Wales, and Immokalee, respectively. During same months, parasitism averaged 8-50% in conventional blocks in southwest Florida where releases were made compared to 7-18% in blocks where parasitoids were not released. Parasitism on sentinel plants placed in a conventional grove averaged 60%, 26%, and 27% in April 09, November 09 and January 10, respectively, and 36% and 22% in November 09 and January 10, respectively, at SWFREC. Thus releases seem to be increasing the incidence of parasitism by *T. radiata* in the field. Additional evaluations are being made and will be presented and discussed. Establishment of large rearing facilities and massive releases are required to increase ACP mortality particularly during spring when young shoots and psyllids are abundant.

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Occurrence and Damage of Red Palm Weevil, *Rhynchophorus ferrugineus* (Olivier), in China

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The red palm weevil (RPW), *Rhynchophorus ferrugineus* (Olivier), is a serious invasive pest of coconut palm in South China. Authors reviewed the occurrence, distribution, damage and integrated pest management of RPW in China. The coconut palm damage by RPW in Wenchang, Hainan in 1998 might be the earliest invasion report on this weevil in China. By 2009, RPW has been found in at least 14 provinces including Tibet in South China after a rapid spread from Hainan Island to the mainland in a decade.

This weevil was brought into China by the introduction of the Canary Island Date Palm (*Phoenix canariensis*) in last century. It caused very serious damage on coconut and areca palm plantations in China. Some other economical palm trees were also involved. In 2007, it was reported that RPW had caused more than 1 million RMB economic losses in Guiyang, Guizhou province in China. Generally, 20-80% of palm trees in a farm can be injured based on some investigations. Therefore, RPW was listed in the Catalogue of Quarantine Pest for Import Plants of People’s Republic of China in 2007. It is difficult to assess the actual loss caused by this pest, but undoubtedly it affects the production of coconut palms as well as other economical palm trees in South China.

In recent years, some studies on different aspects have been made, such as morphology, biology, control methods and risk analysis etc. In general, RPW has 2-4 generations per year in South China, with generation overlapping. Larvae are the main stage to injure the palm trees. Till now, chemical control and trapping are the often used and more effective methods in China. According to risk analysis of RPW in China, this pest might invade Hunan, Hubei, Anhui, and Jiangsu provinces in the future. The transportation of ornamental palms and offshoots as planting material from infested areas contributed to the rapid spread of this pest in China. No doubt, RPW will spread north forward in the near future. More strict quarantine at international and national levels should be applied in China.

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Potential Invasive Pests Workshop

Developing Survey and Mitigation Strategies for the Passionvine Mealybug (*Planococcus minor*)

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The passion vine mealybug, *Planococcus minor*, a pest of over 250 plants including citrus, corn, grape, potato, and soybeans has been established in the Greater Caribbean Basin for at least 20 years. A recent pest risk assessment concluded that the likelihood of this pest becoming established in the USA was high and the consequences of its establishment would be severe. From 1985-2008, this pest was intercepted 698 times on products coming from the Caribbean. Developing survey and mitigation technologies for *P. minor* in the Caribbean could help to reduce the risk of this pest being introduced into the USA. The difficulty in distinguishing *P. minor* from other mealybugs, particularly *P. citri*, makes finding and evaluating the impact of the pest and its natural enemies challenging. Studies were conducted in Trinidad and Puerto Rico to determine the effectiveness of pheromone lures to detect the pest. Laboratory and field trials along with molecular diagnostic tests showed the traps to be highly specific. Although *P. minor* has occurred in Trinidad since 1989 and possibly even earlier, the insect was never reported as a major pest, suggesting natural enemies could be regulating populations. A large natural enemy complex was found in Trinidad by caging *P. minor* infested potatoes taken from a laboratory colony. Two parasitoids collected in Trinidad, *Leptomastix dactylopii* Howard and *Coccidoxenoides perminutus* Girault, have been used successfully in biological control of the citrus mealybug and they are established in the United States. Studies were conducted to determine the efficacy of the two parasitoids in controlling *P. minor* as a feasible option for long-term control of this mealybug. Pheromone traps are now being used to monitor for the pest in south Florida. The studies in the Caribbean will help provide an immediate domestic response if the pest should reach U.S. shores.

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Off-Shore and On-Shore Biological Control Programs to Mitigate the Impacts of Invasive Arthropods and Weeds

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New exotic invasive pests have the potential to cause millions of dollars in losses to agriculture and the environment per year. Preemptive development of biological control technologies and other mitigation strategies in the Caribbean during the early stages of a pest’s invasion into the Western Hemisphere will allowed the time for evaluation and the development of mitigation strategies and tools prior to the pest’s entry into U.S. Once the technologies have been developed and tested, they can readily be transferred to any State that becomes infested. South Florida is particularly vulnerable to invasive pests because of the high volume of agricultural imports entering this area and its proximity to the Caribbean. In a cooperative off-shore and on-shore approach Scientists from United States Dept. of Agriculture, Animal Plant Health Inspection Service, Plant Protection and Quarantine and the University of Florida work together to develop biological control technologies for targeted exotic invasive pests. The team’s efforts help reduce the risk of these pests being introduced into the U.S. as well as to provide an immediate domestic response capability for targeted pests that reach U.S. shores. Having aggressive and successful biological control program delivery capabilities in advance will slow the spread of these invasive species throughout Florida and their potential geographical distribution in the U.S.

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Red Palm Weevil (*Rhynchophorus ferrugineus*), an Invasive Pest Recently Found in the Caribbean that Threatens the U.S. Nursery and Palm Industry

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In tropical and subtropical regions, palms are an important component of the native and urban landscape. They are also often economically important plants for agriculture and landscaping home and tourist based industries. In 2009, the Red Palm Weevil (*Rhynchophorus ferrugineus*), was accidentally introduced into the Caribbean. The pest originates from tropical Asia but has spread through the Middle-East and the Mediterranean where it has caused substantial damage to palm trees. Due to the possibility of the weevil spreading through the Caribbean and to the continental USA, USDA Animal Plant Health Inspection Service, Florida Agriculture and Mechanical University and Aruba’s and Curacao’s Department of Agriculture, Husbandry and Fisheries collaborated to develop survey and mitigation strategies to limit the spread and impact of the pest. In September 2009, a monitoring program was established to determine the population and distribution of the red palm weevil infestations on Aruba and Curacao through the use of commercially available pheromone traps. Additionally, the trapping system was optimized to deploy traps affectively in the urban landscape. Red palm weevil was found to attack and kill four new species of palm, *Bismark Palm* (*Bismarckia nobilis*), *Washington Palm* (*Washingtonia robusta*), *Fiji Fan Palm* (*Pritchardia pacifica*) and *Hurricane Palm* (*Dictyosperma album*), which are used widely in developments and resorts. Due to the small size of the islands and limited distribution of palms, eradication may be plausible using a combination of trapping and curative and prophylactic chemical treatments. A careful assessment of the ecological and logistical feasibility of such an approach, including an assessment of the costs, is needed before embarking on a full scale program. These studies on the pest in the Caribbean will be used to directly frame a USDA plant health emergency response through the development of Animal Plant Health Inspection Service, Plant Protection and Quarantine New Pest Response Guidelines and provide an effective protocol for other Caribbean Islands.

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Next Generation Invasion Biology: Origins, Pathways, Demography, and Future Spread

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Recent progress in several interconnected technologies, including next generation DNA-sequencing, bioinformatics, GIS, database management, and collection science, makes it now possible to diagnose rapidly insect and mite pests and predict their distribution and spread—and all for very little money. Here, we present these methods and accompanying workflow to diagnose, track and predict spread of invasive pests of agriculture in light of changing environmental conditions including changing climates and crop distributions.

These approaches are illustrated with case studies of a series of invasive pests for which genetic and historical data are available, including olive fly Bactrocera oleae, white fly Bemisia tabaci (biotype Q), two spotted spider mite Tetranychus urticae, and red tomato mite T. evansi.

The methods are proposed as part of area-wide, national, and international strategies for monitoring, assessing risk of, and managing invasive species.

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The false spider mites in the genus *Brevipalpus* (Acari: Tenuipalpidae) have been reported as major pests due to their direct feeding damage to crops such as grapes (*B. chilensis* in Chile), pistachios (*B. lewisi* in California) or on various ornamental plants. However, the major concern with certain species within this genus is their ability to vector one or more diseases such as two citrus leprosis viruses, coffee ringspot virus, passion fruit green spot virus and viruses in numerous ornamental plants. *Brevipalpus* mites are polyphagous with females producing females, flat-bodied in shape, long-lived and with feeding behavior characteristics that make them exceptionally well suited to be persistent and efficient vectors of these viruses. Initially, three major morphospecies have been identified as potential vectors of viruses: *B. phoenicis*, *B. obovatus* and *B. californicus*. Because of the weak morphological characters currently used to separate these species, the use of DNA phylogenetic analysis has been intensified. As a result, new cryptic species within this *Brevipalpus* complex have been identified. Our research has attempted to clarify the extent of this species complex, their biologies and their abilities to efficiently transmit the citrus leprosis viruses through the Americas. This is an imminent threat to the US citrus and ornamental industries.

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Nested-PCR Assays Detect Phytoplasma in *Cedusa caribbensis*
Caldwell & Martorell (Hemiptera: Auchennorhyncha: Derbidae) in Puerto Rico

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Recently, phytoplasma infections associated with palm dieback and mortality, and resembling symptoms for lethal yellowing, were reported in Puerto Rico. So far, infected palms appear to be: Royal palm (*Roystonea* spp.), Fishtail palm (*Caryota mitis*), Carpentaria palm (*Carpentaria acuminata*), and coconut (*Cocos nucifera*). Pathogen-vector relationships are crucial to understand host range, disease dispersion, and susceptibility of the many palm species occurring on the island, as well as to provide guidelines to the local ornamental palm industry. Samples from auchennorhynchous insects were collected around phytoplasma-infected palms at the UPR Botanical Garden’s palm collection in San Juan. Specimens identified as *Haplaxius (=Myndus) crudus* (Van Duzee), and *Cedusa caribbensis* Caldwell & Martorell had DNA extracted using CTAB protocol, and PCR was carried out using universal primers for amplification of phytoplasma DNA P1 and P7. PCRs were followed by nested-PCR with a second pair of universal primers R16F2n/R16R2. The amplified products were visualized in agarose gel/UV. Infected plant tissues were used as positive control during PCR essays. A single fragment of same size (~1,400bp) reported on plants was observed in both primer combinations for specimens of *Cedusa caribbensis*. PCR product was not observed on samples from *H. crudus*. Number and size of the fragment were the expected for the occurrence of phytoplasma. All tests were repeated four times. This is the first record of *H. crudus*, a known vector of phytoplasma associated to lethal yellowing of palms, in Puerto Rico. Transmission trials are underway to determine the capability of *C. caribbensis* to transmit the pathogen among palm species.

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EPPO Activities on Potential Invasive Pests
Anne-Sophie Roy
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EPPO is the Regional Plant Protection Organization for the Euro-Mediterranean region, in the terms given by the IPPC (International Plant Protection Convention). EPPO was created in 1951 and currently has 50 member countries. Among the various missions that are assigned to EPPO, one is to prevent the entry and spread of pests and diseases, and another is to provide information on regulated pests or pests which may present potential risks for the EPPO region. Over the years, EPPO has made recommendations to its member countries as to which pests should be regarded as quarantine pests and which regulatory measures should be implemented. These measures are intended to avoid the introduction of pests which are either absent from the EPPO region (e.g. Diaphorina citri, Maconellicoccus hirsutus, Rhynchophorus palmarum) or to prevent further spread of pests which already occur locally (e.g. Bemisia tabaci, Diabrotica virgifera virgifera). However, the existing measures can be challenged by the introductions of new pests, and in particular by those which are showing an invasive behaviour (e.g. Agrilus planipennis, Anoplophora chinensis, Tuta absoluta, Rhynchophorus ferrugineus).

In the EPPO strategy, it is considered essential to assess the risks associated with new invasive pests and to propose management measures against them. EPPO has elaborated a Pest Risk Analysis (PRA) scheme which will be presented. When new pests are emerging in some parts of the world, it is necessary to provide early warning to National Plant Protection Organizations so that they can put in place import inspections or surveillance programmes on their territory. Since 1998, EPPO has set up an Alert List on its website to provide data on emerging pests (e.g. Bactrocera invadens, Drosophila suzukii, Epitrix similis, Xylosandrus crassiusculus). Some of these emerging pests may later be submitted to a PRA and eventually be recommended for regulation as quarantine pests. When quarantine status is felt appropriate for an emerging pest, EPPO Standards can then be developed to provide guidance on diagnostics, phytosanitary procedures, and eradication/containment programmes.

In order to provide data, not only on already regulated pests but also on new invasive pests, the EPPO Secretariat maintains several information systems. For example, the EPPO Reporting Service (a monthly newsletter) reports on events of phytosanitary concern and focuses on new geographical records, new host plants, new invasive species (pests and diseases as well as invasive alien plants). Geographical distributions and host plant lists of many pests, including invasive species, are stored in a database which is currently under reconstruction. Most of this pest-specific information can be retrieved from the EPPO website and is accessible to non-EPPO members.

In the context of increasing trade and climate change, the issue of invasive pests is of particular concern on all continents. Because these species can threaten both cultivated and non-cultivated environments, efforts should continue to be made to facilitate information exchange and cooperation between the different regions of the world.

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The Critical Role of IR-4 in Specialty Crop Pest Management

Michelle Samuel-Foo  
Food and Environmental Toxicology Lab, University of Florida, Gainesville FL, USA

The IR-4 project provides an essential service to minor crop industries in the United States by enabling registration of pesticides to control key insect disease and weed pests. IR-4’s mission is to provide safe and effective pest management solutions for growers of high value specialty crops, which includes most vegetables, fruits, nuts, herbs, nursery and flower crops. The total value of these crops in the U.S. is approximately $43 billion which represents 46% of the total U.S. farm crop value.

The IR-4 Southern region office is located at the University of Florida in Gainesville FL. We work closely with researchers in the Southern US to identify pest management needs and to help provide chemical solutions to control pest problems. Continued interaction between the IR-4 Project and the pest management research community is expected to enhance the ability of producers to continue to maintain pests below economic thresholds.

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Phylogeography of *Diaphorina citri* Kuwayama mtCOI: Two Old World Lineages and a New World Invasion

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**Purpose:** *Diaphorina citri* Kuwayama (Asian citrus psyllid, ACP) is a plant feeding Hemipteran pest that has gained worldwide interest because it has invaded the new world and brought with it huanglongbing (HLB), a severe disease of citrus. The ACP is the only known vector of this disease, and currently the primary strategy for controlling the spread of HLB is to control ACP populations. Geographical origin of the ACP remains somewhat controversial but is thought to be either from southeast Asia or the Indian subcontinent (southwest Asia). Development of biological control strategies can be aided by understanding the genetic diversity of this species and the phylogeographic relationship of distinct populations.

**Scope:** For this reason, a mitochondrial cytochrome oxidase I (mtCOI) haplotype analysis was conducted on ACPs collected from throughout the world including new world introduction sites.

**Methods:** Primers were designed specifically for PCR amplification of an 821 bp fragment of the mtCOI gene. An alignment was constructed using 612 bps of this fragment and consisted of 216 individuals from 52 collections representing 15 countries.

**Results:** There were a total of eight polymorphic sites that separated the sequences into 8 different haplotypes (Dcit-1 through Dcit-8). TCS haplotype network analysis suggests two major haplotype groups, one with southwestern Asia (SWA) and the other, southeastern Asia (SEA) geographic origins. The recent (within the last 15 to 25 years) invasion into the new world originated from only the SWA group in the northern hemisphere (USA and Mexico) and from both the SEA and SWA groups in the southern hemisphere (Brazil). In only one case, Réunion Island, did haplotypes from both the SEA and SWA group appear in the same location. In Brazil, both groups were present, but in separate locations. The Dcit-1 SWA haplotype was the most abundant including ~50% of the countries sampled and 87% of the total sequences obtained from India, Pakistan and Saudi Arabia. The second most abundant haplotype, Dcit-2, the basis of the SEA group, represented ~50% of the countries and contained most of the sequences from Southeast Asia and China. In the haplotype network, the SWA group was predicted to be basal to the SEA group supporting the contemporary view that *D. citri* arose in southwestern Asia (India and Pakistan) before spreading eastward. Interestingly, only the Caribbean collections (Puerto Rico and Guadeloupe) represented a unique haplotype not found in other countries, indicating no relationship between the USA (Florida) and Caribbean introductions.

**Conclusion:** The very limited genetic structure among world populations indicates that the ACP is unlikely to be a cryptic species complex.

**Recommendation:** Although more detailed sampling needs to occur in SEA and SWA areas, these results indicate population differences that may have implications in new world biocontrol strategies (i.e. U.S. populations are related to SWA populations only and thus a search for biocontrol agents may be best done in SWA countries).

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Mealybugs Present in Grand Cayman

Joan Steer
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The introduction of the Pink Hibiscus Mealybug (PHM) (*Maconellicoccus hirsutus*) in Grand Cayman during June 2006 prompted the need to conduct a survey to determine mealybug species present on the island while at the same time monitoring the spread of this serious invasive pest. In addition to the planned survey, a public education programme coupled with a hotline was used to allow the public to call in suspected sites and to enable the surveyors to visit and collect samples from areas not specifically covered in the survey. Between June 2006 and July 2007 more than 1000 samples were collected from a wide range of host plants in Grand Cayman. Confirmations by Dr. Greg Hodges, Entomologist, FDACS/DPI indicated that PHM accounted for more than 50% of the mealybugs collected and twenty four other species were identified as being present in Grand Cayman. More than 55 hosts consisting of a range of agricultural and horticultural plants were found to be affected by mealybugs. The Biological control strategy used in Grand Cayman involved an initial release of predatory lady bugs, *Cryptolaemus montrouzieri*, in the three PHM infested focal sites to buffer the impact of the rapidly spreading invasive pest. Six weeks later this was followed by the release of four biotypes of exotic parasitoids namely (*Anagyrus kamali* Taiwan; *Anagyrus kamali* China; *Gyranosoidea indica* Australia and *Gyranasoidea indica* Egypt) at seven study sites/field insectaries in the south western end of the island. During a subsequent introduction in Cayman Brac a modified strategy was followed eliminating the use of *Cryptolaemus* allowing for a comparison of the effectiveness of the approaches. The parasitoids and predators are established on Grand Cayman and continue to provide good control of PHM as are the parasitoids in Cayman Brac. Of interest, observations of preferred host in the two islands differ, despite the presence of the same range of plant species in both locations.

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Recent and Potentially Imminent Introductions of Coccoidea and Aleyrodidae to Florida and the Caribbean Area

**Ian C. Stocks**
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The plant-parasite insect groups Coccoidea and Aleyrodidae are among the most easily transported plant pests and consistently rank as the some of the most noxious adventive insects following their introduction via the regulated and non-regulated plant trade. The recently introduced species *Aleurodicus rugioperculatus* Martin (Aleyrodidae: Aleurodicinae), *Nippaecoccus viridis* (Newstead) (Pseudococcidae), and the recently described *Phalacrococcus howertoni* Hodges & Hodgson (Coccidae), are causing significant horticultural and ecological damaged, and could easily be distributed into the pan-Caribbean region and the Americas now that they are established and present in the Florida horticultural trade. The ecological aspects of these introduced species will be discussed. Also, several other coccoids and whiteflies that are an imminent threat will be discussed.

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Diaspidid Scale Insects on Imported Fruit are a Substantial Invasion Risk

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In September 1986 a policy was instituted by the USDA exempting diaspidid scale insects present on commercial stone fruit from quarantine action. This decision was based on an unpublished 1985 ad hoc report by a working group of four scientists (see the Miller 1985 reference cited in APHIS 2007). In October 2000 avocado fruit was added to the list of commodities that do not require action when armored scales are intercepted on commercial shipments. The decision of excluding armored scales on fruit shipments as potential source for new invasions, was guided by the assumption that it would be very unlikely that scale insects on fruit would establish new populations on fruit trees. The basis for this assumption was, the fact that only first instars of scale insects (crawlers) are mobile and are capable of establishing themselves on new host plants. Crawlers are 1) short lived and 2) can only walk for short distances. The generally accepted means of long distance dispersal is via wind movement, and even if infested fruit are discarded on compost piles, the wind speed close to the ground is low and consequently, the chance that a crawler will be moved to a suitable host plant was assumed to be extremely small.

When avocado imports were allowed into California in February 2007, several species of armored scales not believed to be present in California were detected on ‘Hass’ avocados entering the state from Mexico. In response to the presence of these scale insects, we established a sampling of avocado fruit entering the state and estimated that ca. 47.6 million live armored scales and an additional 20.1 million live eggs and crawlers were imported into California over an eight month period (Morse et al., 2009). We found eight probable species of armored scales in the samples, seven of which do not occur in California. 89.3% of the live scales belonged to a species new to science, in the genus Abgrallaspis. We also studied the mechanisms used by armored scale crawlers for dispersal and found that besides wind dispersal, crawlers are also transported phoretically by other insects (Magsig-Castillo et al. 2010). This latter method of transport poses a substantial risk that fruit discarded in trash bins or on compost piles can lead to the establishment of new populations. We recommend that imported fruit be treated in such a manner that scale insects present on the fruit are removed or killed before they are imported to other countries.

REFERENCES:


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Invasive Mealybug Pests of Tamil Nadu, India

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Mealybugs are once minor pests of late assumed major pest status. *Ferrisia virgata*, *Maconellicoccus hirsutus*, *Coccidohystrix insolita* and *Brevennia rehi* are the common mealybug pests in India. During 2004-05 there was a sudden outbreak of *Phenacoccus solenopsis* Tinsley in North India and subsequently spread to other parts of the country and it is considered to be the serious pest of vegetables and fruits for the past two years in Tamil Nadu, India. During July, 2008 an invasive mealybug, *Paracoccus marginatus* Williams & Granara de Willink got introduced into Tamil Nadu, India and caused extensive damage to papaya, tapioca, mulberry, guava, Jatropha, Hibiscus, many fruits and vegetables, flower crops, and many weeds including Congress grass, *Parthenium hysterophorus*. This poster describes list of host plants, mode and extent of spread to other areas, seasonal incidence and conducive weather parameters which favour multiplication of the pest. Awareness campaign were organized to contain the pest and to prevent further spread by giving emphasis on correct identification, monitoring the pest, early diagnosis, destruction of affected plants, alternate hosts and possible management with special emphasis on conserving lepidopteran predator, *Spalgis epius* and other coccinellids like *Cryptolaemus montrouzieri*, *Harmonia octomaculata*.

Use of plant products like neem oil, fish oil rosin soap and need based spot application of insecticides like dimethoate, buprofezin, chlorpyriphos and profenophos were also recommended for containing the pest. Cheap mass production technique for the multiplication of *H. octomaculata* was standardized for the management of *P. solenopsis*. Large scale demonstrations in various places are in progress. Importation of parasitoids for *P. marginatus* was done and are being tested for their biosafety to other organisms.

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Basis for Integrating *Bacillus thuringiensis* and *Nesidiocoris tenuis* for Biological Control of *Tuta absoluta*

**Alberto Urbaneja**, Óscar Mollá, Miquel Alonso and Joel González-Cabrera

Centro de Protección Vegetal y Biotecnología. Instituto Valenciano de Investigaciones Agrarias, Moncada, Valencia, Spain

The tomato leafminer *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is a devastating tomato pest native to South America. After its initial detection in eastern Spain at the end of 2006, it spread quickly to other European and northern African countries. Predators such as *Nesidiocoris tenuis* Reuter (Hemiptera: Miridae) were detected preying upon *T. absoluta* eggs immediately after its detection in the Spanish Mediterranean Coast. This predator has shown potential to reduce *T. absoluta* populations under field situation. In addition, different formulations based on *Bacillus thuringiensis* have been tested against *T. absoluta*. *Bacillus thuringiensis* treatments have also evidenced high efficacy for controlling young *T. absoluta* larvae. Therefore, the integration of *B. thuringiensis* treatments with the inoculation or conservation of *N. tenuis* may result in a clean and safe strategy to manage this pest, since *B. thuringiensis* targets larvae and mirids prey preferentially on *T. absoluta* eggs.

Laboratory, semi-field, greenhouse and open-field experiments have been conducted during the last three years to establish the basis for integrating *B. thuringiensis* treatments with augmentative releases of *N. tenuis* to manage *T. absoluta* populations. Our results indicated that it may be possible to design *T. absoluta* control programs based on these two biocontrol agents that will successfully manage this pest while having low impact on the tomato auxiliary fauna. Furthermore, it will minimize the use of chemicals and consequently residues on fruits, hence improving food safety and quality.

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The Hibiscus Erineum Mite, *Aceria hibisci* (Acari: Eriophyidae) a Threat Malvaceae

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The hibiscus erineum mite, *Aceria hibisci* (Acari: Eriophyidae), was discovered in 1906 on the Chinese red hibiscus, *Hibiscus rosa-sinensis* L. (Malvaceae) in the Fiji Islands. This mite was subsequently reported from Hawaii (1989), Australia (1992) and Reunion Island (1997) on *Hibiscus spp.* Jeppson et al (1975) and Perring (1996) reported *A. hibisci* from *Abelmoschus esculentus* L. in Brazil. *Aceria hibisci* was discovered in the Caribbean region in 1997 and is now established in Cuba, Dominica, Guadeloupe, Jamaica, Martinique, and Puerto Rico.

Hibiscus erineum mite feeding severely deforms young leaves, stems, flowers and developing vegetative buds. Some varieties of *Hibiscus rosa-sinensis* appear to be more susceptible to mite feeding damage than others. Current control of the hibiscus erineum mite involves chemicals and cultural methods. Predatory mites have been found associated with hibiscus erineum mite galls in the Caribbean region and may be useful biological control agents. Continued survey of the hibiscus erineum mite is needed to monitor its spread. Additional testing is needed to refine the host preferences for this destructive mite.

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Preparing for Potentially Invasive Pests: Strategies from the Florida Department of Agriculture Division of Plant Industry

Greg Hodges - Presented by: Leroy Whilby
FDACS/DPI, Gainesville FL, USA

The mission of the Florida Department of Agriculture/Division of Plant Industry (FDACS/DPI) is “to protect Florida’s native and commercially grown plants and the state’s apiary industry from harmful pests and diseases.” Florida is high risk sentinel state for the risk of having exotic pest introductions with multiple pathways for pest entry. Each year, FDACS/DPI will respond to new finds of exotic arthropods with the goal of preventing establishment. This presentation will encompass some of the strategies utilized by FDACS/DPI when a new pest arrives.

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Invasion of Exotic Arthropods in South America’s Biodiversity Hotspots and Agro-Production Systems: Prospects for Classical Biological Control

Kris A.G. Wyckhuys¹ and T. Kondo²

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Worldwide, biological invasions affect native species and local ecosystems, posing a threat to global biodiversity and constituting a major impediment to agricultural production. Arthropod invaders can displace native species through competition, predation or disease transmission and occasionally turn into key pests of local agro-production systems. In many parts of the world, there exists a critical need to record exotics, quantify their current (in-)direct impacts and predict associated future threats to native or agricultural ecosystems. In South America, conspicuous exotics and agricultural or forest pests have received a certain amount of scientific attention, but scarce information is available about exotic invasions in natural ecosystems.

Using literature revision, we documented >250 exotic arthropod species in South America. For each species, we recorded initial reports of presence in South America, region of origin, actual impacts in local ecosystems and current management. Some species originated from the Neartic region, others are invasive throughout the Americas or could be potential invaders in North America. Based upon museum and visual records, potential geographic distribution was modeled for the most worrisome exotic arthropods using CLIMEX. Lastly, we quantified potential for importation biological control. Our work could help develop contingency and management plans for invasive arthropods and forms a basis for classical biological control initiatives in the region.

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Discovery of a New Invasive Mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) in China

Zhang Runzhi, Wang Yanping and Li Yalan
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The invasive mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae), has attacked severely to cotton (*Gossypium hirsutum* L.) in Pakistan and India. It expanded dramatically and presented a great economic threat to world cotton production.

*P. solenopsis* was found from Guangzhou City (23°80′ N, 113°17′ E) on August 20, 2008 for the first time in China. Its host plant is *Hibiscus rosasinensis* L. According to the results of field investigation during 2008-2010, the insect was found within 8 provinces including Guangdong (Guangzhou, Panyu, Shaoguan, Zengcheng), Guangxi (Qinzhou), Hainan (Haikou, Sanya), Fujian (Sanming, Xiamen, Zhangzhou), Hunan (Changsha), Zhejiang (Hangzhou, Wuyi), Yunnan (Funing, Huaping, Jinghong, Yongren), Jiangxi (Zhanggong, Yongxiu) and Sichuan (Panzhihua). Although it was found in many provinces in South China, but the distribution areas were small with pot distribution pattern. So far, we have only found *P. solenopsis* attacked cotton in Jiangxi and Hunan where closing to main cotton production areas in China.

Potential distribution analysis by CLIMEX modeling indicated that *P. solenopsis* presents a significant threat to cotton production in China and many Asian countries. The climate of many Chinese cotton-producing areas is suitable for its colonization and establishment.

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Introduction, Dispersal and Potential Impacts of Colorado Potato Beetle, *Leptinotarsa decemlineata*, in China

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The Colorado potato beetle (CPB), *Leptinotarsa decemlineata* (Say), has invaded China since 1993. By 2009 this pest has been found in 36 counties in north Xinjiang in China, causing serious damage on potato, eggplant and tomato crops. Based on the data of historical distribution and investigation in recent years, we identified the introduction sites and reconstructed dispersal history of CPB in China. Based on the economic statistical data and market price in 2007, we estimated the current and potential impact of CPB in China.

According to the results of field investigation during 2006-2009, the top 10 most seriously infested counties are as follows: Huocheng (44°03′ N, 80°52′ E), Habahe (48°02′ N, 86°26′ E), Usu (44°28′ N, 84°41′ E), Yining (43°55′ N, 81°20′ E), Nilka (43°49′ N, 82°30′ E), Burqin (47°41′ N, 86°59′ E), Qapqal (43°50′ N, 81°08′ E), Yumin (46°12′ N, 82°59′ E), Xinyuan (43°25′ N, 83°16′ E) and Tekes (43°13′ N, 81°49′ E). For example, during growth season the number of adults, larvae and egg masses per one hundred plants are 322, 1264 and 173 respectively in Huocheng, 175, 807 and 81 in Habahe, and 104, 298 and 80 in Usu.

There are three isolated invasion entries which are located in Huocheng (1993), Tacheng (46°46′N, 82°59′E; 1993) and Habahe (2000) respectively from south to north. By 2009, the furthest invasion front of CPB has reach at Bositan township in Mori county with the exact site at 43°44′N, 90°41′E. The average advancing rate of invasion front of CPB is about 48 km/year. Four distribution areas are divided from south to north according to natural barriers which are Ili valley, south Dzungarian basin, Tacheng basin and Altay area. The average dispersal rates in these four areas are 9 km/year, 49 km/year, 13 km/year and 27 km/yr respectively from south to north.

Currently the economic loss caused by CPB in China is about 3.3 million USD per year under the present extremely control pressure. When CPB invasion finished in China, the potential loss is estimated to about 192.2 million USD per year. In future, CPB possibly will invade Gansu province which is one of the largest potato production provinces in China.

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The Distribution and Threat of Invasive Codling Moth, *Cydia pomonella* (L.), in China

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Originally resident in southeastern Europe, the Codling moth *Cydia pomonella* (L.) has become a notorious invasive pest for apple industry worldwide. Codling moth is an important quarantine pest in China, the apple industry of China which ranks first in the world (accounts for 42.15% of world production and 40.10% of world cultivated area) is seriously threatened by the invasion of this pest.

Codling moth was first detected in Xinjiang Province of China in 1950s. Through thorough collection and analysis of monitoring data from 35 counties in 22 years, combined with relevant literatures and reports, our study provided a comprehensive distribution status of codling moth in China. Up to now, codling moth distributed in 53 counties of 5 provinces (Xinjiang, Gansu, Inner Mongolia, Ningxia and Heilongjiang) in China. It mainly concentrated in longitude 127.11°-132.57° E and 75.59°-106.48° E, and formed a western and an eastern distribution region. The pest posed a serious threat to the apple industry of Northwest Plateau (mainly in Shaanxi Province) and Bohai Bay (mainly in Shandong, Hebei and Liaoning Provinces), which are the two major apple producing areas of China and account for 80% of apple production in China. Since 2000, the occurrence area of codling moth expanded rapidly, indicating that human activity plays an important role in accelerating the expansion of the pest. Economic damage assessment results showed that codling moth in China may result in more than 600 million U.S. dollars of potential economic losses, and the world's apple industry will also be seriously threatened by apple production damage caused by codling moth in China.

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