Pacific Branch
Entomological Society of America
Eighty-Fifth Annual Meeting

Marriott Hotel
Park City, Utah
June 24-27, 2001

Keith S. Pike, President

Abstracts

Opening Session and Preliminary Business Meeting

Woodworth Award

THE ECOLOGY OF LYME DISEASE IN THE FAR-WESTERN UNITED STATES

Robert S. Lane
Division of Insect Biology, 201 Wellman Hall, University of California, Berkeley, California 94720

Lyme disease is the most prevalent vector-borne disease in California and the United States at large. We have been studying the ecology and epidemiology of this tick-borne spirochetal disease in the Far West since the early 1980s. In California, the Lyme disease spirochete (*Borrelia burgdorferi*) and closely related spirochetes are maintained in a complex web of interconnected cycles involving several species of small mammals and *Ixodes* spp. ticks. The primary tick vector to humans is the western black-legged tick (*I. pacificus*), a widespread species that feeds on lizards, birds and mammals. Although spirochetal infection prevalences in *I. pacificus* adults typically are low (1-2%), those in populations of nymphal ticks sometimes average as high as 12-14% in northwestern California. Certain lizards abundantly infested by *I. pacificus* subadults have been shown to be incompetent hosts for *B. burgdorferi*, which serves to reduce the force of transmission to humans and other animals by the adult ticks. These and other highlights of our ongoing ecologic studies will be presented during this overview.

Comstock Award

LIMITATIONS TO ENTOMOPATHOGENIC NEMATODE RECYCLING IN COLORADO POTATO BEETLE (*LEPTINOTARSA DECEMLINEATA*)

Christine Armer
Entomology Department, Oregon State University

The Colorado potato beetle (CPB) is one of the most economically damaging herbivores on potato foliage. Because this beetle has developed resistance to most insecticides, I am examining biological control mechanisms to help reduce beetle

populations. The entomopathogenic nematode *Heterorhabditis marelatus* kills nearly 100% of CPB prepupae in soil. However, the nematode does not reproduce in the beetle. The beetles feed on glycoalkaloid-rich potato foliage, and appear to sequester the toxic alkaloids, solanine and chaconine. Nitrogen fertilization can increase glycoalkaoid content in the foliage as well as the tubers. The alkaloids could negatively affect the nematodes and their symbiotic bacteria, as these compounds are toxic to many animals and some bacteria. In order to determine the tritrophic effects of the glycoalkaloids on the nematodes and their bacteria, I fed CPB on potato foliage of plants provided no fertilizer, low (equivalent of 200 lb/acre), or high levels (600 lb/acre) of nitrogen fertilizer. I then examined the glycoalkaloid effects on the nematode and its symbiotic bacteria separately.

When the bacteria was inoculated into CPB hemolymph, the bacteria often switched immediately to a secondary form which could not benefit the nematode. Alkaloid content of the plants fed to the CPBs had little effect on the bacterial switch to the secondary form. Even when the bacteria remained in the primary form that produces antibiotics and food for its symbiotes, the nematodes did not grow or reproduce. In a separate study, CPB were fed on plants with zero, low, and high levels of fertilizer, and were then allowed to pupate in moist sand inoculated with 50 nematodes/cm^2. Nematodes did not reproduce in any of the 13 zero-nitrogen-fed beetles, but did reproduce in 6% (2/31) of low-nitrogen-fed CPB, and in 12% (3/26) of high-nitrogen-fed CPB. These unexpected results, in which the nematodes reproduced in the high-alkaloid-fed beetles and not in the ones fed on plants with low levels of alkaloids, may be explained by nematode competition within the host. When too many nematodes infect a single host, nematode reproduction can be limited. The alkaloids may kill most of the nematodes when they enter the CPB, allowing only a few nematodes that have an ability to survive with higher alkaloids levels, to reproduce. Thus, the potato foliar alkaloids appear to inhibit both the bacteria and the nematodes, but in limiting the nematodes, the alkaloids actually select for nematodes that can survive with higher alkaloid levels. Rather than limiting nematode reproduction and recycling in the agroecosystem, high alkaloid levels may actually allow the nematodes to reproduce within the host CPB. I am currently working on selecting an alkaloid-resistant nematode strain that can be applied at lower doses to determine if the allelochemicals can moderate competition. This work emphasizes the importance of considering the entire agroecosystem when implementing biological control.

Monday Morning Session

Student Paper Competition

M. S.

11:00

THE ESTABLISHMENT OF ECONOMIC INJURY LEVELS FOR THE BEET ARMYWORM, *SPODOPTERA EXIGUA*, IN CALIFORNIA SUGARBEETS

David R. Haviland[1], Larry D. Godfrey[1], and Tom Babb[2]

[1] Entomology Department, University of California Davis, One Shields Avenue, Davis CA 95616, USA

[2] Spreckels Sugar Company, P.O. Box 2240, Woodland CA 95776, USA

In recent years the beet armyworm, *Spodoptera exigua*, has surpassed aphids as the most economically important insect pest of California sugarbeets. Late season defoliation and subsequent crop losses have become a primary concern to growers in the central valley. Studies were conducted to determine host plant tolerance to defoliation through the establishment of economic injury levels.

Armyworm populations for the first field experiment were established naturally and then reduced with 0 to 4 insecticide applications during the 12 weeks preceding fall harvest. Season-long treatments of 2, 3, and 4 applications provided the best overall armyworm suppression. No significant differences were found among single applications made in July, August, and September, or multiple-application treatments. Parameters evaluated included leaf area (104 to 122 cm^2), yield (22.6 to 24.0 tons per acre), and sucrose (12.9 to 13.1%). Although economic damage was not incurred, data suggest that no significant losses occur for one time density counts of 7 larvae per 40 sweeps in August, 14 larvae in September, and 9 larvae in October. Also, no significant differences were found for cumulative damages of 3.3 larvae per 40 sweeps over the 11 weeks before fall harvest.

The second field experiment was artificially infested 1, 2, or 3 months before fall harvest with 0, 20, 40, 80, or 120 *S. exigua* eggs per six inches of row. Eclosion (in the absence of predators and parasites) averaged 18.5% (July), 34.0% (August), and 17.8% (September). This is the equivalent of 22.2, 40.8, and 21.4 first instar larvae per plant in the 120-egg treatment. Due to high predation and other variables, larvae failed to establish. The net result was a lack of treatment differences, thus resulting in no significant differences among infestation treatment levels or among infestation dates.

11:10

DEVELOPMENT AND EVALUATION OF ARTIFICIAL DIETS FOR REARING THE LOOSESTRIFE ROOT WEEVIL (*HYLOBIUS TRANSVERSOVITTATUS* GOEZE)

Luis F. Matos and John J. Brown

Department of Entomology, Washington State University, FSHN 166,

Pullman WA, 99163, USA

Purple loosestrife (*Lythrum salicaria* L.) is an exotic wetland weed that overtakes the habitat it enters and reduces plant and animal biodiversity in the U.S. and Canada. Loosestrife infests lands that are not highly productive and therefore it is not cost effective to use herbicides to control this weed. *Hylobius transversovittatus* Goeze (Curculionidae) is an effective biological control agent of purple loosestrife that is not currently mass reared. Adults feed on the leaves of the plant causing some damage. However, the larvae of *Hylobius* feed within the roots and are capable of killing the plant in two to three years. We have developed an artificial diet which enables us to rear *Hylobius transversovittatus* from egg to adult in an average of only 74 days. Currently, 50% of all eggs placed on diet reached the adult stage. Approximately 40% of total mortality occurred during the first ten days. Recent alterations of diet composition and handling techniques have yielded less than 10% larval survival after the first ten days. We are able to rear *H. transversovittatus* for less than two dollars per individual weevil. This is one fifth the current cost of rearing these weevils in green houses.

11:20

ASSESSING THE IMPACT OF PESTICIDE MIXTURES ON THE SURVIVAL AND FECUNDITY OF *DAPHNIA PULEX*

Susanna Hopkins and John Stark

Puyallup Research and Extension Center, Washington State University, 7612 Pioneer Way E. Puyallup, WA 98371, USA

Pesticides commonly found in Puget Sound ground waters (determined from the USGS Fact Sheet – 097-99) were tested individually and in combination at the concentrations detected by the USGS. These pesticides included – Diazinon (0.3 ppb), Chlorpyrifos (0.02 ppb), Malathion (0.1 ppb), Carbaryl (Sevin – 0.04 ppb), and 2,4-D (1.0 ppb). Ten day population growth studies with *Daphnia pulex* neonates (Branchiopoda, Cladocera) were run in the laboratory.

Population growth studies were also conducted using water from several Puget Sound streams. These studies were run concurrently in the laboratory and in the field to assess the impact of multiple stressors in the natural environment. The duration of these studies depended on the temperature of the water. Control tests were run simultaneously in both the laboratory and the field sites using reconstituted water from the laboratory.

At these concentrations there did not appear to be any significant effect by the pesticides, either individually or as a mixture, on either the mortality or the fecundity of *Daphnia*. However, water temperature and nutrition did appear to have a significant impact on the fecundity of *Daphnia*.

Ph. D.

11:30

MASS PRODUCTION OF *ANAGYRUS ANANATIS* FOR AUGMENTATIVE BIOLOGICAL CONTROL OF PINK PINEAPPLE MEALYBUG

Raju R. Pandey and Marshall W. Johnson.

Dept. of Plant and Environmental Protection Sciences, Univ. of Hawaii at Manoa, Honolulu, HI 96822, USA

Three species of pineapple-infesting mealybugs (MB) along with an associated Closterovirus cause Pineapple Mealybug Wilt (PMW) disease. Pink pineapple mealybug, PPM, *Dysmicoccus brevipes* (Ckll.) (Homoptera: Pseudococcidae), is the most common MB in Hawaii's pineapple and is attacked by several natural enemies. Attending ants reduce the effectiveness of natural enemies including that of the most common internal parasitoid wasp *Anagyrus ananatis* Gahan (Hymenoptera: Encyrtidae). In efforts to improve biological control by *A. ananatis* in the presence of ants, possibility of augmenting the natural *A. ananatis* populations by mass-reared individuals is being investigated. PPM reared on Kobocha squash were graded through standard sieves and exposed to parasitoids. Individual mummies were transferred to gel capsules and size of emerging wasps were measured. Host MB size significantly affected the parasitoid body size; mature adult MB producing larger sized wasps. Parasitization of PPM host separated from squash produced *A. ananatis* individuals that were 10% smaller than individuals reared from PPM on the squash. Because the number of hosts attacked by individual wasps was significantly correlated with the wasp's body size, and wasp body size was significantly correlated with host MB size, it was important to produce a uniform mature adult PPM colony for parasitization. Kobocha squash (~700g) infested with 0.5g of mature gravid female PPM produced >2500 mature adult PPM suitable for parasitoid production, which was significantly higher than those from squash infested with PPM nymphs and young adults. With an 80% parasitization rate it was possible to produce >2000 parasitic wasps from one squash.

Poster Presentations

M. S. Competition

D1

DEVELOPING A MORE SPECIES SPECIFIC PHEROMONE MONITORING SYSTEM FOR *HELICOVERPA ZEA* (LEPIDOPTERA: NOCTUIDAE)

Todd B. Adams[1], Peter J. Landolt[2], and Richard S. Zack[1]

[1]Department of Entomology, Washington State University, Pullman, WA, 99164-6382, USA

[2]USDA-ARS, Yakima Agricultural Research Laboratory, 5230 Konnowac Pass Rd. Wapato, WA 98951, USA

The purpose of this research was to develop a more specific pheromone monitoring system for *Helicoverpa zea* (Boddie) while excluding the non-pest, but commonly collected, moth *Heliothis phloxiphaga* (Grote and Robinson). Ratios of two of the four *H.* zea pheromone components, (Z)-7-hexadecenal and hexadecanal, were varied from 0-23.3% and 0-25% respectively. The pheromone blend containing 23.3% (Z)-7-hexadecenal reduced the capture of *H. phloxiphaga* by 60%. In a comparison of five septa types, West-Red septa and West-Gray septa were superior to others in attracting *H. zea* to traps. The best pheromone dose for the optimal capture of *H. zea* was 1.1 mg. In a comparison of trap designs, the Universal Moth Trap and the Scentry® Heliothis Trap were superior in capturing *H. zea* attracted to pheromone. In a direct comparison of the monitoring system currently in use with a monitoring system developed in these experiments, it was found that there was no difference in the numbers of *H. zea* captured, but the number of *H. phloxiphaga* captured was reduced in the experimental monitoring system by 80%.

Another part of this study was to determine the seasonal occurrences and flight patterns of *Helicoverpa zea* (Boddie) and *Heliothis phloxiphaga* (Grote and Robinson). The intent was to compliment recent improvements made to the *H. zea* pheromone monitoring system. In 1999, there appeared to be two flight periods of *H. zea* with evidence of migratory contributions. These periods occurred from early July to late July and from mid August to mid September. In 2000, there appeared to be one continuous flight period from late May through mid October. During both years there appeared to be two flight periods of *H. phloxiphaga*. These periods were from late April to early June and from mid July through August. Early in the corn growing season the majority of the moths captured in pheromone monitoring systems will be *H. phloxiphaga*, a non-economic species. Close attention should be given to the identification of moths trapped from mid June on when servicing *H. zea* pheromone monitoring traps to avoid false positive identifications.

D2

TREATMENT THRESHOLDS FOR CONTROL OF *VARROA DESTRUCTOR* (ACARI: VARROIDAE) IN WASHINTON STATE

James P. Strange and Walter S. Sheppard

Department of Entomology, Washington State University, Pullman WA, 99164, USA

Varroa destructor is the most damaging pest to managed *Apis mellifera* (Hymenoptera: Apidae) colonies worldwide. Two compounds with similar efficacy, fluvalinate and coumaphos, are currently used for control of this mite in the United States; however, chemically resistant mite populations have been found in the United States and Europe. To reduce the selection pressure on mite populations and to decrease the cost of extraneous chemical applications we sought to determine the damage threshold mite population at three times in the year. Treatment threshold numbers were calculated for two commonly used sampling methods in April, August, and October. The accuracy of the two sampling methods, ether rolls and sticky boards, were compared against one another and sampling recommendations are presented.

D3

SUCROSE OCTANOATE AS AN ALTERNATIVE COMPOUND FOR CONTROL OF *VARROA DESTRUCTOR* ON HONEY BEES

M. A. Gardner, J. P. Strange, and W. S. Sheppard

Department of Entomology, Washington State University, Food Science and Human Nutrition Building 252, Pullman, WA 99164-6382, USA

The parasitic mite *Varroa destructor* (Anderson & Trueman) is the greatest problem facing managed honey bee (*Apis mellifera*) colonies in the United States. Currently only two treatments are approved for *Varroa destructor* control, fluvalinate, a synthetic pyrethroid, and coumaphos, an organophosphate. Concerns about resistance development and pesticide residues in hive products highlight the need to consider alternative classes of *Varroa* mite control agents. We report here the results of experiments testing sucrose octanoate as an alternative control of *Varroa destructor.* Sucrose octanoate is a sugar ester, a class of compounds that have previously been used for greenhouse whitefly and pear psylla control. Sucrose octanoate was applied to each frame in a honey bee colony with a pressure sprayer at a concentration of

0.12 percent active ingredient in water. The chemical provided greater than 80 percent control when initial mite levels were less than 2000 per colony, and greater than 50 percent control when colony mite levels were greater than 2000. This was significantly higher than the control treatment of water. Several applications are necessary to obtain adequate control of large infestations. We suggest that sucrose octanoate is a safe and effective compound for *Varroa* mite control and are currently researching a more efficient means of application.

Ph. D. Competition

D4

BENEFITS OF MULTI-LEVEL MONITORING OF PINK BOLLWORM RESISTANCE IN BT COTTON IN ARIZONA

L. Antilla[1], R. Webb[1], M. Tabashnik[2], T. Dennehy[2] and Y. Carriere[2]

[1]Arizona Cotton Research and Protection Council, 3712 E. Weir, Phoenix AZ, USA

[2]Entomology Resistance Management Laboratory, University of Arizona, Tucson, AZ, USA

The advent of Bt cotton has revolutionized the control of pink bollworm, the most serious pest of cotton in the desert southwest. Widespread adoption of Bt technology by Arizona growers has increased the risk of PBW resistance development. To address this issue a multi-level approach to resistance monitoring has been adopted by the Arizona Cotton Research and Protection Council including:

Monitoring of over wintering PBW moth population emergence. This long-term survey provides insight into the suppressive effect of Bt cotton on PBW areawide.

Paired Field Studies-Boll sampling of 36 pairs of adjacent Bt/non-Bt fields statewide measures the continued efficacy of Bt in areas of high PBW pressure.

Embedded Refuge Studies-Sampling studies involving a single row embedded non-Bt refuge strategy provide an effective alternative to external refuge scenarios.

Rapid Response Team-A standardized approach utilizing trained personnel to rapidly investigate reported cases of inadequate field performance of Bt significantly increases the scope of monitoring statewide.

General Posters

D5

RESPIRATION ANALYSIS OF MULTICOLORED ASIAN LADY BEETLES (COLEOPTERA: COCCINELLIDAE) USING CALORESPIROMETRY

E. Barçin ACAR[1], Bruce N. SMITH[2], Lee D. HANSEN[3], Gary M. BOOTH[1]

[1] Department of Zoology, Brigham Young University, Provo UT 84602, USA

[2] Department of Botany and Range Science, Brigham Young University, Provo UT 84602, USA

[3] Department of Chemistry and Biochemistry, Brigham Young University, Provo UT 84602, USA

Recognizing temperature responses of predatory insects is an important part of predicting their potential as bio-control agents of herbivorous insects. Metabolic heat rates (R_Q) and respiration rates (R_{CO2}) of *Harmonia axyridis* Pallas, multicolored Asian lady beetle, were measured in isothermal calorimeters at 5°C intervals from 5 to 40°C. To illustrate the power of current methods of calorespirometry in determining the response of energy metabolism to environmental variables, this study measured metabolic heat and CO_2 production rates of multicolored Asian lady beetle as a function of temperature by isothermal calorimetry. Anabolic rates and energy use efficiencies were calculated as functions of temperature from the calorespirometric data. The respiration-based calculations of isothermal calorimetry were consistent with known behavior of lady beetles at corresponding temperatures. The results demonstrate the energy use efficiency of lady beetles changes continuously with temperature. This methodology provides fast and efficient determination of suitable temperature ranges required for optimum biological control success for beneficial insects.

D6

PREDICTING SEEDING DATES THAT REDUCE INFESTATION RISK BY WHEAT MIDGE *SITODIPLOSIS MOSELLAN*A [DIPTERA: CECIDOMYIIDAE]

E.J. Bechinski

Division of Entomology, University of Idaho, Moscow, Idaho 83844-2339, USA

Management of the wheat midge primarily depends on chlorpyrifos applied as foliar sprays to kill adults before they oviposit on flowering wheat heads. Wheat is most susceptible to larval feeding injury when eggs are laid on flowering heads; larvae cannot complete development if oviposition occurs earlier or later than flowering. A degree-day model that forecasts adult flight activity could enhance IPM decisions by helping growers identify high risk fields (fields in flower when midge activity reaches season peaks). We monitored 2000 flight activity by trapping adults at commercial spring wheat fields along a 20-mile south-to-north transect from Bonner's Ferry, Idaho; we then described midge captures as a function of degree-days above 5?C since 1 January 2000 by fitting a probit model to our data. The model predicts that midge flights begin at 735 DD $_{5?C}$, reach seasonal peaks at 820 DD $_{5?C}$ and end at 915 DD $_{5?C}$. Validation with an independent data set showed that predicted dates of peak seasonal flight fell within 3-to-4 days of observed dates. We are using our flight model in combination with a plant day-degree model so as to identify wheat seeding dates that reduce the risk of larval feeding injury by avoiding coincidence of crop flowering and adult midge emergence.

D7

AGRICULTURAL PRACTICES IN ORCHARDS TO REDUCE PESTICIDES IN SURFACE WATER FOLLOWING DORMANT APPLICATIONS

Brian L. Bret

Sacramento River Watershed Program, 327 College Street, Woodland, CA

The Organophosphate (OP) Pesticide Focus Group (Focus Group) is a working group of the Sacramento River Watershed Program (SRWP). It was formed in June 1999 and is focusing initially on developing a water quality management strategy to address pesticide loading to the watershed from dormant orchard sprays.

The objective of the group is to develop a strategy and a set of voluntary practices whose implementation will result in significantly decreased negative impact of pesticide use on the natural resources of the Sacramento River Watershed. The practices being evaluated have been grouped into three categories:

1. On-Site Practices for Runoff Reduction - Includes cover crops, vegetative filter strips, grassed waterways, water & sediment control basins, berms at low ends of fields, etc.
2. Selection of Pest Management Strategies - Includes alternate year dormant applications, no dormant sprays/in-season as needed, conventional non-OP dormant sprays, bloom-time sprays, pheromone mating disruption, and other pest management strategies.
3. Application Methods – When and where applications are required, includes use of setback/buffer zones, drift mitigation practices, sprayer calibration, nozzle selection, new equipment technology, etc.

A broad menu of management practices have been incorporated into the strategy from which growers can voluntarily select, choosing the combination of practices that best suit their site(s), operations, and needs.

D8

PARASITOIDS IN ALFALFA AFTER EARLY AND NORMAL SEASON INSECTICIDE USE FOR ALFALFA WEEVIL CONTROL

M. J. Brewer

Department of Renewable Resources—Entomology, PO Box 3354, University of Wyoming, Laramie, WY 82071, USA

The effect of selected pyrethroids (applied to alfalfa weevil larvae) and carbofuran (applied pre-hatch of weevils and at the time of pyrethroid application) on alfalfa weevil and parasitoid populations were compared. All insecticides applied to weevil larvae provided good control. Early application of carbofuran provided suppression, and minimized kill of parasitoids, including *Bathyplectes curculionis*. Applied to larvae, the pyrethroids had less effect on parasitoids than carbofuran.

D9

FLYING HIGH - MIDGES WITH ALTITUDE (DIPTERA: CHIRONOMIDAE)

Peter S. Cranston

Department of Entomology, University of California, 1 Shields Avenue, Davis, CA 95616-8584, USA

The Chironomidae (non-biting midges, bloodworms) form a substantial component of the diversity of aquatic macroinvertebrates in all kinds of waterbodies. In California, species-level studies generally have involved taxa associated with ricefields (as beneficials and potential pests), nuisance midges in urban impoundments and floodways, and selected monographic treatments at continental scale. A more diverse range of taxa surely are associated with biological water quality assessment projects, but taxonomic treatments of this important family in these studies have been modest despite the availability of popular genus-level keys, and recognition of more detailed identifications in eastern states.

With funding from Sequoia and Kings Canyon National Parks, a biotic survey has commenced in the southern sector of Sequoia N. P. Surveys at elevations from 1300 to 8000 feet in fall 2000 and spring 2001 have encompassed streams and rivers, using drift nets to intercept floating pupal exuviae and other life stages, and high elevation bogs and meadows.

Initial results show 65 taxa in 40 genera, predominantly in the 'cool stenotherm' subfamily Orthocladiinae, with fewer Tanypodinae and Chironominae. The latter are expected to increase in warmer waters of summer. Twelve genera have not been reported from California previously, comprising mainly lotic taxa associated with smaller high elevation streams or cold bogs. These genera, including *Stilocladius* Rossaro, *Krenosmittia* Thienemann & Kruger, *Paracricotopus* Thienemann & Harnisch and *Rheosmittia* Brundin, seem to be southern outliers of more northern or western outliers of eastern-distributed taxa, and typically are Holarctic in distribution. Some species-level endemism appears likely, but genus-by-genus revisionary study will be necessary to confirm.

These findings, and those to be made in future, likely will provide a more balanced view of the chironomid fauna of California, which currently reflects mostly warm eurythermic, often pollution-tolerant, taxa of the valley floor.

D10

THE IMPLEMENTATION OF AN INSECT WORKSHOP IN THE ELEMENTARY CLASSROOM

Melissa M. Gaver

Eastern Washington University, Education Department, Williamson Hall 312, Cheney, WA 99004, USA

Insects have been used as an educational tool in all grade levels with great success. By keeping live insects in the classroom teachers are able to provide for their students the excitement of caring for and observing one of natures most abundant and fascinating organisms. An insect workshop offered to elementary teachers can further advance the uses of insects by offering ideas and lesson plans for use across subject curriculum. This can also dispel fear and instill in the students an appreciation for insects and their importance in the environment.

D11

PUTO: A PUTATIVE MEALYBUG? (HEMIPTERA: COCCOIDEA: PSEUDOCOCCIDAE)

Penny J. Gullan[1] and Lyn G. Cook[2]

[1]Department of Entomology, University of California, 1 Shields Avenue, Davis, CA 95616-8584, USA

[2]School of Botany & Zoology, The Australian National University, Canberra, The Australian Capital Territory 0200, Australia

Puto Signoret contains almost 60 species that feed on a wide range of plants. They are distributed throughout the Holarctic and Neotropical regions, but over 20 species occur in western North America. Adult females are mealybug-like in appearance but adult males are less degenerate (more plesiomorphic) than the males of typical pseudococcids in showing greater development of the exoskeleton and the eyes. *Puto* is plesiomorphic in cytology (XX-XO) and its endosymbionts differ from those of other mealybugs that have been studied. Cladistic analysis of morphological data from adult females, adult males and first-instar nymphs has placed *Puto* in the mealybug family (Pseudococcidae), and this position has been widely accepted. Another controversial classification puts *Puto* in a family of its own (Putoidae). Nucleotide sequence data from the nuclear small-subunit ribosomal RNA (SSU rDNA, also called 18S rDNA) suggest that *Puto* does not belong to the Pseudococcidae, although its phylogenetic placement is ambiguous. The molecular phylogenetic data suggest that *Puto* diverged from the "advanced" coccoid families (the neococcoids), including the Pseudococcidae, prior to the evolution of paternal genome elimination, which is a shared derived feature of neococcoids.

D12

MONITORING *CARPOPHILUS* SPP. (COLEOPTERA: NITIDULIDAE) IN AUSTRALIAN STONE FRUIT USING AN IMPROVED FOOD-ATTRACTANT

Mofakhar S. Hossain and Cathy Mansfield

Institute of Sustainable and Irrigated Agriculture, Tatura Centre, Private Bag 1, Tatura, VIC 3616, Australia

The attractiveness of five fermenting food odours to *Carpophilus* spp. was investigated in Northern Victoria, Australia at an apricot orchard during one cropping season (October 2000 to January 2001). Polyacrylamide granules were used to absorb yeast fermented apple, peach, apricot and grapefruit juices. No granules were used with grapefruit pulp, but yeast was added to ferment the fruit. Fermented apple juice (FAJ) was used as "standard" bait and its attractiveness was compared to the other food odours. All baits were replaced weekly. Fermented peach juice (FPJ) attracted significantly higher numbers of *C. davidsoni* and *C. hemipterus* compared to that of the other food attractants tested throughout the season. The study suggests that monitoring of *Carpophilus* spp. can be improved by use of FPJ.

It is possible that FPJ could be used to enhance the efficacy of the Carpophilus aggregation pheromone, if it was used as a co-attractant for mass-trapping. This will be the subject of further research.

D13

WHITEFLY TRANSMITTED COTTON LEAF CRUMPLE DISEASE RESISTANCE VERIFIED VIA MOLECULAR TECHNIQUES

E. Natwick[1], R. Gilbertson[2], T. Turini[1], Young-Su Seo[2] and C. Cook[3]

[1]University of California Coop. Ext., 1050 E Holton Rd Holtville, CA, USA

[2]University of California, Davis, CA 95616, USA

[3]Syngenta Seeds Inc., Victoria, TX, USA

Ten cotton, *Gossypium hirsutum* L., cultivars or breeding-lines were evaluated in the field for resistance to the cotton leaf crumple (CLCr) disease caused by (Genus *Begomovirus*, Family *Geminiviridae*) *Cotton leaf crumple virus* (CLCrV) transmitted by silverleaf whitefly, *Bemisia argentifolii* Bellows and Perring. The cultivars Texas 121, AP 4103, AP 6101 and Stoneville 474 and the breeding-lines were NK 2165C, NK 2108SS, NK 2387C, NKX C429-93-2ct, NKX 2907, and NKX 2207 were in Imperial Valley, CA. Cotton entries were rated for severity of CLCr disease symptoms and the presence of CLCrV in leaves of selected plants of each cultivar/breeding-line was determined by dot blot hybridization with a CLCrV DNA probe and PCR analysis with degenerate geminivirus primers. DNA sequencing of geminivirus DNA-A and DNA-B fragments, amplified from symptomatic cotton plants, was used to confirm geminivirus infection and partial characterize CLCrV. Results showed differences in whitefly infestation levels and virus disease symptoms among cotton entries. The cultivar AP 4103 had a higher CLCr disease rating than other entries except AP 6101. The breeding-line NK 2387C, with Cedix parentage, had a lower CLCr disease rating than other entries except Stoneville 474 and NK X2207. There were visible CLCr disease symptoms in Stoneville 474 and NKX 2207, but KN 2387C did not display visible CLCr disease symptoms nor was viral DNA detected in this line.

D14

TESTING OBLIQUE BANDED LEAFROLLER (*CHORISTONEURA ROSACEANA*) PHEROMONE LOAD RATES FOR MONITORING AND PREDICTING DAMAGE IN FRENCH PRUNES

Carolyn Pickel[1] and W. H. Olson[2]

[1]University of California IPM, 142-A Garden Hwy, Yuba City, CA 95991, USA

[2]UCCE, 2279 Del Oro Ave, Suite B Oroville, CA 95965, USA

Two experimental load rates from Trece, Inc. were compared to the commercial lure to determine if lower load rates can be used as a better indicator of population levels. This was done to determine if trap catches can be used to predict damage at harvest. The lures were tested in thirteen orchards throughout the state. Each orchard had three treatments. The 8253P, a low amplitude lure, was placed in the check, reduced risk, and grower standard blocks to compare treatments. The commercial lure 3223 and the lowest load rate 8709 were placed in the reduced risk treatment to compare traps catches. Traps were placed at least 10 trees from each other. The trap catches from the 3 traps were compared to larval sampling conducted from 3/1/2000 through 8/15/2000 and the oblique banded leafroller damage at harvest in each treatment to see which rate would be the best indicator of population density. The correlation between in-season larvae (R^2=0.42) and damage at harvest (R^2=0.50) was considerable better with the ultra low load lure (8709) than the other two load rates. The correlations between in-season larvae and the other commercial (3223) and the low load (8253P) were all less than R^2=0.18. The correlation for the 8709 lure shows that if you catch more than 80 moths you will have more than 1% damage at harvest. Correlations between mean in-season larvae and damage at harvest was R^2= 0.81. This shows a

high reliability of having damage at harvest when more than one larva is found. There was a poor correlation between fruit damage found in season and harvest.

D15

KEEP IT COMPLEX: BIOLOGICAL CONTROL OF MITES IN WASHINGTON HOP YARDS

T. S. Price and D. G. James

Washington State University, Irrigated Agricultural Research and Extension Center, Prosser WA 99350-8694, USA

Mite populations (*Tetranychus urticae*) were monitored during the summer of 2000 in a pesticide-free hop yard at WSU-Prosser, Washington, to determine the extent of biological control provided by endemic natural enemies. Arthropods (pests and beneficials) were monitored weekly during March to October by sampling and examining leaf samples.

Early season (May to mid-July) numbers of *T. urticae* remained at low levels with insect predators, primarily the mite-eating ladybird, *Stethorus picipes*, and anthocorid, *Orius tristicolor*, providing good mite control by targeting localized 'hot spots'. Predatory mite (*Galendromus occidentalis/Neoseiulus fallacis*) populations developed during July augmenting and maintaining control of *T. urticae*. By September, numbers of phytoseiids exceeded numbers of *T. urticae*. Population levels of twospotted mite generally remained below 5/leaf for the whole season (well below the conservative damage threshold of 10/leaf) and cones were virtually free of mites at harvest. Prospects for utilizing the endemic complex of natural enemies for biological control of mites in Washington hop yards, are discussed.

D16

EFFECT OF MONOSODIUM GLUTAMATE AND GLUTAMATE RECEPTOR ANTAGONISTS ON CODLING MOTH LARVAE FED APPLE LEAVES

Maciej A. Pszczolkowski, Luis F. Matos, Sandye M. Bushman and John J. Brown

Department of Entomology, Washington State University, Pullman, WA, USA

We found that larvae of codling moth can successfully complete the first instar when fed apple leaves instead of apples. Although the maximum body weight of larvae fed leaves is less than that of larvae maintained on apples or on artificial diet, 100% larvae molted to the second instar 3-5 days after hatch. Monosodium glutamate (MSG), widely used as a culinary taste enhancer, can increase feeding on leaves by codling moth larvae. Depending on the concentration, the duration of bioassay, and larval age at time of application, MSG increased leaf intake by 25-60% over larvae given control, solvent- treated leaves. The effect of monosodium glutamate was best demonstrated in the first day following hatch. Exposure to MSG also accelerated molting to the second instar. MSG increased feeding intensity only if the neonates had been exposed to MSG within first 3h of feeding.

Using vertebrate glutamate receptor (GluR) antagonists, we documented that vertebrate- type glutamate receptors may play a role in feeding behavior of codling moth larvae. GluR antagonists suppressed feeding intensity only if the neonates had been exposed to these chemicals within first 3h of feeding. Addition of GluR antagonists to test solutions abolished the increase of feeding ratios caused by MSG.

We also tested combined effects of MSG and Spinosad, a fermentation-derived lacton, on codling moth larvae. Stimulatory properties of MSG were preserved in the presence of Spinosad fromulation, Success®, and mortality from Success®/MSG combination increased by a factor of 3.1 in comparison to Success® alone. Our results extend previous concepts regarding feeding stimulant incorporation into pesticide formulations that act via alimentary tract, and suggest that lower amounts of toxic ingredients may be used, without affecting efficacy of these formulations. Here, we postulate that first instar codling moth larvae are potential targets for treatment with pesticide formulations enhanced with monosodium glutamate.

D17

ASSESSMENT OF INSECTICIDE EFFICACY FOR ROOT WEEVIL CONTROL

T. L. Collins, R. L. Rosetta and S. E. Svenson

Department of Horticulture, Oregon State University, NWREC, Aurora, OR 97002-9543, USA

The trial was conducted on *Rhododendron* 'Catawbiense Album' in 1-gallon containers. In May of 2000, adult stages of black vine root weevil (BVW), and rough strawberry root weevil (RSW), were established in the rhododendrons (seven BVW, three RSW applied to each container). On May 30 treatments were applied to the rhododendrons. Treatments were evaluated for percent adult mortality at 6 and 14 days after treatment (DAT), June 5 and June 12 respectively, for all treatments.

For black vine weevil (BVW) at 13 DAT, both rates of lambda cyhalothrin treatments had highest Effective Kill Ratios (EKR) for BVW compared to all other treatments except acephate and bifenthrin. In this trial there were differential

effects of pesticides based on species. While acetamiprid appeared ineffective for BVW, it was effective for RSW. Similarly, soil applied thiamethoxam did not significantly kill BVW, but did have higher EKRs for RSW.

In a "re-challenge" study, untreated weevils were added to treated pots 20 DAT, and evaluated 23 DAT. The foliar thiamethoxam was still effective for BVW, but the lambda cyhalothrin was not. For BVW, the lambda cyhalothrin provides a more effective initial kill, but the thiamethoxam has better residual kill. In contrast, lambda cyhalothrin was still effective against RSW, along with the high rate of foliar thiamethoxam and soil applied thiamethoxam. Bifenthrin was not different from the untreated controls for RSW. The best Residual Kill was provided by the high rate of foliar applied thiamethoxam, killing 39% of the BVWs, and 66% of the RSWs.

D18

ECOLOGY AND IDENTIFICATION OF THE GRAPE LEAFHOPPER EGG PARASITOIDS *ANAGRUS* SPP. IN WASHINGTON'S COLUMBIA BASIN

Christian P. Storm, David G. James, Larry Wright

Irrigated Agriculture Research and Extension Center, Washington State University, 24106 N. Bunn Road, Prosser, WA 99350, USA

In south central Washington, there are two leafhopper species, the western grape leafhopper *Erythroneura elegantula* Osborn and the Virginia creeper leafhopper, *E. ziczac* Walsh (Hemiptera: Cicadellidae), which are pests of wine grapes. In the IPM systems of California, the egg parasitoids *Anagrus* spp. (Hymenoptera: Mymaridae) provide ample leafhopper control, but in Washington, no real attempt has been made to integrate them with conventional control. Currently, very little is known about the *Anagrus* spp. in Washington. Using the key by Triapitsyn (1998), at least four species have been identified, including *A. erythroneurae, A. daanei, A. atomus* and *A. tretiakovae*. Species of leafhoppers and *Anagrus* spp. were identified on blackberry, wild rose and grapes and the populations of leafhopper and *Anagru*s spp. were monitored through the growing season.

D19

INSECT RESPONSE TO PLANT DIVERSITY AND PRODUCTIVITY ON AN EXPERIMENTAL HAZARDOUS WASTE BURIAL SITE

Erik J. Wenninger

Department of Biological Sciences, Idaho State University, Pocatello, ID 83209-8007, USA

The primary aim of this study was to determine how insect communities responded to two plant community treatments (a crested wheatgrass monoculture and a diverse community of native shrubs, grasses, and forbs) and three irrigation regimes (summer irrigation, fall/spring irrigation, and ambient precipitation only) on an experimental site designed to test protective cap designs for isolating buried hazardous waste. The site consisted of a grid of 12 plots with each plot divided into six contiguous 8×8 m sub-plots; each plot represented one replicate of each plant $\times$ irrigation treatment combination. I sampled insects by sweep-netting in June, July, and August 2000 and compared insect species richness and abundance among the treatments.

Early in the summer insect species richness and abundance were strongly dependent upon both vegetation and irrigation treatment, while irrigation treatment alone was a better predictor of insect distribution later in the summer. Insect richness and abundance were both greater on the high diversity plant communities and fall/spring irrigated plots in June. In July and August insect abundance showed no relationship with vegetation treatment. Insect richness in July was higher on the high diversity plant communities, but showed no relationship with vegetation treatment in August. In both July and August insect richness and abundance were greater on both supplemental irrigation treatments. Insect abundance and species richness were both positively correlated with total plant cover throughout the summer. The possibility of insect herbivore outbreak on this experimental site—particularly on the plant monoculture—is of potential concern. However, total insect abundance and richness were not strongly tied to plant diversity throughout the summer, and insect trophic groups (e.g. herbivores and predators/parasitoids) showed similar distribution patterns, suggesting that the monoculture on this site may not be predisposed to outbreak.

D20

EFFECT OF TEMPERATURE ON THE BIOLOGY OF *BRACHYCAUDUS SCHWARTZI* (HOMOPTERA: APHIDIDAE)

Serdar Satar[1] & Raymond Yokomi[2]

[1]Çukurova University, Faculty of Agriculture, Department of Plant Protection, Balcali 01030 Adana, Turkey

[2]USDA, ARS, Crops Pathology and Genetics Research, 9746 So. Zediker, Parlier, CA, 93648, USA

During a field survey of aphids in the San Joaquin Valley in July 2000, we encountered the aphid *Brachycaudus schwartzi* on peach and nectarine trees. The aphid was heavily parasitized by *Lysiphlebus testaceipes.* Therefore, we began a temperature-dependent study of the aphid at constant temperatures of 15, 20, 22.5, 25, 27.5, 30, and 32.5 °C. The host plant used was detached shoot terminals of the nectarine variety May Five and was maintained by Hoagland's solution. The shortest development time of the aphid was 6.9 days at 25°C and the longest was 19.9 days at 15°C. Adult longevity was 38.5 days at 15°C and the highest offspring per female was 46.4 nymphs per female at 20°C. The intrinsic rate of increase (r_m) at the various temperatures was 0.109, 0.199, 0.241, 0.286, 0.058 and 0.053 at 15, 20, 22.5, 25, 27.5, and 30°C, respectively. The lower threshold for development was 10.4°C; hence, we conclude that this aphid is good spring and fall aphid. However, we found low level field infestations of this aphid throughout the summer. Therefore, we feel this aphid is an important host of *L. testaceipes* and can be useful in a pest management program as a banker host for the parasite.

Monday Afternoon Session A

Submitted Papers

1:30

RESEARCH UPDATE ON THE TAXONOMY AND BIOLOGY OF THE BIRD NEST BLOWFLY, *PROTOCALLIPHORA* (DIPTERA: CALLIPHORIDAE)

Terry Whitworth

Whitworth Pest Control, Inc., 2533 Inter Ave., Puyallup, WA 98372, USA

The 1989 publication "Bird Blowflies (*Protocalliphora*) in North America (Diptera: Calliphoridae)" by Sabrosky, Bennett, and Whitworth did much to clarify the taxonomy and biology of this confusing complex of species. In the 12 years since this work was published I have tested the adult and puparial keys on thousands of specimens. The adult keys have proven reliable, but the puparial keys are inadequate except for the species in the northeastern U.S. My current research is focused on producing a puparial key capable of distinguishing the 26 known species of nearctic *Protocalliphora*, plus 3 new species, soon to be published. Material for this study has primarily been generated by soliciting bird nest donations from birders throughout the U.S., Canada and Alaska. Since 1992 over 3000 nests have been examined, yielding about 1500 infested nests and, at least, 18 species of *Protocalliphora*. Data from these nests is being used to determine parasite host preferences, parasite populations in nests and species distribution.

1:40

TWO ISOFORMS OF AN ARTHORPOD DEFENSIN FROM *ORNITHODOROS MOUBATA* (ACARI: ARGASIDAE)

Yoshiro Nakajima[1], DeMar Taylor[1] and Minoru Yamakawa[1,2]

[1]Institute of Agriculture and Forestry, University of Tsukuba, Ibaraki, Tsukuba, 305-8572, Japan

[2]Laboratory of Biological Defense, National Institute of Sericultural and Entomological Sciences, Ibaraki, Tsukuba, 305-8634, Japan.

We previously purified and determined the partial amino acid sequence of a 4 kDa peptide having high homology with scorpion defensin from the hemolymph of adult fed female soft ticks, Ornithodoros moubata. In this study, the full length sequences of two defensin isoforms were obtained. Deduced amino acid sequences, reveal a precursor protein of 73 amino acid residues with a mature portion consisting of 37 amino acid residues. This mature peptide contains six cysteine residues conserved in the same location as other invertebrate defensins. Phylogenetic analysis reveals that Ornithodoros defensin is most closely related to scorpion defensin and other more ancient arthropods. Ornithodoros defensin mRNA is constitutively expressed and up-regulated by blood-feeding and bacterial injection. Ornithodoros defensin gene expression occurs mainly in the midgut. This is the first report of the cloning and gene expression of an antibacterial peptide from the Acari.

1:50

VITELLOGENIN AND ECDYSTEROID TITERS IN *ORNITHODOROS MOUBATA* (ACARI: ARGASIDAE) DURING VITELLOGENESIS.

Kazumasa Ogihara[1], Atsuko Moribayashi[,2] and DeMar Taylor[1]

[1]Institute of Agriculture and Forestry, University of Tsukuba, Ibaraki, Tsukuba, 305-8572, Japan

[2]Department of Medical Entomology, National Institute of Infectious Diseases, Tokyo,162-0052, Japan.

Vitellogenin (Vg) titers in the hemolymph of mated and virgin *Ornithodoros moubata* females were determined by the spotting-scanning method. Ecdysteroid titers in the hemolymph and concentrations in whole body extracts were determined by RIA. Vg was first detected in mated females 4 days after engorgement and peaked on day 6, after which, the concentrations decreased and remained at low levels during egg-laying. Vg concentrations in the virgin females followed a similar pattern, except the levels were much lower, the oocytes did not develop beyond immature vitellogenic stages and no egg laying occurred. Three peaks of ecdysteroids were seen on day 3, day 8 and day 16 in mated whole females; whereas, virgin females showed no peaks but maintained low levels throughout the 20 days after feeding. Ecdysteroid concentrations in the hemolymph peaked on day 3 and day 6 and then remained at low levels. On the other hand, virgin female hemolymph showed low levels of ecdysteroids throughout the 20 days. The appearance of a peak of ecdysteroids in both the whole body and hemolymph prior to a peak in Vg suggests that ecdysteroid stimulate the production of Vg by the fat body. The high levels of ecdysteroids from day 6 through day 8 of the mated females may be involved in maturation of occytes and egg-laying. The third peak of ecdysteroids may be due to their presence in the ovary and eggs, because this peak did not appear in the hemolymph and eggs were shown to contain high concentrations of ecdysteroids.

2:00

LOCATING THE SOURCES OF AN INVASIVE PEST USING A MTDNA GENE GENEALOGY

D. A. Downie

Department of Entomology, University of California, One Shields Ave., Davis, CA 95616, USA

The grape phylloxera is native to North America where it attacks a subset of available wild species of *Vitis*. In the 19th century it was accidentally introduced into French vineyards and subsequently spread rapidly into viticultural regions around the globe. Knowledge of the source regions within North America and *Vitis* host species of these invasive populations would improve the effective use of host plant resistance in management by allowing inferences to be made about where best to look for resistant germplasm. This study used data from a 462 bp fragment of the mitochondrial cytochrome oxidase 1 gene (CO1) to place samples from the introduced range around the globe onto a phylogeny constructed from sequences collected from across the native range on all wild *Vitis* species that were found to be attacked. The data suggest that the majority of samples from vineyards were introduced from the northern region of the US on the grape species *V. riparia*, but most insects from California vineyards have a geographic origin along the eastern US coast and may have originated on *V. vulpina*.

2:10

CORRELATION OF MITE ABUNDANCE ON ORCHARD GROUND COVER, TREE TRUNKS, AND TREE LEAVES

Diane G. Alston

Department of Biology, 5305 Old Main Hill, Utah State University, Logan, UT 84322, USA

To further our understanding of mite dispersal patterns in orchards and to determine if early season mite densities on ground vegetation are predictive of mite densities in trees in July and August, correlation analyses were conducted for mite densities from three apple and five tart cherry orchards in northern Utah in 2000. Findings suggest that spider mite (*Tetranychus urticae* and *T. mcdanieli*) densities on ground cover immediately under tree canopies in May and June aren't good predictors of densities in trees later in the season (r^2=0.38-0.42), perhaps because spider mites disperse from ground cover further away and from sources outside the orchard. In contrast, results suggest that *Galandromus occidentalis* populations do build up on ground vegetation throughout the season and early season densities can be good predictors of densities in trees in July and August (r^2=0.92-0.96). Correlations were strong between spider mite densities caught on sticky bands on tree trunks and on leaves in trees in July and August when spider mite densities were at their peak (r^2 =0.89-0.98) suggesting that sticky trunk bands may be a useful "early warning" mite monitoring method. Although predictions of mite abundance in trees in July and August based on numbers on floor vegetation earlier in the season were not possible, findings reconfirm the importance of orchard ground cover management practices that minimize build-up of spider mites and conserve predaceous mites.

2:20

OF PLANT AND INSECT RESPONSES TO FEEDING DAMAGE BY CEREAL APHIDS

Frank J. Messina and Margaret E. Karren

Department of Biology, Utah State University, Logan, UT 84322-5305, USA

We examined the behavioral and population responses of aphids to wheat plants previously infested by either the Russian wheat aphid (*Diuraphis noxia*) or the bird cherry-oat aphid (*Rhopalosiphum padi*). In choice tests, adults of both aphid species avoided excised leaves damaged by the bird cherry-oat aphid, but only the Russian wheat aphid avoided Russian wheat aphid-damaged leaves. In free-flight cages, alates of the bird cherry-oat aphid settled more often on control plants than on plants previously infested by its own species, but the settling behavior of *R. padi* was unaffected by previous Russian wheat aphid infestation. Populations of both aphid species grew faster on control plants than on plants damaged by the bird cherry-oat aphid. Previous Russian wheat aphid infestation had no effect on the population growth of either species. Taken together, our experiments reveal specificity in both the effects of each aphid species on wheat plants and in the responses of each aphid to the same type of damage.

2:30

RELATIVE ABUNDANCE OF HOP APHID (HOMOPTERA: APHIDIDAE) PARASITOIDS ON *PRUNUS* DURING THE SPRING IN WASHINGTON

Lawrence C. Wright and David G. James

Irrigated Agriculture Research and Extension Center, Washington State University, 24106 N. Bunn Road, Prosser, Washington 99350-9687, USA

Hymenopterous parasitoids that attack the hop aphid, *Phorodon humuli* (Schrank), are rare on hops during the summer but are common during the spring on *Prunus* spp., the aphid's overwintering host. We reared the parasitoids collected from aphids on *Prunus* foliage (mostly red-leaf ornamental varieties) in the hop growing areas of south central Washington to determine parasitoid identity and relative abundance during the springs of 1999 and 2000. In 1999, 802 primary parasitoids and 1,448 hyperparasitoids were reared from 83 samples collected from 47 sites. In 2000, we collected 94 primary and 180 hyperparasitoids in 59 samples from 28 sites. Parasitoids (primary plus hyperparasitoids) were reared from over 86% of the samples in 1999 and 61% in 2000 indicating their importance as biological control agents. *Lysiphlebus testaceipes* (Cresson) was the most abundant primary parasitoid, accounting for 81.6% of the primary parasitoids in 1999 and 52.1% in 2000. *Praon unicum* Smith was second in abundance with 14.3% in 1999 and 37.2% in 2000. Other primary parasitoids were *Aphelinus* spp. (0.9% in 1999, 4.3% in 2000), *Aphidius ervi* Haliday (1.0% in 1999, 1.1% in 2000), *Diaeretiella rapae* (M'Intosh) (0.3% in 1999, 0% in 2000), and *P. occidentale* Baker (0.4% in 1999, 0% in 2000). *Aphelinus* spp., *P. occidentale* Baker, and *P. unicum* are new records for the hop aphid. Hyperparasitoids were in the genera *Alloxysta* (Charipidae), *Asaphes* and *Pachyneuron* (Pteromalidae), and *Dendrocerus* (Megaspilidae). Biological control of hop aphids on *Prunus* reduces the number of aphids flying to hops and is therefore likely to be an important factor in the management of this pest. However, the large number of hyperparasitoids may limit primary parasitoid effectiveness.

2:40

FACTORS INFLUENCING GRAPE MEALYBUG INFESTATION IN SAN JOAQUIN VALLEY TABLE GRAPES

Walter Bentley[1], Lee Martin[1], Rachid Hanna[2], Peggy Schrader[3], and Don Luvisi[3]

[1] University of California, Statewide IPM Project, Kearney Agricultural Center, 9240 S. Riverbend Ave., Parlier, CA 93648, USA

[2] University of California Davis, Department of Pomology, One Shields Ave., Davis, CA 95616, USA

[3] University of California Cooperative Extension, Kern County, 1031 S. Mt. Vernon Ave., Bakersfield, CA 93307, USA

Significantly ($P<0.05$, Fisher's Protected LSD) fewer gray field ants were found on mealybug infested vines which either had a sticky barrier on the vines, a common vetch/Merced rye cover crop between the vine rows, or both, when compared to infested vines without a cover crop or sticky barrier. In June, where the vines had ants excluded, numerically fewer grape mealybugs were found at the base of canes, and in September, fewer mealybugs were found infesting clusters. The greatest abundance of mealybug infested clusters where found on the vines with the greatest abundance of field ants. There was a significant correlation ($P<0.01$) between the number of mealybugs found at the base of canes in June with the infestation of clusters at harvest. Significantly more ($P<0.01$, Fisher's Protected LSD) mealybug infested clusters were found where vines were girdled in June, compared to non-girdled vines. Where delayed dormant treatments of Lorsban, Imidan, Applaud (unregistered) and Admire (registered and applied in June) were applied, there were significantly fewer mealybugs ($P<0.05$, Fisher's Protected LSD) than treatments with the unregistered Actara, Pyramite, Pyramite plus Latron, and the Untreated plots. Overall mealybug infestation in the chemical control plots (Ruby seedless) were the lowest in four years.

3:30

THE INDIANMEAL MOTH GRANULOSIS VIRUS: A PROTECTANT FOR DRIED FRUITS AND NUTS

Patrick V. Vail

USDA, ARS, Horticultural Crops Research Laboratory, 2021 South Peach Avenue, Fresno, CA 93727, USA

The average annual production of dried fruits and nuts in California exceeds one million metric tons, and is worth nearly $1.5 billion. Postharvest processing further increases product value. Storage insects, usually Indianmeal moth (IMM), *Plodia interpunctella* (Hübner), cause commodity losses by direct damage and product contamination. Repeated infestations may occur in storage and marketing channels. Beside direct damage, copious amounts of silk may render a commodity unmarketable. The control method of choice is fumigation (MB or PH_3).

The IMM granulosis virus (IMM-GV) has been tested on many commodities as a potential alternative to these fumigants. Results have demonstrated acceptable efficacy against IMM infestation in raisins, almonds, walnuts and grains when used as a protectant. Over 95% control was reported in most cases and reached 100% in a number of cases. A production/ formulation method was developed for IMM-GV and was later patented. A registration package has been submitted by AgriVir, the licensee for the patent, to USEPA and CalEPA and approval is expected shortly.

An integrated system utilizing controlled atmospheres (CA) and IMM-GV provide short (CA) and long term (IMM-GV) control. Very low numbers of moths were trapped from virus-treated walnuts and only 0.2% of the walnuts were seriously damaged as compared to 35% for untreated walnuts. Quality was maintained at levels acceptable by industry standards. Moth emergence was reduced by more than 90% for 2 years post-treatment. Similar results were obtained with almonds. We intend to conduct more studies with AgriVir's commercial formulations of the GV.

3:40

NEXTER A NOVEL BROAD SPECTRUM CONTACT MITICIDE AND INSECTICIDE.

John Helm[1], Bart Brinkman[2] and Will Fletcher[3]

[1]John Helm, 3423, N Dewey Ave., Fresno, Ca 93722, USA

[2]Bart Brinkman, 5130, Second Ave. SE Salem, OR 97302, USA

[3]Will Fletcher, BASF, 26 Davis Dr, RTP, NC 27709, USA

BASF received California registrations, in March 2001, for Nexter® 75 WP miticide/insecticide (common name pyridaben) on grapes, peaches, nectarines, plum/prunes and nut crops including pistachios. Nexter® is a broad spectrum miticide that provides long term control of mites in the families Tetranychidae and Eriophyidae and demonstrates insecticidal activity against whiteflies, psylla, leafhoppers and aphids. Pyramite ™ miticide/insecticide (pyridaben) will remain as the labeled product for apples and pears. An overview will be presented on current registrations, recent label changes and the merits of combining Nexter in an integrated pest management program.. Specifically, the influence of timing and temperature, on product performance, will be addressed. Pending registrations will also be reviewed.

3:50

MANAGING TEPHRITID FRUIT FLY SPECIES GLOBALLY WITH A SPINOSAD BAIT FORMULATION

J. M. Richardson[1], J. E. Eger[2], G. D. Thompson[3], L. G. Gomez[4],

R. E. Boucher[3], M. D. Lees[5], and M. D. Culy[3]

[1]Dow AgroSciences, 9330 10th Avenue, Hesperia, CA 92345, USA

[2]Dow AgroSciences, 4813 W. Tyson Street, Tampa, FL 33611, USA

[3]Dow AgroSciences, 9330 Zionsville Rd., Indianapolis, IN 46268, USA

[4]Dow AgroSciences, Edificio Atlantis, 13 Calle 3-40, Zona 10, Guatemala, Guatemala

[5]Dow AgroSciences, 5200 Parkford Circle, Granite Bay, CA 95746, USA

Tephritid fruit fly detections and reproducing populations have been troublesome at many locations in the United States, as well as globally. In recent months, quarantines have been established due to Mexican fruit fly detections in San Diego county and olive fruit fly infestations throughout California. Mediterranean fruit fly detections have also been chronic in Florida. Outside the continental U.S., fruit fly populations are established in Hawaii, Central and South America, southern Europe, Africa and Asia.

Dow AgroSciences partnered with the USDA to develop improved fruit fly bait formulations. This partnership resulted in the development of NAF-550 and GF-120. These optimized formulations were developed to increase bait consumption and fly mortality, improve short and long term attractiveness, and extend rainfastness. Improvements in selectivity to non-target insects, including repellency to pollinators, were also obtained. The baits are non-corrosive and non-staining. Laboratory research, small-plot tests, and commercial experience have confirmed high levels of activity against fruit flies. Data demonstrate the utility of spinosad baits for controlling several fruit fly species.

4:00

XDE-225 (GAMMA CYHALOTHRIN), A NEW FULLY-RESOLVED PYRETHROID PRODUCT – FIRST YEAR FIELD PERFORMANCE

J. M. Richardson[1], M. B. Hertlein[2], E. A. Flora[3], B. Bisabri[4], and M. D. Culy[2]

[1]Dow AgroSciences, 9330 10th Avenue, Hesperia, CA 92345, USA

[2]Dow AgroSciences, 9330 Zionsville Rd., Indianapolis, IN 46268, USA

[3]Dow AgroSciences, 7521 W. California Ave., Fresno, CA 93706, USA

[4]Dow AgroSciences, 109 Canon Dr., Orinda, CA 94563, USA

XDE-225 (gamma cyhalothrin) is a technologically advanced "pure" (totally resolved) pyrethroid isomer. Whereas lambda cyhalothrin is a mixture of two isomers, one active and one inactive, gamma cyhalothrin contains only the active isomer. By removing the inactive isomer, field rates of one-half the active ingredient would be expected to provide similar control, compared to the non-resolved product. This latest-generation pyrethroid is being developed through Pytech Chemicals, a joint venture between Dow AgroSciences and Cheminova.

In the US, 43 field studies were conducted on alfalfa, cole crops, tomatoes, cotton, sweet corn, grain corn, rice, soybeans and peanuts in 2000. The studies were designed to make direct comparisons of selected rates of lambda cyhalothrin to gamma cyhalothrin at one-half those rates. Over a broad range of insect species, first-year results suggested that gamma cyhalothrin was twice as active as lambda cyhalothrin, on a grams a.i./ha basis. Statistically, differences in efficacy could rarely be detected. However, trends suggested that lambda cyhalothrin had faster knockdown, while gamma cyhalothrin exhibited longer residual activity. No symptoms of phytotoxicity were detected with either product, nor were instances of secondary pest resurgence observed in any of the studies.

4:10

PEST RESPONSE IN TABLE GRAPES TO LOW TEMPERATURE COMBINED WITH SLOW RELEASE SULFUR DIOXIDE PADS

Victoria Y. Yokoyama[1], Gina T. Miller[1] and Carlos H. Crisosto[2]

[1]USDA, ARS, Horticultural Crops Research Laboratory, 2021 S. Peach Ave., Fresno, CA 93727, USA

[2]University of California, Kearney Agricultural Research Center, 9240 S. Riverbend Ave., Parlier, CA 93648, USA

The effect of low temperature storage combined with slow release sulfur dioxide pads was determined in basic laboratory and large-scale commercial tests on western flower thrips, *Frankliniella occidentalis* Pergande; grape mealybug, *Pseudococcus maritimus* (Ehrhorn); Pacific spider mite, *Tetranychus pacificus* McGregor; twospotted spider mite, *Tetranychus urticae* Koch; and, omnivorous leafroller, *Platynota stultana* Walshingham. Temperatures within the foam containers among the packed clusters decreased from ambient to 2°C within approximately 1 d and ranged from 0.4-1.7°C in all tests. Sulfur dioxide concentrations in the foam containers ranged between 0.2-1.6 ppm during the 1-6 wk storage period in basic tests and 0.5-1.1 ppm during the 1-8 wk storage period in the large-scale test. Western flower thrips was completely controlled by a ≥1 wk exposure. Grape mealybug mortality was ≥93% after 2-5 wk exposures and 100% after a 6 wk exposure in basic tests. Pacific spider mite and twospotted spider mite mortality was 98.0 and 99.6%, respectively, after a 6 wk exposure. Mortality of grape mealybug and twospotted spider mite increased significantly at ≥3wk exposures and Pacific spider mite mortality increased significantly at ≥4wk exposures. Mortality of the spider mites in general was directly related to the duration of exposure. An 8 wk exposure to low temperature storage combined with slow release sulfur dioxide pads in the large-scale test resulted in 100% mortality of western flower thrips, twospotted spider mite, and omnivorous leafroller. The treatment resulted in <8% survival of grape mealybug and <1% survival of Pacific spider mite in the large-scale test. The combination treatment offers an economical method to attain quarantine control of certain insects and mites.

Moday Afternoon Session B

Symposium

Arthropod Ecology: Current and Changing State of Affairs

1:05

COLUMBIA RIVER GORGE SPRINGS: A STUDY OF THEIR UNIQUE AQUATIC INSECT FAUNA

Richard W. Baumann[1] and Gene R. Fiala[2]

[1]Department of Zoology, Brigham Young University, Provo, UT 84602, USA

[2]1274 NE 30th Lane, Gresham, OR 97030, USA

Surveys of the aquatic insect fauna of Columbia River Gorge springs in Oregon and Washington have yielded interesting data on their unique and often endemic faunal elements. Aquatic insects, especially the truly aquatic orders Ephemeroptera, Plecoptera and Trichoptera, contain species that are restricted to the torrenticolus, lotic habitats that are found here. Endemic species are common and some might even represent monotypic genera. What ecological factors have produced these unique insects? Are conditions still ideal for the survival of highly specialized species? Should we be learning all we can about this system? What is being done to preserve these specialized habitats so that this ecosystem and its unique faunal elements can survive?

1:30

WHEN BEES COLLIDE: HONEY BEE INTRODUCTIONS TO THE NEW WORLD

Walter S. Sheppard

Department of Entomology, Washington State University, Pullman WA 99164-6382, USA

The native range of the honey bee, *Apis mellifera*, includes Africa, Europe and portions of western and central Asia. Within this vast range over 2 dozen distinct subspecies are recognized, belonging to several distinct lineages. The origin of much of the subspecific diversity in the species is generally believed to be centered around Pleistocenic glaciation of Europe and the formation of refugia near the Mediterranean or to shifts in vegetation patterns in Africa. Subsequent adaptation to the temperate ecological conditions of northern Europe and Asia, the seasonality of the Mediterrranean region or the wet-dry season patterns of sub-Saharan Africa has resulted in distinct differences among the subspecies in morphology, behavior and annual colony life cycle.

Within historical time humans have introduced at least nine *A. mellifera* subspecies into the New World, including examples from each of three main evolutionary lineages. Most notable recently was the introduction and spread of descendants from a sub-Saharan African subspecies, *A. mellifera scutellata*, introduced into Brazil in the 1950's. The historical pattern of introductions to the New World, the spread of both temperate and tropically adapted subspecies and the status of contact areas and hybridization in managed and feral populations are discussed.

1:55

IMPORTANCE OF MIGRATION TO UNDERSTANDING INSECT BIOLOGY

David N. Byrne

Department of Entomology, The University of Arizona, Tucson, AZ 85721, USA

It is well known that the ability to walk or fly contributes tremendously to insect fitness, particularly when they are engaging in activities such as searching for mates, oviposition sites, shelter and suitable hosts. The advantages of insect movement and the complex set of behavioral and physiological processes that are associated with this phenomenon are receiving heightened attention. Much insect movement can be characterized as migration. Definitions of migration describe specific behavior, and by implication physiology. Kennedy's 1985 definition appears most workable. He described migration as follows. "Migratory behaviour is persistent and straightened-out movement effected by the animal's own locomotory exertions or by its active embarkation on a vehicle. It depends on some temporary inhibition of station-keeping responses, but promotes their eventual disinhibition and recurrence.' It is important to note that Kennedy's definition makes no mention of scale. Whiteflies moving 25 m between closely spaced patches, while ignoring suitable habitats, are engaging in migration in the same manner as black cutworms moving across several states. Migrating insects do so to increase their fitness, regardless of size and distance traveled.

Examples here are drawn from our research on migration by *Bemisia tabaci*, the sweet potato whitefly, and its aphelinid parasitoid *Eretmocerus eremicus.* Movement by *B. tabaci* has met all the classic criteria of migration in both laboratory and field experiments. It is capable of sustained flight in a vertical chamber for >2 h. In the field it has been found to migrate 5 km in a single morning. Flight by *E. eremicus* is significantly influenced by age, mating status and gender. Fitness benefits and costs are thought to be different for the two sexes.

2:20

BUFFERS, A POTENTIAL SOURCE OF ARTHROPOD PESTS IN THE PACIFIC NORTHWEST?

Douglas B. Walsh

Irrigated Agriculture Research and Extension Center, Washington State University, 24106 N. Bunn Road, Prosser, WA 99350, USA

Regulations resulting from the Endangered Species and Clean Water Acts could impact land and water use throughout the Pacific Northwest. Establishment of riparian buffers is a primary strategy promoted in salmon recovery plans. Proponents for restoration of riparian buffers rarely consider the impact these buffers might have on populations of terrestrial arthropods. The plants that persist in riparian buffers determine the resultant arthropod population dynamics. In natural ecosystems plants persist in balance with their environment. Can community level homeostasis be achieved in narrow riparian strips? A literature survey of recommended plants for use in the Pacific Northwest in rehabilitating riparian buffers has identified several species that are hosts for specific agricultural pests. Use of these plants in riparian buffers could prove problematic for nearby agricultural producers. I have observed increased abundance of several key arthropod pests in poorly maintained riparian buffers compared to properly established and maintained buffers. A concern is that naturalized exotic weeds can effectively compete with preferred native plants in riparian buffers. My direct observations in temperate shrub-steppe is that generalist arthropod pest populations are greater in sites composed of exotic flowering weeds then in sites composed primarily of perennial native bunchgrass species.

3:00

HANFORD NUCLEAR SITE: A CHANGING MANDATE

Richard S. Zack and Christophor N. Looney

Department of Entomology, Washington State University, Pullman, WA 99164-6382, USA

The Hanford Nuclear Site, located in southcentral Washington, comprises 560 square miles of predominantly shrub-steppe habitat. The Site is administered by the United States Department of Energy. The land was acquired in 1943 as a national security area for the production of plutonium used in nuclear weapons. Most of the Site has been closed to the public since 1943 and is, therefore, is a large remnant of a shrub-steppe ecosystem that has otherwise changed radically throughout the surrounding Columbia Plateau. Today, Hanford's mandate has changed and it is less known as a site of nuclear weapons development than for its international reputation in nuclear waste management, environmental restoration, and research and development.

Information, resulting from an intensive entomological diversity study , is presented concerning the species composition, seasonal appearance, and habitat diversity of insects on the Site. In general, the insect fauna of Hanford is like that found throughout the central basins of Washington and Oregon and may represent a species composition that was characteristic of a much more widespread shrub-steppe habitat before the advent of large-scale agriculture and urbanization.

3:25

GHOST FORESTS, GLOBAL WARMING, AND THE MOUNTAIN PINE BEETLE

Jesse A. Logan[1], Barbara J. Bentz [1], and J. A. Powell[2]

[1]Rocky Mountain Research Station, Logan UT 84321, USA

[2]Utah State University, Logan, UT, USA

Maintaining an appropriate seasonality is a basic ecological requirements for insects living in seasonal environments. Critical life history evens must be appropriately timed with seasonal cycles. Additionally, it is often selectively advantageous for individuals in the population to synchronize their activities. The two basic components of an appropriate seasonality are therefore timing (the time of year the event occurs) and synchrony (the range over time of the event). In most terrestrial insects, some explicit physiological mechanism, such as diapause, serves to maintain both aspects of seasonality. However, some ecologically important insects, such as the mountain pine beetle, apparently lack an explicit physiological timing mechanism like diapause. Seasonality of such insects is said to be under direct temperature control.

In this talk, we first discuss the mechanistic basis for direct temperature control of seasonality in the mountain pine beetle. Many, if not most, *Dendroctonus* species lack an explicit life-history timing mechanism like diapause. This is in spite of the fact that synchrony of adult emergence is absolutely necessary for the mass-attack strategy that overcomes tree defenses. We demonstrate that an appropriate seasonality is a natural consequence of the interaction between seasonal temperatures and stage-specific developmental rates. In doing so, we introduce a new paradigm for modeling direct temperature control of seasonality.

The modeling framework we developed is used to first analyze the current geographic distribution of mountain pine beetles, with respect to both latitude and elevation. Results from this analysis has provided insights into past outbreak

events that occurred in high-elevation whitebark pine ecosystems. We also conclude from this analysis that the geographic distribution for the mountain pine beetle is comprised of adapted regional populations that differ significantly in their thermal ecology. These predictions were confirmed in empirical studies comparing northern populations (Idaho, Montana) to southern populations (southern Utah).

We finally discuss the implications of our modeling work for climate change induced range expansion and invasion of new habitats by the mountain pine beetle. We conclude that some communities that have evolved without significant mountain pine beetle pressure are highly vulnerable under even conservative climate change scenarios. This potential is illustrated using extensive data that has been collected for the past 7 years at one high elevation whitebark pine site in central Idaho. We further examine the potential for northern range expansion into previously unoccupied lodgepole pine habitat. Through this northern range expansion, previously unoccupied jackpine also become vulnerable. The current distribution of jackkpine is separated from mountain pine beetle populations by either being too far north, or by the impenetrable barrier of the Great Plains. If Mountain pine beetle populations expand north through lodgepole pine into contiguous jackpine habitat in Canada, then there is no apparent reason why a waterfall effect would not follow, spilling across the North American continent to jackpine in the Great Lakes region.

3:50

WILL BIORATIONAL INSECTICIDE PRODUCTS BE SUSTAINABLE COMPONENTS OF IPM SYSTEMS OF THE FUTURE?

Timothy J. Dennehy

University of Arizona, Extension Arthropod Resistance Management Laboratory, Department of Entomology, Tucson, AZ, USA

In the last ten years a number of insecticidal products have been registered for use in agriculture that are safer to humans and non-target organisms and less harmful to the environment than conventional nerve poisons. Many have physiological targets unique to arthropods. In Arizona these include: transgenic cotton expressing a toxin from *Bacillus thuringiensis*, insect growth regulators that disrupt chitin synthesis or cause imbalances in insect juvenile hormone, and the insecticidal fermentation product, spinosad. Deployment of these biorational insecticidal products in Arizona has greatly reduced use of conventional insecticides and provided major advancements in integrated management of insect pests. However, these are very fragile successes in IPM and only time will tell if they will fall victim to pest resistance. I will describe the impact that these new insect management products have had on Arizona agriculture, detail commodity-based efforts to pro-actively thwart resistance buildup, and summarize new findings regarding resistance to each. Lastly, I will discuss relevant actions of public research universities and the pesticide industry that mitigate against rational use of insecticides.

Tuesday Morning Session A

Symposium

Cereal Leaf Beetle

8:30

CEREAL LEAF BEETLE IN MONTANA; DAMAGE POTENTIAL IN THE INTERMOUNTAIN WEST

Sue Blodgett and Katherine Miller

Dept Entomology, L. Johnson Hall, Montana State University, Bozeman, MT 59717, USA

The cereal leaf beetle, *Oulema melanopus* (CLB) is a serious pest of barley and wheat in Montana. It was first detected in Montana in 1989, in Yellowstone County. Since that time, three to four counties each year have been added to its distribution in Montana. Spring wheat, irrigated malt barley and feed barley crops have been the crops that have received the most insecticide application.

Four CLB treatment levels, were applied to irrigated and dryland barley plants (1999) or individual tillers (2000) in the field. Biomass and grain yields were collected from each plot. Impact of parasitism by *Tetrastichus julis*, established in Montana, on insect damage parameters was examined through cage studies.

8:55

HISTORY OF THE CEREAL LEAF BEETLE BIOLOGICAL CONTROL PROJECT

Ruthann Berry

USDA, APHIS, Plant Protection & Quarantine, Niles Biological Control Laboratory, 2534 South 11th Street, Niles, MI 49120, USA

The Cereal Leaf Beetle (CLB), *Oulema melanopus* (L.), has been a pest of cereal crops throughout Europe and Asia since recorded history. CLB was first found in the United States in Berrien County, Michigan in 1962. From there this invasive pest spread rapidly throughout most of the midwestern and northeastern part of the country and caused economic damage. To alleviate this loss of agricultural revenue, the United States Department of Agriculture (USDA) in 1963 initiated the search for effective and safe natural enemies in the pest's native range in Europe. In 1966 a Biological Control Laboratory was established in Niles, Michigan to implement biological control of CLB. Four species of natural enemies, one egg parasitoid and three larval parasitoids, were considered the best candidates for biocontrol and were imported to the Niles Laboratory and university cooperators for culturing and subsequent releases.

The first parasitoid to be released and become established was the egg parasitoid, *Anaphes flavipes* (Foerster). Since larval parasitoids (*Tetrastichus julis* (Walker), *Diaparsis temporalis* Horstmann, and *Lemophagus curtus* Townes) were not easily reared in the laboratory, field insectaries were established to colonize these species for later redistribution. By 1978 this complex of egg and larval parasitoids had become established throughout the CLB range in the United States and were successfully controlling the CLB. The USDA ended the project with an estimated $170 million net value of the biological control program. Prior to biocontrol, losses due to CLB were as high as 55% in spring wheat (USDA 1982).

Since 1978 the CLB has continued to expand its range moving into several southeastern states. In 1984 CLB was found in Utah and later in several northwestern states. To address this new infestation, USDA reactivated the CLB project and began importing strains of natural enemies from Europe that were better suited for the climates of these new regions.

USDA is currently involved with several northwestern states in developing a proactive approach for managing this pest with proven biocontrol strategies before the CLB reaches levels of economic damage. The USDA Niles Laboratory is assisting in the project by coordinating field insectaries, supplying natural enemies for release, and delivering workshops for technology transfer to interested States.

9:20

NATURAL ENEMIES OF THE CEREAL LEAF BEETLE

Ruthann Berry

USDA, APHIS, Plant Protection & Quarantine, Niles Biological Control Laboratory, 2534 South 11th Street, Niles, MI 49120, USA

When the Cereal Leaf Beetle (CLB), *Oulema melanopus* (L.), became established in the United States, local natural enemies did not exist to control this invasive pest. USDA collected parasitoids from the CLB's native areas in Europe and Asia, which were then studied at the ARS laboratory in Sevres, France to determine their control potential and host specificity. Four hymenopterous parasitoids represent the established complex that is successfully controlling CLB in most of the United States:

Anaphes flavipes (Foerster) [Hymenoptera: Mymaridae]
A. flavipes is a multivoltine egg parasitoid of the CLB. This is the preferred beneficial for controlling the CLB because it eliminates a large portion of the CLB population and has a high dispersal rate.

Tetrastichus julis (Walker) [Hymenoptera: Eulophidae]
T. julis is a multivoltine, gregarious endoparasitoid of CLB larvae. *T. julis* has proven to be the most successful of the larval parasitoids.

Diaparsis temporalis Horstmann [Hymenoptera: Ichneumonidae]
This species is univoltine and is a solitary endoparasitoid of the CLB larvae. *D. temporalis* is better synchronized with the host than *T. julis* or *L. curtus.*

Lemophagus curtus Townes [Hymenoptera: Ichneumondiae]
This multivoltine species is a solitary endoparasitoid of the CLB larvae. *L. curtus* was the last CLB larval parasitoid to become established.

10:05

STANDARDIZED SURVEY FOR DETECTION OF CEREAL LEAF BEETLE IN THE WESTERN STATES

Mark E. Hitchcox

Washington State Department of Agriculture, 21 N. 1st Ave, Suite 103, Yakima, WA 98902, USA

Since 1962, the geographic range of cereal leaf beetle (CLB), *Oulema melanopus* (L.) in the US has spread to the western states of Idaho, Montana, Nevada, Wyoming, Utah, Oregon and Washington. The spread of CLB has ushered the need for timely and effective detection surveys for the insect. Detection surveys are the primary method for the early detection of new CLB populations and necessary for satisfying export quarantine requirements. Furthermore, detection surveys are integral to proactive biocontrol implementation by providing early detection of CLB in an area.

In response to the spread of CLB, western state agricultural and federal entomologists, university researchers, extension agents, and industry representatives have joined in a cooperative effort to form the CLB Working Group. Originally formed to aid in the redistribution of biocontrol agents, the group also serves as a scientific forum to discuss CLB-related methodology and research. In 2001, the CLB Working Group developed standardized detection survey methods to facilitate comparison of CLB data among regions, and ensure equal sampling intensity for quarantine issues.

Discussion in early 2001 resulted in standardized methods for CLB detection surveys. Results include:

- minimum number of fields sampled per county,
- visual observations as necessary part of survey,
- sweep sampling equipment and techniques,
- number and distribution of sweeps/field,
- criteria for defining optimum field conditions,
- criteria for defining optimum environmental conditions.

The details and biological rationales of these guidelines will be discussed. Western CLB cooperators are encouraged to use these guidelines when developing detection survey protocols for the 2001 season.

10:30

CEREAL LEAF BEETLE IN IDAHO

Robert L. Stoltz

University of Idaho, Twin Falls R and E Center, P.O. Box 1827, Twin Falls, ID 83303-1827, USA

Infestations of cereal leaf beetle were first discovered in southeastern Idaho in 1982. Spread from the initial area did not occur until 1994. Since then it has spread throughout the Snake River plain and to the three northernmost counties. Control measures are applied only to spotty areas of high infestation. Releases of *Tetrasticus julis* have been made annually in selected areas since 1998. It has been recovered in Bonneville and Cassia counties. In the original Cassia county release site, percent larval parasitism was 75-100% in 2000. There has been no successful recovery of egg parasites released in 1998.

10:55

THIRD INVESTIGATION AND SUMMARY ANALYSES OF CEREAL LEAF BEETLE MORTALITY IN ALFALFA BALES WITH A PROPOSED DECISION PROCESS FOR EXPORT CERTIFICATION

Alan H. Roe and Dr. Jay B Karren

Department of Biology, Utah State University, Logan, UT 84322, USA

Three similar experiments to determine mortality of cereal leaf beetle (CLB) adults in baled alfalfa were conducted during 1998, 1999, and 2000. Mortality was examined over periods of 28 to 120 days for baled adults, adults inserted manually into bales, and adults stored in an incubator. Results were statistically consistent when compared within and between years. No live adults were found later than 38 days elapsed time. Initial mortality among baled treatments ranged from 77 to 91% and was 26 to 55% (38% average) higher than that of inserted treatments. Regression estimates of 100% mean mortality ranged from 38 to 42 days for baled treatments and from 46 to 62 days for inserted treatments; a single estimate of 34 days resulted for stored insects. Providing CLB with grass hay or grains rather than alfalfa did not reduce mortality. Bale temperatures ranged from 53 to 113 deg. F. (12 to 45 deg. C.) with relative humidities of 60 to 68%. Lower humidity (41 to 46%) among stored CLB (at constant 60 deg. F.; 16 deg. C.) was the only reasonable explanation for their high mortality rate. Regression predictions of minimum mortality (lower limits of 100% mean mortality estimates) were based on data for all years combined. These predictions were used to develop a series of risk decision tables, where risks were based on the predicted maximum chance of survival and the maximum chance of prediction error with various numbers of sample units. The risk of introduction of transported CLB in baled crops is a function of the CLB field population at harvest, the number of bales shipped per time period, and the storge quarantine period for the shipments. These first two factors and the risk decision tables were related together to develop a method of calculating suitable storage quarantine periods based on various CLB field populations and bale shipment rates.

11:20

USING STATISTICAL SURVEY DATA FROM 1996-2000 TO COMPARE CURRENT TRENDS, AND TO PREDICT FUTURE TRENDS AND SHIFTS IN CEREAL LEAF BEETLE (*OULEMA MELANOPUS*) POPULATIONS IN THE STATE OF UTAH

Jay B. Karren and Steve R. Keller

Department of Biology, Utah State University, 5305 Old Main Hill, Logan, UT 84322-5305, USA

When comparing compiled statistical survey data from the years of 1996-2000, there is evidence of continual progress in the controlling of the cereal leaf beetle biologically in spring barley, oats, and wheat with the European parasitic wasp, *Tetrasticus julis*, obtained from USDA/APHIS in Niles, Michigan. Survey variables include: the number of fields used, the number of eggs in the fields, the number of larvae per/sq ft, percentage parasitism of the larvae and the effects on the cereal leaf beetle populations in surveyed fields and all other grain growing areas of Utah. When high parasitism rates are coupled with the farmer's cooperation and patience to limit or omit chemical spays, it has resulted in a firmly established parasite population which increases crop productivity, yield and quality while decreasing the costs of insecticides. Estimated savings are 5.00-10.00 dollars per acre of spray cost per year.

Tuesday Morning Session B

Symposium

Biological Control: Understanding and Using Generalists and Assemblages

8:05

COMPARING PARASITOIDS AND PREDATORS IN PEA APHID BIOCONTROL: ARE SPECIALISTS BETTER?

William E. Snyder

Department of Entomology, Washington State University, 166 FSHN Building, Pullman, WA 99164-6382, USA

Parasitoid hymenoptera and diptera are often considered to be the best biological control agents. This is because these natural enemies are specialists that have a tight dynamical linkage with their prey. This coupling can allow specialists to exert a strong numerical response as herbivore densities increase, and perhaps drive herbivore densities back down. In contrast, generalist predators have long generation times and are polyphagous, making it unlikely that generalists can dynamically respond to changes in densities of any single prey species. Also, through intraguild predation, generalist predators might interrupt the otherwise more effective control exerted by specialists. However, few studies have compared the impact of generalists and specialists in the same crop within a single experiment.

In alfalfa, pea aphids (*Acyrthosiphon pisum*) are attacked by a diverse community of natural enemies, including a specialist parasitoid wasp, *Aphidius ervi*, and a guild of generalist predators, primarily made up of *Nabis* and *Orius* bugs, Coccinellid and Carabid beetles, and web-building spiders. In a field experiment, we manipulated both the parasitoid and the generalist predator guild, and recorded the impact of each class of natural enemy on pea aphid population dynamics. The parasitoid had little impact on aphid population growth initially, but mounted a strong numerical response that eventually caused pea aphid populations to decline. In contrast, the generalist guild had an immediate impact, lowering the aphid's rate of population growth. However, the generalists did not exert density dependent control, so that pea aphid densities continued to increase throughout the experiment. When both classes of natural enemy were present, pea aphid dynamics reflected the impact of both generalists and specialists – pea aphid population growth was depressed early, and pea aphid densities strongly declined later. Densities of parasitoid pupae were 50% lower in the presence of generalists, indicating that intraguild predation was common. However, the ratio of parasitoids to aphids was not changed, and the impact of the two types of natural enemies was additive when both were present. Laboratory feeding trials indicated that two important predators in the foliage, nabid bugs and coccinellid beetles, preferentially fed on aphids rather than parasitoid pupae, which might explain the lack of an overall change in aphid-parasitoid ratios in the presence of the generalist guild.

Overall, the density independent impact of generalists and the density dependent impact of specialists were complimentary, so that biocontrol was most effective when both classes of natural enemy were present. The impacts of generalists and specialists were additive despite a high rate of intraguild predation, because predators did not alter percent parasitism by *A. ervi*.

8:30

CHARACTERISTICS OF GENERALIST PHYTOSEIIDS AND IMPORTANCE IN BIOLOGICAL CONTROL

James A. McMurtry

Oregon State University, Corvallis; University of California, Riverside; P.O. Box 4487, Sunriver, OR 97707

Generalist phytoseiid mites represent a broad range of taxonomic groups and biological types. These mites are usually characterized by high reproduction on pollen, low- medium reproduction on the target mite or thrips pest, random distribution on the plant, rarely correlated with that of the target pest. Physical and biological features of the plant can be important factors in determining their abundance. Generalists are often the dominant phytoseiid species in stable ecosystems, and they may be important in the control of two different kinds of pests (e.g. thrips and mites). A high predator prey ratio, induced by early-season reproduction on alternate foods, may be the key to their success. Examples of important species include case histories on apple, grape, glasshouse crops, citrus and avocado.

8:55

INFLUENCE AND SYNERGISTIC EFFECTS OF ABOVE AND BELOW-GROUND HERBIVORY BY TWO HOST-SPECIFIC WEEVILS AND PLANT COMPETITION ON THE PERFORMANCE OF HOUNDSTONGUE

Mark Schwarzlaender

PSES Department, University of Idaho, Moscow, ID 83844-2339, USA

Houndstongue (*Cynoglossum officinale*L.) is a monocarpic, short-lived perennial that has been introduced into North America where it invades rangeland and forests. The effects of below-ground herbivory by the weevil *Mogulones cruciger*, above-ground herbivory by the sibling species *M. trisignatus*, and interspecific plant competition on houndstongue growth and reproduction were comparatively studied in field cages during two years in its native range in Europe. During first year growth, houndstongue rosettes were not negatively influenced by any of the three stress factors. All plants flowered during the second year. Plant competition led to a reduction in the number of shoots and the sum of shoot heights of bolting plants during early summer of the second year. Five weeks later, after plants had set seed and were harvested, plant competition led to a reduction in average root weight, shoot weight and reproductive weight of houndstongue. Fertility and individual seed weight were not affected. Further, plant competition led to a reduction in all above/below-ground biomass ratios**.** Root herbivory led to a reduction in shoot weight and reproductive weight of plants as well as in above/below-ground biomass ratios, similar to plant competition. Shoot herbivory however, had no negative effect on any of the recorded plant growth parameters. Attack rates for *M. trisignatus* were significantly smaller than those for *M. cruciger*, which may, in part, explain the difference between the effect of above and below-ground herbivory on plant performance. No synergistic interactions between effects of plant competition, above, and below-ground herbivory were found. The results of this study in regard to the suitability of both weevil species as biological control agents is discussed in the context of the "silver-bullet" and stress accumulation theories.

9:20

INS AND OUTS OF HABITAT MANAGEMENT FOR ENHANCING BIOLOGICAL CONTROL

Robert L. Bugg

University of California Sustainable Agriculture Research and Education Program, University of California, One Shields Avenues, Davis, CA 95616-8716

Providing habitat for parasites and predators of agricultural pests has often been a hit-or-miss proposition. In part, because researchers hurry to conduct "critical experiments" without the benefit of behavioral data. In the event of initial negative results, some scientists abandon the field altogether. Yet such abandonment may be as premature as were the experiments. Seasonal and diel dormancy and dispersal patterns are as important as dietary data in enabling us to enrich and refine our biological intuition. Here, using interviews with several imaginative and determined scientists, I recount the twists and turns of several important research programs. These stories show how, through sequences of experiments, initial assumptions dissolved and new insights and opportunities for enhancing biological control emerged.

10:00

INSECT PATHOGENS IN PEST CONTROL: USE AS GENERALISTS AND THEIR POTENTIAL IN ASSEMBLAGES OF BIOCONTROL AGENTS

Donald W. Roberts

Department of Biology, Utah State University, Logan, Utah 84322-5305, USA

Naturally occurring epizootics of disease in insect populations have made it clear to most entomologists that insect pathogens can be important population reduction factors. There are persistent efforts by entomologists to repeat, through human intervention, these types of disease outbreak. Industry is interested in developing generalist pathogens for different agricultural systems. Most pathogens, however, have limited host range. This is particularly true of insect viruses, which are mostly limited to Lepidoptera, and normally to a few genera or families within that group. The most widely utilized pathogen, *Bacillus thuringiensis*, also is somewhat host specific. Specific strains of entomopathogenic fungi tend to have fairly limited host ranges; but some, particularly in the genera of *Beauveria* and *Metarhizium*, have rather broad spectra. One of these, a *Beauveria* isolated from grasshoppers in Montana, has been commercialized and widely distributed for control of insects from several taxonomic orders. A single isolate of *Metarhizium* also has been commercialized for control of insects as diverse as cockroaches, greenhouse pests and termites. Great advances have been made with production, packaging, and formulation with these products because the potential for larger markets encouraged more extensive background research. To obviate host specificity, assemblages of biocontrol agents have been sought for various crops worldwide. For example, approximately one million hectares of soybean is treated with a nucleopolyhedrosis virus in Brazil. There is but one lepidopterous pest of soybean in Brazil, but there also is a group of pentatomid pests for which fungi are being sought. Like other Hemiptera, the pentatomids are sap-sucking insects and,

therefore, cannot ingest entomopathogenic organisms. Fungi are the only microorganisms which can penetrate insect cuticle. Accordingly, they will be needed in most pathogen assemblages since, at some time during the season, sucking insects probably will be a problem. In some cases, cocktails of fungal species and strains have been used to increase the number of targets. Assemblages which include parasites and predators sometimes have been discouraged because of fear that the fungi present will adversely affect beneficial insects. To date, this has not been a practical problem as illustrated by the fact that the sugarcane industry in Brazil mass produces an *Apanteles* wasp for Lepidoptera control and introduces at the same time *Metarhizium anisoplae* for spittle bug control. There is much to be learned about the interactions between pathogens, as well as pathogen maintenance in the field after release; but significant progress has been made.

10:25

EXPLOITING NATURAL ENEMY ASSEMBLAGES IN THE MANAGEMENT OF CALIFORNIA'S CITRUS PEST

Robert F. Luck, Lisa D. Forster, and Joseph G. Morse

Department of Entomology, University of California, Riverside CA 92521, USA

Historically, citrus pest management in southern California's coastal and inland coastal regions has relied on natural enemies to suppress its pests both indigenous and exotic for about 130 years. In contrast, citrus pest management in the San Joaquin Valley has relied on broad-spectrum pesticides to suppress its pests. The evolution of pesticide resistance in several key citrus pests in the San Joaquin Valley has forced growers to seek alternative pest suppression tactics. Exploiting resident natural enemies coupled with augmentative releases of commercially produced natural enemies and the judicious use of selective pesticides has provided a cost effective alternative management strategy for managing the Valley's citrus pests. However, the recent arrival of two new exotic pests and one new regional pest illustrate the need for continued ecological research to develop non-disruptive pest management tactics which can be integrated into the current pest management strategy for California's citrus.

10:50

GENERALIST PREDATORS AS AN AGROECOSYSTEM SERVICE

L. E. Ehler

Department of Entomology, University of California, One Shields Avenue, Davis, CA 95616-8584, USA

Beet armyworm (BAW), an exotic pest of California sugarbeet, is exploited by a complex of natural enemies in the state's Great Central Valley. Experimental investigations in the southern Sacramento Valley revealed that native predators, such as minute pirate bug (*Orius tristicolor* [White]), damsel bug (*Nabis americoferus* Carayon), big-eyed bugs (*Geocoris* spp.), and larvae of green lacewing (*Chrysoperla carnea* [Stephens]) plus the lygus bug (*Lygus hesperus* Knight), were major predators of BAW eggs on spring-planted sugarbeet, often destroying entire egg masses before hatch. Such unplanned or "fortuitous biological control" of an exotic pest by native predators may maintain BAW populations at acceptable levels in nontreated sugarbeet fields.

This action of natural enemies also represents an "agroecosystem service" to the grower. Placing a value on such a service may be relatively simple when the cost of the alternative is easily determined. For example, many sugarbeet producers in northern California apply the insecticide chlorpyrifos for control of BAW, which costs about $15per acre. A grower who treats a 100 acre field (typical size for the region) would spend $1500 one or more times during the growing season. Recent research suggests that a density of two predatory bugs per plant will provide a comparable level of control—an agroecosystem service that is worth $1500. This is a new way of thinking for pest control advisers and sugarbeet growers in northern California, but one that should increase their appreciation for conservational biological control.

11:20

NATURAL ENEMY ASSEMBLAGES IN ACTION: EXAMPLES FROM AUSTRALIA AND WASHINGTON STATE

David G. James

Irrigated Agriculture Research and Extension Center, Washington State University,

24106 North Bunn Road, Prosser, WA 99350, USA

Arthropod pest management systems based on the conservation and utilization of endemic natural enemy assemblages, are sustainable, environmentally safe and are usually highly cost-effective. Conservation biological control has a long history of success, which pre-dates the involvement of entomologists. A renaissance of interest in conservation biological control is producing a growing catalogue of successful arthropod management systems based on this approach in crops around the world. Summaries will be presented of two commercial pest management programs based on assemblage biological control in Australian grapes and citrus, and a program being developed for hops in Washington State.

Tuesday Afternoon Session A

Graduate Student Symposium

1:30

WHEAT STEM SAWFLY PARASITISM IN SELECTED DRYLAND WHEAT PRODUCTION PRACTICES IN MONTANA

Justin B. Runyon, Wendell L. Morrill, and David K. Weaver

Department of Entomology, Montana State University-Bozeman,

Bozeman, MT 59717, USA

The wheat stem sawfly, *Cephus cinctus* Norton, is a major pest of wheat in the northern Great Plains. Sawfly-infested plants have lower yield and usually lodge, reducing the amount of grain that can be harvested. In 2000, losses because of sawfly infestations were estimated to exceed $18 million in Montana alone. Two parasitoids, *Bracon cephi* (Gahan) and *B. lissogaster* Muesebeck, attack the wheat stem sawfly in wheat, but provide satisfactory control only in isolated cases. The effects of common wheat production practices were examined. Sawfly parasitism levels in tilled vs. untilled, and block vs. strip fields were compared.

In general, little difference in sawfly parasitism was found between tilled and untilled fields. However, parasitism was lower in intensely tilled fields. No difference was found in sawfly parasitism between strip fields and block fields. Sawfly parasitism was uniform across block fields, even though sawfly infestations often decreased with distance from the field edge. Replacing intensive tillage with minimum tillage or chemical fallow will better conserve sawfly parasitoids and result in a cumulative increase in sawfly parasitism over multiple years. Planting block fields instead of strips should have little effect on sawfly parasitism and may decrease sawfly infestations.

1:55

EXAMINING THE EFFECTS OF N DEPOSITION ON CALIFORNIA FORESTS BY ASSESSNG CHANGES IN INSECT HERBIVORE COMMUNITIES

Michele Eatough and Timothy D. Paine

Department of Entomology, University of California, Riverside, Riverside CA 92521, USA

This project examines the impact of ozone and nitrogen additions on arthropod herbivore communities of three plant species in a xeric mixed conifer forest impacted by Los Angeles basin emissions. In eastern forests, nitrogen saturation has been associated with forest decline. Because of differences in nitrogen cycling in western forests, high levels of nitrogen may be deposited without leading to decline. The impact of LA Basin emissions on surrounding forests may therefore be mediated by changes in foliar chemistry that are optimally examined by assessing herbivore populations. Nitrogen oxides and ozone both alter plant growth and chemistry in ways expected to alter nutritional quality for insect herbivores. Changes in herbivore communities can affect plant productivity, plant community composition and predator populations. For these reasons, monitoring changes in the insect community can be an important indicator of the effect of pollutants on ecosystem processes. Treatments consisted of ambient exposure and nitrogen fertilizer additions (control and 150 kg/ha/yr) at two sites east of Los Angeles. The western-most site near Crestline, CA (CP) has historically been associated with high concentrations of ozone and high levels of nitrogen deposition, while the more eastern site at Barton Flats (BF) has received relatively low input from atmospheric ozone and nitrogen. Insects were extracted from foliage collected during the 1998-2000 growing seasons. Discriminant function analysis indicates that fern communities at both sites are responding similarly to increasing nitrogen additions. Pine communities at CP showed less divergence between fertilized and unfertilized trees than did pines at BF. This may indicate that these pine are already strongly affect by nitrogen deposition. The response of oak communities to nitrogen additions was less consistent.

Even though there was no consistent affect of nitrogen additions on oak communities for more typical years, during a spring 2000 fruit-tree leafroller outbreak, nitrogen additions may have affected the severity of herbivore impact on oak. In May, as the leafrollers completed development, control oak were significantly more damaged than fertilized oak. This was surprising since nitrogen fertilization has been shown to enhance performance and increase abundance of arthropods. Further investigation showed that in April, newly opened, expanding buds of fertilized oaks had significantly longer leaves and significantly fewer leaves/gram foliage, indicating that leaves of fertilized trees had developed faster than leaves on control trees. Leafroller abundance was significantly correlated with number of leaves sampled ($r^2 = 0.56$, $p = 0.001$) and negatively correlated with leaf length ($r^2 = -0.39$, $p = 0.032$), but not correlated with foliage mass sampled ($r^2 = 0.23$, $p = 0.21$). We hypothesize that rather than being influenced primarily by plant chemistry which would predict better leafroller performance on fertilized trees, leafroller performance was effected by plant phenology, and early instar leafrollers performed better on the more closed and protected buds of the unfertilized oak.

2:45

TEMPERATURE EFFECTS ON ENTOMOPATHOGENIC NEMATODE INFECTIVITY AND LONGEVITY

Christine Armer
Entomology Department, Oregon State University

The entomopathogenic nematodes *Heterorhabditis marelatus* and *Steinernema riobrave* can provide effective control for a range of agricultural and nursery insect pests. *H. marelatus*, from the cool coastal area of Oregon, can infect hosts at cooler temperatures, whereas *S. riobrave*, from southern Texas, is active at hotter temperatures. This study examines the temperature range at which these two nematodes can infect hosts, and perhaps equally as important, at what temperatures the nematodes can survive. The nematodes were applied to moistened sand at 100 nematodes/cm^2, and were held in growth chambers at 4ºC, and 13ºC up to 37ºC in 3ºC increments. Portions of inoculated sand were removed periodically and were placed in petri dishes with *Galleria mellonella* larvae as indicators of nematode survival and infectivity. These experiments showed that, although *H. marelatus* can only develop within hosts held at 13ºC-25ºC, it can survive at temperatures from 4ºC to 31ºC. *S. riobrave* can survive from 4ºC to 37ºC, but can rarely infect hosts outside the 22º-31ºC range. The range of temperatures at which the nematodes can survive increases the window of opportunity for application of the nematodes for biological control of pest insects. Although the soil to which the nematodes are applied can heat or cool beyond the infective range, the nematodes can survive to infect the hosts at optimal temperatures when the soil heats or cools with daily and seasonal temperature cycles.

3:10

OPTIMUM TIMING OF MITICIDE APPLICATION FOR CONTROL OF *VARROA DESTRUCTOR* (ACARI: VARROIDAE) IN WASHINGTON STATE

James P. Strange

Department of Entomology, Washington State University, Pullman WA, 99164, USA

Varroa destructor is the most damaging pest to managed *Apis mellifera* (Hymenoptera: Apidae) colonies worldwide. I sought to determine the most effective timing for application of fluvalinate and coumaphos, which are currently used for control of this mite in the United States. Because fluvalinate resistant mite populations have been found in the United States and Europe it is advantageous to reduce the selection pressure for resistance in mite populations. Miticide applications were made in April, August, or October and compared to semiannual and continuously treated colonies. Colony health parameters were measured five times during the year. The results indicate that a single fall application of miticide is sufficient to control mite outbreaks throughout the year.

Tuesday Afternoon Session B

Symposium

Urban Entomology

1:30

CARPENTER ANTS IN WESTERN STATES AND CURRENT MANAGEMENT STRATEGIES

Laurel D. Hansen

Biology Department MS 3180, Spokane Falls Community College, 3410 W. Fort Wright Drive, Spokane, WA 99224

Species of carpenter ants in western states that are either structurally damaging or nuisance pests include: *Camponotus modoc, C. vicinus, C. herculeanus, C. noveboracensis,* and *C. essigi* Each of these species may have multiple nesting sites with a parent colony in an area with high moisture and satellite colonies occurring in drier areas, commonly within structures. In management programs, location of these colonies is problematic and newer strategies such as baiting are being implemented. Sprays applied in perimeter treatments are effective in preventing infestation of structures in high risk areas and these treatments are also effective during the foraging season in eliminating ants from within structures.

1:55

STATUS OF THE RED IMPORTED FIRE ANT INVASION OF CALIFORNIA

Les Greenberg

University of California Riverside, Riverside, CA, USA

There were 3 initial hot spots for Red Imported Fire Ants in California — South Orange Co. near Trabuco Canyon, North Orange Co. near Cerritos, and the Coachella Valley in the Palm Springs – Rancho Mirage vicinity. All of these locations were very heavily infested during the initial inspections in 1998 and 1999. In Orange Co. the Fire Ant Authority has been actively treating sites, excluding nurseries and golf courses, for about 1 year. All applications are being done on the ground with spreaders attached to ATVs or handheld, and blowers to reach hillsides. Similar treatments are being done in the Coachella Valley by Vector Control. The Exclusion branch of the CA Department of Food and Agriculture (CDFA) monitors for fire ants in the nurseries and golf courses and puts them into compliance agreements which assure that they will eradicate their fire ants. Quarterly monitoring for 1 year is done in locations that were initially positive.

Since these original infestations were discovered, additional survey work by CDFA, Vector Control, and county Agricultural Commissioner's office personnel have found additional infestations in Los Angeles and West Riverside counties. These more recent finds are spotty in nature, with a few mounds scattered over several blocks or in a nursery. Therefore, they are probably secondary infestations that arrived before quarantine measures were in place. Quarantines now cover the movement of plants, soil, sod, hay, honeybees, and ground moving equipment. It is likely that the spread of fire ants by people has been greatly reduced or eliminated. The fire ants can spread on their own by flight. However, unlike the eastern part of the country, they can only survive here where there is irrigation. Natural areas have not to date been infested. Our big advantage over the rest of the country is that the fire ants are in pockets where there is water and cannot fill in the entire landscape.

We have been doing field trials in the Coachella Valley the last 2 years trying out a variety of products against fire ants. A new product with good potential is granular fipronil. Distance and Amdro have also proven very effective for long-term control. Talstar is good for quick knock-down emergencies and seems to have some residual activity. We are also trying out a soil fungus, *Beauveria bassiana*, as an alternative fire ant treatment where traditional pesticides are not desired.

We also have a research laboratory at the South Coast Field Station in Irvine. We have collected fire ants from most locations in southern CA and are keeping them there. We have begun laboratory trials to look for non-toxic alternatives to drenches for use in nurseries. We are also testing freeze-dried artificial baits as fire ant attractants, as well as exploring the use of liquid toxicants in sugar water.

2:45

TURF AND ORNAMENTAL PEST MANAGEMENT IN THE TROPICAL WESTERN PACIFIC

Ross H. Miller[1], Ken S. Gokey[2], Russell Young[3]

[1] CALS-AES, University of Guam, Mangilao, Guam 96923

[2] Mangilao Golf Club, Mangilao, Guam 96923

[3] Leo Palace Resort, Manenggon Hills, Yona, Guam 96914

Guam's humid tropical climate, coupled with its island setting and easy accessibility by air and sea as a popular tourist and business destination, render it extremely susceptible to exotic, invasive pests. A number of introduced insect pests commonly infest turf and ornamentals on Guam, resulting in substantial expenditures for pest management by local golf courses, hotels and recreational areas. The major turf pests on Guam include sod webworms, mole crickets, and billbugs, armyworm and white grubs while the Poinciana looper, *Pericyma cruegeri*, is a major pest of ornamental trees. The biology and impact of these and other potentially invasive alien pests is discussed, as are the management strategies that have proved most effective for them. IPM strategies developed for turf and ornamental pests on Guam have application for other tropical island environments in the Pacific Basin and Asian Rim countries.

3:30

THE DYNAMICS OF AN INVASIVE URBAN PEST, THE PHILIPPINE MILK TERMITE *COPTOTERMES VASTATOR* ON GUAM, NORTHERN MARIANAS, YAP AND PHILIPPINES

Lee S. Yudin

University of Guam, UOG Station, Mangilao, Guam 96923

An invasive pest can be described, as any organism that has the ability to invade, spread, and establish itself in environments in which it is not wanted. The subterranean termite, *Coptotermes vastator* (Light) or commonly called the Philippine milk termite is one of the most predominant and destructive invasive insect pest of both residential and commercial structures on Guam, Northern Mariana Islands, Yap, and in the Philippines. This species causes millions of dollars of economic loss to both urban and rural dwellers. At present, its habitat is strictly tropical and subtropical. It has recently been reported on Oahu in the Hawaiian Islands. Due to hot and humid climatic conditions that exist in the Western Pacific, active termite feeding is uninterrupted during the year. Studies on Guam conducted since the early 90's utilizing triple mark and recapture methodologies, wood consumption rates, and the use of hexaflumuron bait have shown conclusive evidence of successfully eliminating *C. vastator* from previous high infestation of urban dwellings. However, *C. vastator* is not the only invasive species found in this region, *Schedorhinotermes*, *Nasutitermes* and *Microcerotermes* are three additional subterranean species that inhabit this part of the world. All are invasive subterranean termite species and are found primarily in ornamental trees used for landscaping. The dynamics of these invasive termites will be described.

3:55

ALTERNATIVES FOR THE INTEGRATED MANAGEMENT OF FORMOSAN SUBTERRANEAN TERMITES IN HAWAII

Julian R. Yates III

Plant & Environmental Protection Sciences, University of Hawaii, 3050 Maile Way, Honolulu, Hawaii 96822, USA

The Formosan subterranean termite, *Coptotermes formosanus* Shiraki, is Hawaii's most economically important insect pest. Its biology, aggressiveness, and cryptic and unpredictable foraging behavior make this insect difficult to detect and control. Soil termiticides with less residual activity than organochlorine insecticides and consumer demand for non-chemical control methods has redirected research towards developing and evaluating alternatives for managing this pest. These alternatives include physical particle barriers, wire mesh barriers, in-ground and aboveground baiting systems, removable building components, and termite resistant construction materials.

4:20

BAITING *HETEROTERMES AUREUS* (ISOPTERA: RHINOTERMITIDAE) IN TWO URBAN COMMUNITIES IN ARIZONA

Paul B. Baker

University of Arizona College of Agriculture, Department of Entomology, Tucson AZ 85721, USA

A study was initiated in 1999 to determine the effectiveness of termite baiting systems in controlling the desert subterranean termite *Heterotermes aureus* (Snyder) in Tucson and Phoenix, AZ. In this 27 plus month study, 15 curative and 15 preventative residential sites were established. Curative sites had live termites within the structure; preventative sites had evidence of termites within the area but not within the structure. A total of 1090 stations are being monitored monthly, 497 are at the preventative sites and 593 are at the curative sites. Mean number of days to initial baiting for preventative sites was 109. Preventative sites in Phoenix required twice the number of days 180 to initial baiting compared to Tucson at 85 days. Mean initial baiting for all the curative sites was 93 days, with Phoenix needing a few more days than Tucson, 102 vs 88, respectively. Numbers of stations baited at the curative sites are over 3x's that of the preventative 141 vs 45 respectively. Percent auxiliary stations baited at the curative sites was over 2x's that of the preventative sites. Other data collected includes % monitors consumed, % bait consumed, mold, and termite number/species present.

4:45

TEN YEARS AFTER - AFRICANIZED HONEY BEES IN THE UNITED STATES

Walter S. Sheppard

Department of Entomology, Washington State University, Pullman, WA 99164-6382, USA

Following the introduction of a sub-Saharan African honey bee subspecies to Brazil in the mid 1950's, descendant "Africanized honey bees" (AHB) expanded their range to reach the United States within 40 years. While the southern climatic limit of this range expansion was established in Argentina by the mid-1970's, AHB populations continued to move northward after reaching Texas in 1990. At present, feral Africanized honey bee populations can be found from Texas through California. Ecological factors related to winter survival will likely limit this expansion, although interbreeding could permit introgression of AHB genes into US populations beyond climatic limits. A major outcome of Africanization in the US is an ever-increasing need to maintain genetic control of matings in queen production areas, which provide AHB-free stock for commercial pollination and honey production operations.

Within the subtropical areas of the US where AHB are now established, beekeeping techniques have changed to better utilize this bee. In these areas, public awareness of AHB defensive traits and behavior has been enhanced through widespread educational and extension efforts. As a result, Africanized honey bees are a very minor risk factor for human safety. The demand for swarm elimination from urban environments has resulted in development of new businesses specializing in AHB swarm removal. More than a decade after their arrival in the US, Africanized honey bees remain a "problem" manageable through the combined efforts of beekeepers, policy makers and an informed public.

Presenter Index