SEASONAL POPULATION DYNAMICS OF GLASSY-WINGED SHARPSHOOTER EGG PARASITOIDS: VARIABILITY ACROSS SITES AND HOST PLANTS

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ABSTRACT
The California Department of Food & Agriculture (CDFA) has a number of sites in southern California where they are releasing egg parasitoids of glassy-winged sharpshooter (GWSS). To date, species released include *Gonatocerus ashmeadi, G. fasciatus, G. morrilli,* and *G. triguttatus* and very recently, a strain of *Anagrus epos* from Minnesota. CDFA monitors for parasitoid establishment and population dynamics at release sites. This project is intended to complement and expand the scope of this monitoring with an eye towards improving our understanding of the benefit of releasing alternative parasitoid species and how well they are surviving, dispersing, and impacting GWSS populations.

INTRODUCTION
One of CDFA's parasitoid release sites in southern California is Field 7H on the UC Riverside campus. A two-year field study in and around this release site was conducted to examine the temporal and host plant distribution of *Homalodisca* oviposition and associated egg parasitism (Al-Wahaibi 2004). In the current project, we plan to expand on this study and monitoring done by CDFA in an attempt to improve our understanding of the population dynamics of endemic and released parasitoids in and around release sites. Although control programs appear to be effective at reducing GWSS populations, biological control is a more sustainable and environmentally friendly means of contributing to vector reduction and may have to suffice in much of California where chemical control is either impractical (e.g., urban areas) or economically unfeasible.

In the two-year (July 2001 – June 2003) study by Al-Wahaibi (2004) around CDFA's release site on the UC Riverside (UCR) campus, parasitism was due to a total of eight parasitoid species with *Gonatocerus ashmeadi*, *Ufens principalis* (previously *Ufens* A, Al-Wahaibi et al. 2005), *Ufens ceratus (*previously *Ufens* B), and *G. morrilli* being the most abundant. *Ufens* spp. were dominant on jojoba while on other plants, *Gonatocerus* species tended to dominate. Across all ten host plants sampled, ranked percent parasitism was *G. ashmeadi* (27.4%), *U. principalis* (19.8*%), U. ceratus* (2.9%), *G. morrilli* (2.1%,), *G. incomptus* (0.4%), *G. novifasciatus* (0.3%), *G. triguttatus* (0.1%), and *G. fasciatus* (0.01%). Note, however, that these data may have been biased by the proximity of nearby hosts harboring smoke-tree sharpshooter and high levels of *Ufens* spp. on jojoba.

OBJECTIVES (As Modified)
1. Monitor GWSS egg parasitoids in several areas in southern California at CDFA's parasitoid release sites, comparing levels of *G. ashmeadi, G. morrilli* (Texas strain), and *Anagrus epos* (Minnesota strain).

RESULTS
Based on discussions with our CDFA cooperators, we have made several changes in project objectives, experimental design, and methodologies because of low levels of GWSS at several initial monitoring sites, changes in the species / strains of parasitoids CDFA has reared and released, the number of parasitoids they have been able to produce over this past year (this has been a very difficult year as far as rearing GWSS egg masses which are the cornerstone of the rearing program), and what makes practical sense within an applied management program (Shea et al. 2002) given advances in our knowledge regarding *Gonatocerus* species and the new strain of *Anagrus epos* from Minnesota (see below).

We have settled on monitoring parasitoid levels at six sites in southern California. Three sites are near the coast (Irvine, Mission Viejo, and San Juan Capistrano) and three are in the southern California interior region (Corona, Temecula, and

UCR 7H). Egg masses are collected from Eureka lemon trees at each site (initially we were monitoring navel orange at some sites but we decided it would be best to switch to the same citrus variety at all sites for comparison) and are returned to the laboratory where parasitoids are reared out and identified. The initial plan was to monitor two sites in each of three environmental regions (coastal, interior, desert) but after several months of monitoring two sites in the Mecca region of the Coachella Valley, we decided that GWSS levels were too low to obtain meaningful data, we dropped these two sites, and added a third site in both the coastal and interior areas. We checked with cooperators and thought it unlikely we could find other sites in the desert region with high GWSS levels, especially in view of the GWSS management program there. In finalizing selection of the six monitoring sites we were constrained by two major objectives: (1) sites should not be sprayed or should be sprayed at a minimal basis only with selective pesticides so that parasitoids might survive and (2) GWSS levels at each site should be at least moderately high so that we could find and collect egg masses. We now have at least several months of data from each of the six sites and feel we have met both objectives at each site.

The type of monitoring data we collect at each site is listed below. We are using CDFA's basic monitoring protocol with modifications. Note that we have two replicated sampling plots at four sites, only one at Irvine (because the site is too small for two) and six at Temecula. In Temecula, in collaboration with Dr. Nick Toscano and Mr. Rodney Mendes, we are comparing two replicates of each of three treatments for control of GWSS within an organic citrus block; treatments are (1) untreated control, (2) parasitoid releases, and (3) control of GWSS with two sprays of an organically approved spray = Pyganic + Nufilm.. Note that management of GWSS within organic citrus has been problematic within the Temecula GWSS management program being run by Dr. Toscano and thus, he expressed an interest in evaluating parasitoid releases at this site. We started this experiment with three replicates of each of the three treatments but mid-way through out study, citrus in two of the replicates was leased to a different grower who stopped watering the trees for several months. As a result, we dropped these six plots and added three new plots (one replicate of each treatment) within the portion of the ranch being run by our grower-cooperator, Mr. Albert Salazar.

1. *Sticky Cards to Monitor for Adult GWSS levels*: Use 10 yellow sticky traps in each plot to assess adult GWSS levels every two weeks.
2. *Leaf Sampling*: Count and collect the number of fresh GWSS egg masses on 10 leaves collected from the end of branches on each of 10 trees in each plot every two weeks. In contrast to method 3, this is intended to return a less-biased estimate of GWSS egg mass levels. Old egg masses are counted, but not collected. The egg mass sampling is mainly intended to estimate recent GWSS egg mass levels and to serve as a means of collecting egg masses for parasitoid rearing.
3. *Time Search for GWSS Egg Masses*: Do five two-minute time searches near the center of each plot every two weeks, looking for, counting, and collecting viable (new) GWSS egg masses. Continue sampling an additional 30 minutes until a minimum of five egg masses are found from 2 and 3 combined.
4. *Parasitoid Emergence Data*: Using egg masses collected in 2 and 3 (aim for 5-10 egg masses per date if possible), return egg masses to the lab at UCR and rear out and identify parasitoid species that are present.

Over the period of our study, there have been changes in the species / strains of parasitoids CDFA rears and releases. Our initial experimental design was to release *G. ashmeadi* and one of *G. fasciatus, G. morrilli,* or *G. triguttatus* at each site. As of September 2005, CDFA decided to change the strain of *G. morrilli* being released. The new strain is from Texas and contains a genetic marker, which should allow differentiation between the released *G. morrilli* and endemic populations of this species (preliminary work indicates these two strains do not interbreed, de Leon et al. 2004, 2005). Thus, we decided to revise our experimental design to compare *G. ashmeadi* and Texas *G. morrilli* releases at each of the six sites we are monitoring, allowing for a comparison of how these two species do at interior versus coastal sites (with three sites in each region). Our experimental plan was to release 250 parasitoids of each of two species in each plot every two weeks (two plots at four sites, one plot at Irvine, six plots at Temecula). Due to rearing constraints, we have not been able to achieve this target release rate. However, we feel the monitoring we are doing does have value, especially in determining levels of endemic *Gonatocerus* species prior to release of *Anagrus epos* (see below).

From the data collected to date, all three coastal sites produced a much higher percentage of *Gonatocerus morrilli* than the three interior sites. For example, in the month of May, the following data were observed from the collected egg masses: Irvine Ranch produced 29 wasps, 93% were *G. morrilli* and 7% were *G. ashmeadi*; Mission Viejo produced 112 wasps, 63% were *G. morrilli*, 20% were *G. ashmeadi*, and 18% were *G. novifasciatus*; San Juan Capistrano produced 286 wasps, 91% were *G. morrilli*, 3% were *G. ashmeadi*, and 6% were *G. novifasciatus*; Temecula produced 136 wasps, 28% were *G. morrilli*, 56% were *G. ashmeadi*, and 16% were *G. novifasciatus*; Agricultural Operations produced 64 wasps, 1.5% were *G. morrilli*, 72% were *G. ashmeadi*, and 27% were *G. novifasciatus*. It appears *G. morrilli* will continue to be the dominant parasitoid species in the coastal orchard sites throughout the year, but it may be premature to draw conclusions at this point. *G. novifasciatus* appears to be of lesser importance throughout the collections, however, it is the third most prevalent species of *Gonatocerus* in our collections.

Anagros epos was collected in Minnesota by Dr. Roman Rakitov (Center for Biodiversity, Illinois Natural History Survey, Champaign, Illinois) near Glyndon, Clay Co., Minnesota, from egg masses of *Cuerna fenestella* Hamilton (a native, univoltine proconiine sharpshooter) on *Solidago* sp. (goldenrod, *Compositae*) and *Zigadenus* sp. (death camus, *Liliaceae*) and

sent to Dr. Serguei Triapitsyn at the UCR quarantine facility under an appropriate permit (Hoddle & Triapitsyn 2004, Triapitsyn & Rakitov 2005). A permit for release from Quarantine was obtained in 2005 by Dr. David Morgan and this strain is presently being reared by CDFA and has already been released at a few field sites (but not at any of the six sites we are monitoring). A major focus of our project starting in Feb. 2006 will be to monitor for establishment and persistence of this species at each of our six study sites.

As companion research to field establishment, Mr. John Lytle plans a series of experiments with the Minnesota strain of *A. epos*. The questions being asked are: (1) How will *A. epos* do in competition with *G. morrilli*, the dominant egg parasitoid in our three coastal sites? (2) How well will *A. epos* establish at coastal versus interior study sites (we will use clamp cages to compare survival at the six study sites in addition to sampling for recovery of *A. epos*)? (3) Will *A. epos* exhibit a preference for GWSS egg masses on citrus versus other leafhopper species present on grasses or other hosts (lab studies will be done to examine this question)? (4) Will the Minnesota strain of *A. epos* mate with endemic strains of *A. epos* in California or is it a different species (see the progress report in the Proceedings by Morse and Stouthamer)?

CONCLUSIONS

Data from the first year of field monitoring has been confounded to some degree by changing experimental sites (due to low GWSS levels at some sites and the desire to monitor the same variety of citrus at each site), changes in the species of parasitoids that CDFA is releasing, and lower levels of parasitoids being available for release than was planned. When doing applied research within an evolving biological control program (Shea et al. 2002), such changes should be expected but we must admit that the data we have been able to obtain are not as "clean" as one might hope when setting up an experimental design. We are well in place, however, to run a rather clean evaluation of the establishment and persistence of the Minnesota *A. epos* strain starting Feb. 2006.

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