BIOLOGY AND ECOLOGY OF THE GLASSY-WINGED SHARPSHOOTER IN THE SAN JOAQUIN VALLEY

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Reporting Period: The results reported here are from work conducted May 2003 to October 2005.

ABSTRACT

We followed glassy-winged sharpshooter (GWSS) preference and age structure on ornamental host plants in Bakersfield, California. Averaging data across all sampling sites and collection dates, grape, citrus, apple, *Xylosma*, cherry and flowering pear were the most preferred ovipositional sites. GWSS nymphs were most often collected on oleander, flowering pear, *Xylosma*, crabapple, *Abelia*, and crape myrtle. Adults were most often collected on oleander, *Xylosma, pyracanthum*, crape myrtle, and crabapple. Over the 3 year period, population patterns were clearly evident: new egg masses were first found in mid-March, followed by a strong April-May oviposition period, the resulting nymph and adult GWSS populations follow in sequence. A summer decline in GWSS density was primarily the result of high egg parasitism during the second oviposition period. Throughout the field survey, we sampled resident GWSS predators and parasitoids. Emerged parasitoids were primarily *Gonatocerus ashmeadi*. Predators were primarily spiders and the Argentine ant. In 2004-05, we manipulated combinations of GWSS host plant species, to investigate year-long GWSS survival and age structure. Treatments were: citrus, euonymus, grape, oleander, crape myrtle, citrus and grape, and oleander and crape myrtle. Only in the combination of citrus and grape was there an increase in GWSS density. During the urban surveys, we also collected plant material (e.g., potential vector host plants) and potential insect vectors to determine the incidence of *Xylella fastidiosa (Xf)*. This material was processed in the laboratory using "immunocapture DNA extraction" to determine the presence of *Xf*. Results showed that GWSS collected in urban regions often (≈10%) carried *Xf*, however, it was not the strain that causes Pierce's disease.

INTRODUCTION

Glassy-winged sharpshooter (GWSS), *Homalodisca coagulata*, has a wide host range (Redak et al. 2004) on which it can survive outside of pesticide-treated agricultural crop systems. Elimination of alternate host plants for the blue-green sharpshooter, *Graphocephala atropunctata*, was an effective method for controlling the spread of Pierce's disease (PD) in coastal wine grape regions. Because the GWSS host species range is so extensive, such similar habitat manipulation requires knowledge of GWSS biology and ecology on common host plants. To improve GWSS management in the largely untreated urban areas of the Central Valley, we studied GWSS host preference, egg deposition, age structure, and levels of natural regulation on different host plants. To develop a more complete description of host plant influence on GWSS age structure and natural enemy impact, we conducted both urban surveys and manipulative experiments. Specifically, we sought to determine the potential of common plant species used in residential landscaping to either reduce or increase GWSS densities. The developed information will provide a better understanding of GWSS seasonal movement and infestation foci. Of primary concern to regional control programs is whether or not untreated urban GWSS populations serve as an inoculum source for either the insect vector or the bacterial pathogen, *Xylella fastidiosa* (*Xf*). Therefore, we also screened common plants and GWSS collected for the presence of *Xf*. When completed, information on the abundance, host plant use, and seasonal dispersal patterns of GWSS and natural enemies in urban settings will better enable researchers to predict GWSS movement and host plant succession in the SJV, and the data may be useful for modification of surrounding vegetation, such as trap crops, to suppress GWSS movement into vineyards.

OBJECTIVES

1. Determine GWSS biology and ecology throughout the season, particularly its age structure on and utilization of the different host plants that represent common breeding or dispersion refuges for GWSS in the San Joaquin Valley.
2. Determine the contribution of resident natural enemies on glassy-winged sharpshooter mortality and whether natural enemy abundance or species composition varies significantly on different GWSS host plants or ecosystems in the San Joaquin Valley.
3 Determine the presence of *Xf* in GWSS collected from different host plant species and in selected ecosystems in the San Joaquin Valley.

RESULTS

Objective 1 - Survey

GWSS numbers, age structure and natural enemies were surveyed in seven residential areas in Bakersfield, California. Each site was selected for its combination of different plant species that host both GWSS and *Xf*. Most of the sampled sites had 3-8 individual plants of each plant species, with 3 or more GWSS host plant species in close proximity. The 30 host plant species surveyed included: rose, star jasmine, Chinese elm, flowering pear, apple, pink lady, ivy, nectarine, photinia, citrus, gardenia, privet, euonymous, hibiscus, agapanthus (lily of the Nile), grape, crape myrtle, eucalyptus, oleander, *Xylosma* and Wheeler's dwarf. Each month, samples were taken to determine densities of GWSS and natural enemies (samples consisted of a 1 min beating-collection of the foliage into a large sweep net). We also recorded plant condition. None of the sampled sites were treated with insecticides for GWSS. From April 2003 to August 2005, we made >9000 plant samples (sample plant × sample date). There was an significant impact of sample site on GWSS density, as one site had more GWSS (nymphs and adults) (2.81 ± 0.16 per sample) than the other six sites (range 0.16 ± 0.02 to 0.61 ± 0.04 GWSS per sample) (F = 79.73, df = 6, 9116, P < 0.0001). Overall, GWSS densities were not high enough to be an economically important problem in these urban landscapes. The data presented were averaged across all sample sites.

GWSS adults and nymphs exhibited strong host plant feeding preferences (Figure 1B, C). GWSS females were highly selective relative to ovipositional hosts, but there was not a strong correlation between those plant species that were fed upon and upon which egg masses were deposited (Figure 1A, 1C). This was especially true with respect to oleander, as reported by other researchers. When data were averaged across all sampling sites, grape, citrus, apple, *Xylosma*, cherry, and flowering pear were preferred oviposition sites (Figure 1A). Summarizing the data across all sample locations reduced the apparent important of crape myrtle as an oviposition host, because it was common at survey sites with low GWSS density. Oleander and privet may be the most important overwintering hosts in the urban regions, however, they were not preferred oviposition hosts. In contrast, crape myrtle and crabapple were dormant throughout winter and, according to our samples, played no role in the GWSS overwintering; however, they were excellent hosts for oviposition and nymphal development during late spring and summer time.

Host plant feeding preferences of adults and nymphs were not identical. GWSS nymphs were most often collected on oleander, flowering pear, *Xylosma*, crabapple, abelia, and crape myrtle (Figure 1B). Adults were most often collected on oleander, *Xylosma*, pineapple guava, pyracanthum, crape myrtle, and crabapple (Figure 1C). In 2004, we also began separately monitoring GWSS density on the "suckers" that grew from the base of plants, where GWSS nymphal and adult densities were commonly high. These plant parts were only occasionally available because of management practices.

Field surveys began in June 2003, with samples taken every 2-4 weeks. Over the three year period, population patterns were clearly evident. New egg masses were first found in mid- to late-March (in the Bakersfield region), followed by a strong April-May ovipositional period (Figure 2A). The resulting nymphal and adult GWSS populations followed in sequence in each year (Figure 2B, 2C). The second ovipositional period was strongest between mid-June through October. In 2003, there appeared to be a large fall ovipositional period, but this reflected (i) fewer sites surveyed in this initial year, causing a greater influence of the site with higher GWSS densities, and ii) decreasing GWSS populations since 2003 (a result of egg parasitism). The summer decline in GWSS density was primarily a result of high egg parasitism during the second ovipositional period and, secondarily, mortality of GWSS from predation and abiotic factors.

Objective 1 – Manipulative experiments.

In 2003 and 2004, we used uncaged, potted plots to categorize the resident GWSS population dynamics on different perennial and annual host plant species (Daane et al. 2004). Here, we report on a second experiment in which we manipulated combinations of GWSS host plant species, planted in the soil and enclosed in large cages, to investigate year-long GWSS survival and age structure. Individual treatments were: citrus, Euonymus, grape, oleander, and crape myrtle. Combinations were: citrus + grape and oleander + crape myrtle. Each cage was inoculated with 43-55 GWSS nymphs (3^{rd} instars) in July 2004.

In all cages, there was considerable mortality after the initial inoculation, with GWSS density dropping from an inoculum of ca. 45 nymphs to < 6 nymphs per cage (Figure 3) as transfer of GWSS nymphs proved difficult. From this initial inoculum, some individuals reached the adult stage and deposited eggs during the fall period (Figure 4). Only in the citrus + grape combination treatment was there a steady GWSS population from late summer through the following spring, resulting in an increase in GWSS density (Figure 3). When the experiment was terminated in June 2005, there had been > 47.3 ± 23.3 egg masses per cage in the citrus + grape treatment (Figure 4), which would have produced 100's of nymphs.

Objective 2 – Natural enemies

During the surveys of GWSS population dynamics in non-agricultural regions, described previously, we collected information on GWSS natural enemies, using sampling techniques such as GWSS egg mass collections (>100 leaves per perennial plant species per collection) and potential GWSS predator collections (beat and sweep samples). As in all studies, we recorded host plant species and seasonal period. *Gonatocerus ashmeadi* and *G. triguttatus* (Triapitsyn et al. 1998) comprised about 98 and 2% of reared parasitoids from GWSS egg masses, respectively. Parasitism levels were lower in 2005 than reported in 2004 (Daane et al. 2004) and were 0.25 ± 0.25, 0.90 ± 0.45, 39.5 ± 4.3, and 24.3 ± 4.3% for March, April, June, and July, respectively (no egg masses were collected in May; August samples have not yet been processed). On common oviposition hosts, there was a significant impact of host plant species on percentage parasitism for flowering pear – 2.4% ± 2.4% (only 8 egg masses), photinia – 5.5 ± 3.2%, euonymus – 25.0 ± 6.5%, *Xylosma* – 49.5 ± 5.8%, crape myrtle – 78.9 ± 4.6%, and "other" 9.7 ± 5.2%. This difference was significantly and positively correlated to oviposition period; for example, crape myrtle was a common oviposition site in June and July samples. There was also an impact of collection site on percentage parasitism, which was significantly and positively correlated to the GWSS egg mass density.

Predators were also observed feeding on GWSS egg masses, nymphs, and adults. The most common predators were jumping spiders and the Argentine ant. Samples of these predators were sent to the Western Cotton Research Laboratory, where the predator gut content is being assayed with immunologically-based assays that employ pest-specific monoclonal antibodies (MAbs) for the presence of GWSS egg protein using the ELISA by Drs. Hagler, Fournier, and Leon (Hagler et al. 2004). These studies will provide direct evidence of predation by generalist predators.

Objective 3 - *Xylella.*

We have collected ≈2000 GWSS nymphs and adults from ornamental plants in Bakersfield for testing of *Xf* presence; of these, 210 adult GWSS have been processed, with each trial using a batch of 4-8 GWSS. Of these, 16.5% of the processed lots tested positive for *Xf*. All of the *Xf* positives that were tested for *Xf* strain were found to carry a *Xf* strain resembling the oleander *Xf* strain. A summary of these trials will be included in later reports.

CONCLUSIONS

We have described GWSS population density and age structure on ornamental plants common in residential landscaping in the SJV. We have further described natural enemy presence. This research adds significant information to that collected in Riverside and Ventura counties to help predict GWSS movement and develop control programs. The research has broader implications for use of ornamental landscape and riparian plants within agricultural settings (e.g., landscaping around farm buildings and homes). Plants which act as preferred hosts for both vector and pathogen can be targeted for control. By testing GWSS for the presence of *Xf*, researchers will identify potential sources of the pathogen, thereby preventing potential epidemic spread of Pierce's disease causing *Xf* throughout a reservoir of ornamental host plants. A thorough analysis of this data set will be made at the end of the residential survey (May 2006).

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FUNDING AGENCIES

Funding for this project was provided by the CDFA Pierce's Disease and Glassy-winged Sharpshooter Board.

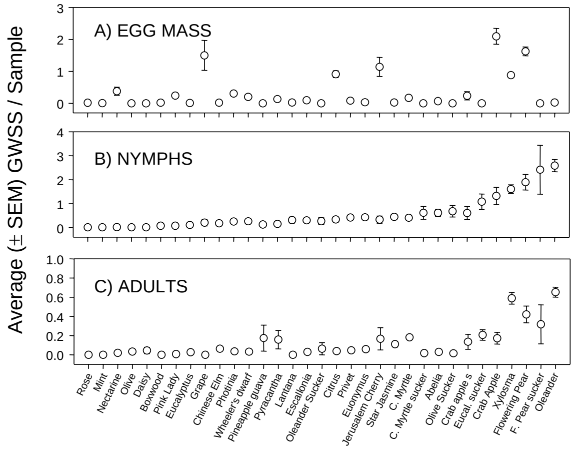

Figure 1. Average densities (per sample ± SEM) of GWSS (A) egg masses, (B) nymphs and (C) adults among the different ornamental host plants surveyed.

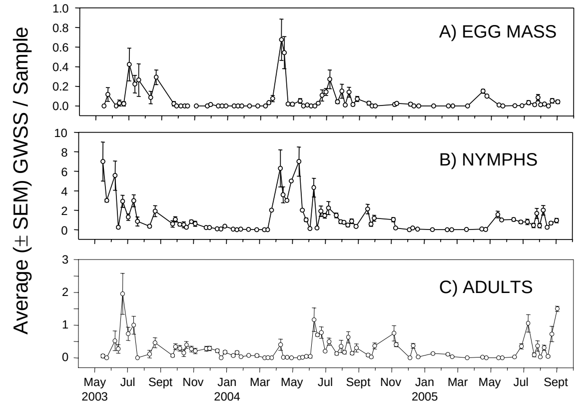

Figure 2. Seasonal densities (per sample) for GWSS (adults and nymphs) on ornamental host at seven sampled sites in Bakersfield, California.

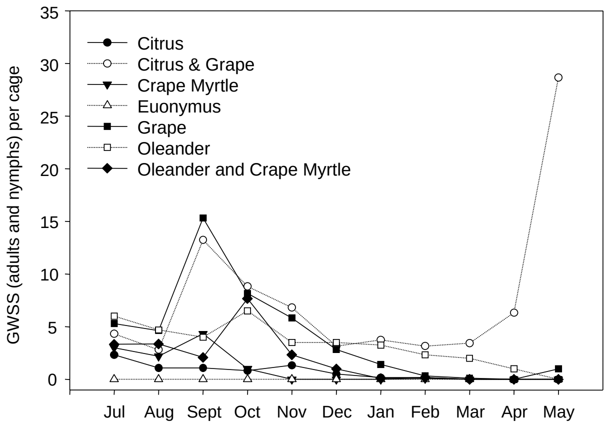

Figure 3. Average densities of GWSS (nymphs and adults) on different ornamental host plants that were caged individually or in combinations.

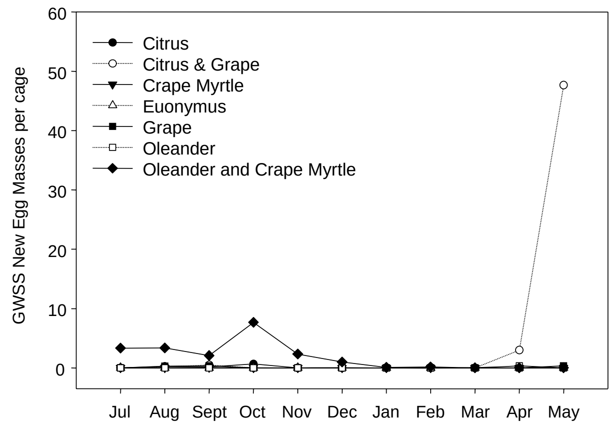

Figure 4. Average densities of GWSS new egg masses on different ornamental host plants that were caged individually or in combinations.