

**ACCOMPLISHMENT REPORT  
MULTISTATE RESEARCH ACTIVITY**

**Project Number: S-267**

**Project Title: Biological Control of Selected Arthropods, Pests and Weeds**

**Period Covered: October 1, 1995 through September 30, 2000**

**Date of This Report: April 4, 2001**

**Annual Meeting Date: March 4, 2001**

**Participants:**

Mathew Baur	Louisiana State University
Ken Bloem	USDA, APHIS, NCBI- Florida
Kris Braman	University of Georgia
David Buntin, Secretary	University of Georgia
Juang-Horng Chong	University of Georgia
Jim Cuda	University of Florida
Chris Geden	USDA-ARS, CMAVE, Florida
Jerome Grant	University of Tennessee
Edd Harrison	Rhom and Haas
Donn Johnson	University of Arkansas
Susie Legaspy	USDA-ARS, CMAVE, Florida
Norm Leppla, Chair	University of Florida
Gloria McCutcheon	Clemson University-CREC
Charles O'Brien	Florida A&M University
Ronald Oetting	University of Georgia
Stuart Reitz	USDA-ARS, CMAVE, Florida
John Ruberson	University of Georgia
Eric Schreiber	Florida A&M University
Glynn Tillman	USDA-ARS, IBPMRL, Georgia
David Washko	Rohm and Haas
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**Brief summary of minutes of annual meeting** (entire minutes at [www.agctr.lsu.edu/s267](http://www.agctr.lsu.edu/s267)): The project participants met in conjunction with the Entomological Society of America, Southeastern Branch. Chairman Norm Leppla called the meeting to order at 9:15 AM and acknowledged special service to the project. David Buntin and John Ruberson have provided exceptional leadership and support. Les Ehler, Bob O'Neil, Jim Nechols and Rob Wiedenmann prepared very thorough and useful reviews of the new project draft. Although not able to attend, Frank Gilstrap, our CSREES Administrative Advisor, assisted greatly in developing and gaining approval for our new project.

Norm described the rich history of the project and considerable resources devoted to biological control in the region. This project has been S-192, S-238, S-267 and now S-303, as it

has evolved. It began as a classical biological control project to support foreign exploration for natural enemies of arthropod pests and weeds. However, it currently has a strong IPM component with pesticide effects on natural enemies, host specificity evaluations, and conservation and augmentation biological control. Interest in this regional project has never been stronger but we must emphasize collaboration across ecological areas and among states.

The keynote address, "Status of Red Imported Fire Ant Biological Control," was presented by David Oi, USDA-ARS, CMAVE, Gainesville FL. David discussed the current status of various biological control agents for fire ants and indicated that current efforts are focusing on self-sustaining agents. As a result of past adventive introductions, a protozoan, *Thelohania solenopsae*, is present in populations in Louisiana, Texas and Florida. *T. solenopsae* has been propagated and released at other sites throughout the southeastern U.S. The agents currently receiving considerable attention are several species of phorid flies that decapitate fire ant workers. One species has been released and is well-established and spreading naturally from sites in central Florida. This fly also has been released in one or a few sites in most southern states. A second phorid species has been approved for release. A proposal to conduct an area-wide biological control program on fire ants is pending. Most southern states also are funding research activities directed at fire ant suppression.

State reports were prepared by the participants and distributed at the meeting (UF, FAMU, GA, KY, LA, NC, TN, USDA-FL, USDA-GA, USDA-TX, VA- available by request). Additionally, Jerome Grant has ended his term as the S-303 representative to the National Biological Control Institute, Customer Advisory Group. Jerome discussed the duties of the position and asked the group to nominate a replacement. Chris Geden volunteered to be the new representative. Mathew Bauer presented a discussion on the current S-267 Web site. Norm Leppla reviewed the minutes of the 2000 meeting with regard to the re-write of the project. He reviewed the new objectives and discussed their intent. During the year, he prepared and submitted a grant proposal to the Southern Region Sustainable Agriculture Research and Education Professional Development Program for the group to survey parasitoids of major pest groups in the South. Unfortunately, the grant was not funded. Norm discussed the importance of more cooperative activities by group members and set the stage for five breakout groups, one to discuss each of the S-303 objectives. After about one hour, each group reported general research and outreach plans for next year:

Objective 1: Cooperatively survey for, import and assess natural enemies for invasive pests (classical biological control of insects and weeds) Chris Geden, Leader. *Hydrilla verticillata* and *Diaprepes abbreviatus* are primary targets. Parasites for the citrus root weevil will be imported from Puerto Rico. Work will continue on giant salvinia at the USDA, FAMU, USGS and other institutions. New parasites are being tested to control filth flies.

Objective 2: Assess integration of exotic and indigenous natural enemies with current and novel pest management approaches, to improve environmental and economic sustainability (biological control and IPM) John Ruberson, Leader. Emphasis is being placed on pesticide effects on natural enemies. A list serve will be established to facilitate preparation and management of an associated database. The protocols for testing will be standardized.

Objective 3: Evaluate effects of introduced natural enemies on target and non-target organisms (host specificity testing on insects and weeds) Jim Cuda, Leader. Areas of activity include post-release evaluations of natural enemies, adaptation of boll weevil rearing techniques for a weevil that attacks tropical soda apple, more quantitative experimental methods, and natural enemies that adapt to non-target species. *Cactoblastis cactorum* will be addressed as a possible “black eye” for biological control. Evaluations will continue on the melaleuca weevil, phorids for fire ants and native weevils for purple loosestrife.

Objective 4: Characterize and quantify the impact of indigenous natural enemies on pest and beneficial species (impact evaluation of native organisms on weeds and insects) Susie Legaspy, Leader. Brown citrus aphid control with *Lysiphlebus* spp., *Ageniaspis* spp. for citrus leafminer, and glassy-winged sharpshooter biological control are high priorities. Additionally, natural enemy surveys will be conducted, if funded.

Objective 5: Improve colonization and efficacy of natural enemies through habitat manipulation for resident species and improvement of rearing, distribution, and establishment of released exotic or native natural enemies (augmentation and conservation biological control) Glynn Tillman, Leader. Cover crops and reservoirs, such as clover in cotton, will be studied. Nectar sources in sorghum could “trap” *Helicoverpa zea*. *Orius* spp. are important predators of thrips. Field tests will be conducted on biological control of the tarnished plant bug, *Lygus linearis*.

## **Accomplishments and Impacts:**

### **Objective 1**

**University of Florida (Howard Frank, Jim Cuda)**- A southern strain of the tachinid fly *Ormia depleta* (from the Brazilian state of Rio Grande do Sul) is being investigated in the laboratory and a culture of the tachinid fly, *Admontia* sp., imported from Honduras was destroyed. Biological studies were completed in U.S. quarantine and South America with the defoliating sawfly *Heteroperreyia hubrichi* Malaise (Hymenoptera: Pergidae), a natural enemy of the Brazilian peppertree, *Schinus terebinthifolius*. Ecoclimatic sites for release of *H. hubrichi* in Florida were identified using climate-matching software (CLIMEX) and the web-based Florida Automated Weather Network (FAWN). The insect was approved by the Technical Advisory Group (TAG) for release in Florida in 1997, and is currently undergoing an environmental assessment (EA) to satisfy the National Environmental Policy Act (NEPA) requirements. Studies on the Brazilian peppertree psyllid, *Calophya terebinthifolii* Burckhardt (Homoptera: Psyllidae), were initiated at the Forest Protection Laboratory Nursery, Curitiba, Brazil. This psyllid was collected on the following varieties of *Schinus terebinthifolius* -*rhoifolius*, *pohlianus* and *raddianus* (Florida variety). International and interagency cooperation between the University of Florida and USDA-ARS laboratories in Argentina and Stoneville, MS, has accelerated the survey and host testing process for discovering/screening potential natural enemies for tropical soda apple (TSA), an invasive weed of improved pastures and natural areas throughout the southeastern United States. Quarantine and field tests with the leaf beetle, *Gratiana boliviana* (Coleoptera: Chrysomelidae), from Argentina and southern Brazil were concluded, and a petition for field release in the USA was submitted in April 2000. During this review period, two additional potential biocontrol

agents, the flower-bud weevil, *Anthonomus tenebrosus* Boheman (Coleoptera: Curculionidae); and another leaf beetle *Gratiana* sp., were found on TSA plants in Brazil, and initial screening tests were conducted. Research projects will continue on *Ormia depleta*, *Larra bicolor*, and *Pheropsophus aequinoctialis*, three potential insect biocontrol agents for mole crickets. The fly, *Admontia* sp., will be cultured and tested against *Metamasius* spp. weevils (non-target species) known from Florida. Parasitoids of the citrus root weevil will be sought in northern Venezuela, Guadeloupe, Belize, Nicaragua and Cuba.

**Florida A & M University (Charles O'Brien)**- Studies will be conducted in the West Indies to support future biological control of the citrus root weevil.

**Louisiana State University (Seth Johnson and Matthew Baur)**- A temperately adapted strain of the parasitic tachinid fly, *Ormia depleta*, from southern Brazil was released at the Burden Experiment Station in Baton Rouge and City Park in New Orleans in May 2000 for mole cricket biological control. Establishment will be determined in 2001. The first release of *Pseudacteon tricuspis*, a parasitoid of red imported fire ant, was made in September 1999, 5 miles north of Covington, LA. *P. tricuspis* establishment and impact on fire ant populations will be monitored for three or more years at each release site. Flies from the first release site near Covington had dispersed 0.5 miles north by October 2000.

**University of Tennessee (Jerome Grant and Paris Lambdin)**- Releases of the introduced decapitating fly were made against the black imported fire ant and its hybrid at several locations in Tennessee; thus far, no recurring generations of this fly have been recovered.

**USDA-Florida (Chris Geden)**- Received colonies of the following into quarantine for evaluation against filth flies: *Trichopria* spp. (Diapriidae, from Russia and Kazakhstan), *Spalangia nigroaenea* (Pteromalidae, from Russia and Kazakhstan), *S. cameroni* (from Russia and Kazakhstan), *S. endius* (from Russia and Kazakhstan), *Muscidifurax raptor* (from Russia and Kazakhstan), and *Tachniaephagus zealandicus* (Encyrtidae, from Brazil).

### **Objective 2:**

**University of Florida (Jim Cuda)**- Preliminary studies were conducted to use low-level aerial surveillance techniques to monitor establishment and impact of introduced natural enemies on Brazilian peppertree, *Schinus terebinthifolius*.

**North Carolina State University (David Orr and Kathy Kidd)**- Releases of lab-reared *Trichogramma* stingless wasps were evaluated as biological control agents of Nantucket pine tip moth in first year loblolly pine plantations. In release plots, larval tip moth populations were reduced 60%, and length of tunneling was reduced about the same. Predation of *Trichogramma* spp. by ants prior to their emergence was lower when capsules were applied in a clumped distribution versus a uniform pattern. Microhabitats varied significantly within plantations; however, microclimates were within acceptable levels for successful *Trichogramma* spp. releases. A study was performed to evaluate the potential for an insect growth regulator (tebufenozide), a natural enemy (*T. exiguum*), and modified spray techniques (whole-tree vs. terminal-only

application) for suppression of Nantucket pine tip moth damage in Virginia pine Christmas trees. Parasitism levels between *T. exiguum* release and control plots did not vary significantly in any tip moth generation. Tebufenozide provided significantly greater suppression of damage than acephate, a commonly used pesticide for Christmas trees. The work with *Trichogramma* spp. in pines has led to a larger joint project with timber industry partners.

**University of Tennessee (Jerome Grant and Paris Lambdin)**- An IPM program for musk thistle, incorporating plant-feeding weevils, included a multi-tactical approach for area-wide management using of chemical herbicides, mowing, plant-feeding insects, and cultural methods to reduce germination and establishment. The plant-feeding weevils, *Rhinocyllus conicus* and *Trichosirocalus horridus*, are widely established in eastern Tennessee and move into thistle-infested areas where mowers or herbicides cannot be used. Economic savings to state agencies involved in weed management is \$500,000 to \$1 million annually, and similar savings are estimated for agricultural land managers. Further research will assess the environmental benefits in terms of reduced herbicide use. A manual is being developed of exotic and invasive species, and their management, along roadways. It is the first statewide, comprehensive study to assess exotic vegetation along interstates. Assistance is being provided to Saturn Inc. (the automobile manufacturer) to develop IPM plans for their agricultural lands.

**USDA-Georgia (Glynn Tillman)**- The ability of a strip crop of sorghum to serve as a trap crop for the corn earworm in cotton was investigated. The mean number of corn earworm eggs per acre was higher in the grain sorghum than in the cotton. The main objectives of the "On Farm Rye/Legume Cover Crop and Conservation Tillage Project" were to: 1. Improve soil quality and 2. Provide a cover crop to serve as a relay of beneficial insects into cotton. Treatments included: 1. A blend of three species of legumes: balansa clover, crimson clover, and hairy vetch; 2. The blend of legumes stripped with rye; 3. Rye; 4. Crimson clover; and 5. Normal tillage with no cover. This project was initiated in Dec. 2000. Cover crops will be evaluated for their potential to be utilized as refuges for beneficial insects in field borders. A few of the cover crops are sunrise clover, common vetch, coriander, oilseed radish, Partridge pea, Barkant turnip, and Bannapoli rape.

**Virginia (VPI & SU) (Loke Kok)**- The susceptibility of natural enemies to synthetic pesticides was determined.

### **Objective 3**

**University of Florida (Howard Frank, Jim Cuda and Marjorie Hoy)**- The citrus root weevil, *Diaprepes abbreviatus* (L.), is an adventive pest from the Caribbean region that has infested several crops, i. e., citrus, sugarcane, vegetables, ornamentals in Florida for over 30 years. Several egg parasitoids, *Ceratogramma etiennei*, *Quadrastichus haitiensis*, and *Aprostocetus vaquitarum*, have been introduced from the Caribbean Region to control this pest. *C. etiennei* (Hymenoptera: Trichogrammatidae) from Guadeloupe was tested for specificity against eggs of native lepidopteran species, closely related weevils, i.e., *Pachnaeus* spp., and curculionids released for biological control of weeds. Other introduced species are being screened for specificity and potential as hyperparasitoids. *C. etiennei* has been recovered from *D. abbreviatus*

eggs and is established in south Florida. *Q. haitiensis* has been recovered from some weevil eggs in south and central Florida. Two parasitoid species, *Tamarixia radiata* and *Diaphorencyrtus aligarhensis*, have been imported, evaluated and released to control the citrus psyllid. *T. radiata* has overwintered and spread in at least three of the 1999 release sites in southeast Florida (Ft. Pierce, Boynton Beach and Boca Raton). The risk assessment for *Lipolexis scutellaris*, a parasitoid of the brown citrus aphid, *Diaphorina citri*, was completed in spring 2000 and submitted to the *ad hoc* committee of the Institute of Food and Agricultural Sciences organized by Dean Richard Jones. Following review by the committee, the risk assessment was forwarded to the Florida Department of Agriculture and Consumer Services, Division of Plant Industry. Approval was given in June 2000 to release *L. scutellaris* in Florida and the first parasitoids were immediately distributed into citrus in Alachua County. Approximately 14,000 *L. scutellaris* were released into citrus groves in Marion, Lake, Orange, Polk, Pasco, Indian River, St. Lucie, Lee, Hendry, Collier and Dade counties at a total of approximately 70 different sites. Two potent vertebrate toxins, lophyrotomin and pergidin, were recently isolated from larvae of the defoliating sawfly *H. hubrichi*, a candidate for classical biological control of the Brazilian peppertree (BP), *Schinus terebinthifolius*, and also larvae of the sawfly *Lophyrotoma zonalis* Rohwer (Hymenoptera: Pergidae), a candidate for control of the Australian melaleuca or paperbark tree, *Melaleuca quinquenervia* (Cav.) S.T. Blake, in Florida. Because fatal livestock poisonings by ingestion of sawfly larvae have occurred in at least four countries on three different continents, it could be very damaging to the discipline of classical biological control of weeds if sawflies released as biocontrol agents in the U.S. caused unexpected mortality in native birds and mammals. Quantification of these toxins and cytotoxicity studies are in progress. Host specificity studies were conducted for stem thrips, *Pseudophilothrips ichini*, using 30 plant species in 11 families. BP and California peppertree, *S. molle*, supported complete development of *P. ichini*. Field surveys conducted in Brazil confirmed that mango is not attacked by *P. ichini* under natural conditions. The nematode *Steinernema scapterisci* will again be produced commercially, and the product will be compared with standard chemical pesticides on golf course turf to control *Scapteriscus* spp. mole crickets.

**Florida A & M University (Charles O'Brien)**- A new Center for Biological Control has been established in collaboration with the USDA-APHIS and USDA-ARS. A training workshop in weevil and larval identification was held for three Miami Port Authority inspectors. A completed information/expert system of 21 genera and 29 species of weevil biological control agents in North America is being modified. An invitational talk was presented at a short course on the *Diaprepes* root weevil in support of ongoing biological control of this citrus pest. Work was begun on an integrated control plan for *Hydrilla verticillata* at Wakulla Springs State Park, with the FAMU Center for Biological Control releasing and monitoring *Hydrellia pakistani* flies. The flies are established and several mats of hydrilla in the river area have “crashed.”

**North Carolina State University (David Orr and Kathy Kidd)**- Work was done to develop an understanding of the biology and ecology of kudzu as part of a broader effort aimed at biological control of this invasive weed. Comparisons were made of physiological characteristics, growth and susceptibility to insect herbivory of kudzu plants grown from seed collected from various locations in Anhui Province, China, and North Carolina. Chinese plants had twice the growth rate of U.S. plants. It was found that, although both native and naturalized insects effectively

pollinate kudzu, only native herbivores effectively destroy the seed crop. Diversity and abundance of arthropod communities were similar in soybeans and kudzu. This work has provided the scientific basis for development of a biological control project aimed at kudzu, a major weed in the southeastern U.S..

**University of Tennessee (Jerome Grant and Paris Lambdin)**- The composition of lady beetles was determined in nine habitat types on the Barrens Plateau in middle Tennessee, 20 species of lady beetles representing 15 genera were collected. Six species comprised 86.8% of all lady beetles. The non-indigenous species, *Harmonia axyridis* (52.2%) and *Coccinella septempunctata* (10.7%), were the two most commonly encountered. The convergent lady beetle, *Hippodamia convergens*, common in North America, was not collected during this study, suggesting possible displacement by exotic species occupying a similar niche. Field studies are underway to assess the impact of the introduced thistle-feeding weevils, *Rhinocyllus conicus* and *Trichosirocalus horridus*, on non-target species of thistles.

**USDA-Florida (Chris Geden)**- The host range of the following fly parasitoids was evaluated using house fly, stable fly, horn fly and *Sarcophaga bullata* as hosts: *Trichopria* sp., *Spalangia nigroaenea*, *S. cameroni*, *S. endius*, *S. gemina* (from Brazil), *Muscidifurax raptor*, *M. raptorellus* (from Chile), *Tachniaephagus zealandicus*, and *Dirhinus himalayanus* (Chalcididae, from Morocco). This is the first systematic evaluation of parasitoids against horn flies. Host range studies with fly parasitoids will continue.

#### **Objective 4**

**University of Florida (Howard Frank, Jim Cuda)**- Field and laboratory studies were completed on a midge whose larvae mine the apical meristems of hydrilla, *Hydrilla verticillata*, and in the process disrupt new shoot growth. Field observations and laboratory experiments demonstrated that developing larvae severely injured or killed the plant's growing tips, preventing new hydrilla stems from reaching the surface of the water column. A laboratory colony of the midge was established for experimental purposes and maintained in the laboratory for 16 generations. The rearing program produced a sufficient number of specimens of the appropriate life stages for species identification. The hydrilla-attacking midge was identified as *Cricotopus lebetis* Sublette. This midge had not been recognized as a distinct species in Florida prior to this study. The biology of the native aquatic parasitic wasp *Trichopria columbiana* Ashmead (Hymenoptera: Diapriidae), a parasitoid of two *Hydrellia* flies released for classical biological control of hydrilla in the US, was investigated in the laboratory. *Trichopria columbiana* was found to be a solitary endoparasitoid of the pupal stage of *Hydrellia pakistanae* Deonier and *H. balciunasi* Bock (Diptera: Ephydruidae). Parasitism by *T. columbiana* is probably one of the principal biotic factors preventing the two *Hydrellia* flies from reaching their biotic potential, and having a greater impact on the target weed hydrilla.

**Florida A & M University (Charles O'Brien)**- Fly populations and their effect on the various *Hydrilla* mats are being studied in anticipation of further releases.

**University of Kentucky (Ken Yeargan)**- The predator, *Geocoris punctipes* undergoes reproductive diapause and populations from central Kentucky and southern Georgia differ with regard to the critical photoperiod required to induce diapause. In 2000 a study was initiated in Kentucky to determine the stage/instar of *G. punctipes* that is sensitive to photoperiodic induction of diapause. A better understanding of diapause in *G. punctipes* will be useful for rearing this predator and marketing it for augmentative releases (e.g., for biological control in greenhouse settings).

**University of Tennessee (Jerome Grant and Paris Lambdin)**- Research has been conducted to address biological control of selected arthropod pests and weeds: 1. Assess the incidence of gypsy moth, *Lymantria dispar*, and associated natural enemies, 2. Determine species composition of lady beetles in selected ecosystems to assess the impact of exotic species, such as the multicolored Asian lady beetle, on native species, 3. Identify native predators of scales in pine habitats along four elevation gradients, 4. Assess the incidence and species composition of insects associated with purple loosestrife, *Lythrum salicaria*, in upper eastern Tennessee, and 5. Assess the incidence of natural enemies of Japanese beetle, *Popillia japonica*. Large numbers of a native chrysomelid, *Atlica litigata*, were observed on purple loosestrife. Two parasitoids (Diptera and Hymenoptera) were recovered from about 5% of the adults (ca. 200) collected from purple loosestrife on 7-8 June 2000. Parasitoid identifications have not yet been provided. In a two-year study evaluating indigenous and previously established natural enemies of Japanese beetle, few parasitized (<1% parasitized by *Tiphia vernalis*) and infected (<1%; no milky spore-infections caused by *Paenibacillus popilliae*) grubs were recovered. Several bacteria and fungi (<1%) were isolated from grubs (*Acinetobacter baumannii*, *Bacillus thuringiensis* subsp. *canadensis*, *Bacillus thuringiensis* subsp. *dendrolimus*, *Bacillus megaterium*, *Metarhizium anisopliae*, and *Paecilomyces lilacinus*); however, their impact on grub populations is not known. Few adult *T. vernalis* were recovered from parasitized grubs, and no parasitized adult beetles were documented. Results suggest that levels of biological control of Japanese beetle in eastern Tennessee are very low. Gypsy moth populations are not permanently established in Tennessee; however, annual infestations do occur. Predators, primarily ant species, fed readily on gypsy moth eggs and pupae placed in the field. Of the potential predators found on egg masses and pupae, 123 were ants, representing five genera, primarily *Aphaenogaster* spp. and *Paratrechina* spp. (representing 85% of all ants collected). Several genera (e.g., *Aphaenogaster* spp. and *Camponotus* spp.) commonly fed on egg masses and pupae. The predatory status of *Paratrechina* spp. was unclear. No *Entomophaga maimaiga* was recovered from bioassayed soil samples.

**USDA-Florida (Chris Geden)**- The relative virulence of 14 strains of *Beauveria bassiana* was evaluated against larvae of the lesser mealworm, *Alphitobius diaperinus*, in the laboratory. Field trials were conducted using two strains and three formulations of *B. bassiana* against pest beetles in Georgia poultry houses. Bait formulations of *B. bassiana* were evaluated against adult houseflies in the laboratory. Results of the *B. bassiana* work suggest that bait formulation may be effective management tools for house fly, hide beetle and lesser mealworm populations in poultry manure. Evaluation of entomopathogenic fungi for management of livestock/poultry pests will continue.

**USDA-Texas (Susie Legaspi)**- Scientists from Texas, Florida, and California initiated a joint project on biological control of native aphids in citrus in the Lower Rio Grande Valley of Texas (LRGV). In anticipation of the arrival of the brown citrus aphid, *Toxoptera citricida*, into South Texas, predators were evaluated as possible biocontrol agents. The objectives of the project were to: 1. Conduct periodic field surveys of local commercial and dooryard citrus to assess the population dynamics and seasonality of the major predators of the native aphid species; 2. Measure the efficacy of the indigenous predators against the native aphid pests of citrus in south Texas; and 3. Conduct quantitative measurements of citrus tristeza virus titer in infected field trees, and to relate plant phenology and cultivar to transmissibility. Three native aphid species were commonly found in citrus, the spirea aphid, *Aphis spiraecola*, the cotton aphid, *Aphis gossypii*, and the black citrus aphid, *Toxoptera aurantii*. Other aphid species collected from citrus and weeds were identified as *Aphis nerii* from climbing milkweed, *Uroleucon ambrosiae* from citrus and *Hyperomyzus carduellinus* from sow thistle. *H. carduellinus*, which was discovered in Florida three years ago, is said to be originally from Southeast Asia and may well be a new state record for Texas. Beneficial predators in the weed-infested orchards were mainly the syrphid flies, the blood red ladybeetle, *Cycloneda sanguinea*; twice-stabbed ladybeetle, *Chilocorus stigma*; and the green lacewing, *Chrysoperla rufilabris*. Laboratory predation studies using coccinellid beetles feeding on *A. spiraecola* and *A. gossypii*, indicated that the convergent ladybeetle, *Hippodamia convergens*, was the most voracious predator followed by *C. sanguinea*, *Coleomegilla maculata* and *Hyperaspis* sp. For example, in a 1-hr feeding duration, we found that *H. convergens*, *C. sanguinea*, *C. maculata* and a *Hyperaspis* sp. preyed on 15, 11, 11 and 7 spirea aphids per adult beetle, respectively. To date, no citrus tristeza virus was detected in any of the field leaf samples.

**Virginia (VPI & SU) (Loke Kok)**- Specific effects of released biological control agents on pests and possible side effects are being studied at field sites where they have become established. Density of biological control agents, pests, and their distribution will be monitored.

### **Objective 5**

**University of Florida (Howard Frank, Jim Cuda)**- The leafroller, *Episimus utilis*, Zimmerman (Lepidoptera: Tortricidae), a candidate for classical biological control the Brazilian peppertree, *Schinus terebinthifolius*, has been difficult to rear. Multiple generations of the moth were finally obtained when adults were provided with Gatorade® as a nutritional supplement. Preliminary results indicated that adult females tend to survive longer and produce more eggs when provided with Gatorade® as a food source compared to a 10% honey/water solution or deionized water. Mass rearing and release *A. vaquitarum* in Florida will continue. Mass rearing systems also will be developed for parasitoids of citrus root weevil.

**University of Georgia (Kris Braman and David Buntin)**- Intensity and type of management, the cultural variable shade, and the combination of woody and herbaceous annual and perennial plants were evaluated for their effect on key landscape arthropod pests and beneficials. Carabidae, Staphylinidae, Formicidae and Aranea were not reduced by any strategy that included full traditional management with insecticide, herbicide, fungicide and fertilizer applied on a prescribed basis. Spiders and ants were collected more often in full sun plots. Carabids,

staphylinids and spiders were collected more often from pitfall traps in turf than in wood-chip mulched plant beds, whereas ants were equally common in both locations. *Chrysoperla rufilabris* was shown to be a more suitable candidate than *Rhinocapsus vanduzeei* for augmentative, not inoculative, release against the azalea lace bug. However, *R. vanduzeei* can effect reductions in azalea lace bug populations in the landscape and should be conserved. Sites managed by landscape professionals were monitored biweekly for beneficial arthropod activity. More than 30 generalist predator taxa were identified. Spiders and green lacewings were the most numerous and both were found on all plant taxa sampled. *Rhinocyllus conicus*, a biological control agent of musk thistle, is now widely distributed throughout the Piedmont region of Georgia. This weevil also attacks flower heads of another exotic weed, *Carduus crispus*, and was recovered in low numbers in 2000.

**University of Kentucky (Ken Yeorgan)**- Laboratory studies were completed on the harvestman, *Phalangium opilio*, the dominant opilionid species in Kentucky soybean fields. This species feeds on *Helicoverpa zea* eggs and first instar larvae. The polyphagous lady beetle, *Coleomegilla maculata*, was previously shown to oviposit frequently on the weed, *Acalypha ostryaefolia*, hophornbeam copperleaf, leading to higher densities of large *C. maculata* larvae on nearby corn. Oviposition preference was studied on *A. ostryaefolia* and eight other common broadleaf annual weeds in the field. When nine weed species were available, significant oviposition preference was found for *Abutilon theophrasti*, velvetleaf. *C. maculata* oviposition was not significantly influenced by the availability of potential prey or presence of *A. ostryaefolia* floral and fruiting structures. The diurnal and nocturnal predation of *C. maculata* eggs were observed on sweet corn, *Amaranthus ostryaefolia*, *A. theophrasti*, and *A. hybridus* L. *Coleomegilla maculata* egg clusters on *A. theophrasti* and *A. ostryaefolia* were preyed on less frequently than clusters on *A. hybridus* and corn, indicating that *A. theophrasti* and *A. ostryaefolia* provide refuge from predation and cannibalism of *C. maculata* eggs. Unlike any of the other plant species studied, both *A. theophrasti* and *A. ostryaefolia* possess numerous glandular trichomes. It appears that *C. maculata* preferentially oviposits on plants with glandular trichomes and this behavior reduces predation on its eggs. Studies of the predatory capabilities the most common harvestman found in Kentucky soybean fields (*P. opilio*) will provide a better understanding of this species' potential for suppressing pest populations in soybean. Investigation of the oviposition behavior of *C. maculata* could lead to methods of indirectly augmenting populations of this predator in cornfields (e.g., companion plantings). A study will be aimed at determining the stage/instar of *G. punctipes* that is sensitive to photoperiodic induction of diapause. Investigations will continue on the oviposition behavior of *C. maculata* and the ecology of *P. opilio*. The role that indigenous natural enemies may play in control of the newly introduced aphid pest of soybean, *Aphis glycines*, will also be studied.

**University of Tennessee (Jerome Grant and Paris Lambdin)**- Studies are underway to assess rearing methodology for *Geocoris punctipes* and its impact on selected pests in the greenhouse. Impact of artificial diet on biological characteristics (e.g., fecundity, fertility, predation rate, longevity, etc.) of *G. punctipes* will be evaluated, as well as the predatory capabilities of artificially reared adults on selected pests in cages in the greenhouse. The kairomone attraction of adult hemerobiids and anthocorids to the sex pheromones of three *Matsucoccus* spp. was assessed at five elevation gradients in pine-dominated forests. Hemerobiids were most abundant

in stands of table mountain pine, *P. pungens*, on dry, rocky ridges between 914 m and 1,392 m. Also, 14 of 25 specimens of *Elatophilus inimica* were captured from traps baited with pheromones. This arthropod species represents new county and state records, and this is the southern-most distribution record.

**Virginia (VPI & SU) (Loke Kok)**- Colonization and efficacy of natural enemies is being improved through habitat manipulation for resident species and improved rearing, distribution, and establishment of released exotic or native natural enemies. Methods for producing and using natural enemies will be improved by identifying and modifying environmental conditions that inhibit their reproduction.

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**Authorization:**

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