REPRODUCTIVE BIOLOGY AND PHYSIOLOGY OF GLASSY-WINGED SHARPSHOOTER

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INTRODUCTION

The glassy-winged sharpshooter (GWSS), *Homalodisca coagulata* (Say), is a serious pest of many tree and vine crops (Turner and Pollard 1959, Nielson 1968). The main concern of the presence of the GWSS in California is that this insect is an efficient vector of the bacterium, *Xylella fastidiosa*, which causes vascular disease in multiple crops, including grapes, citrus, and almonds, along with horticultural plants, including oleander and mulberries (Meadows 2001, Hopkins 1989, Purcell and Hopkins 1996). An adult GWSS need only encounter the Pierce's disease causing bacterium, *X. fastidiosa*, once while feeding on an infected plant and it will then be a vector of *X. fastidiosa* for the rest of its life (Frazier 1965, Purcell 1979, and Severin 1949).

Little is known about the reproductive biology of the GWSS. It has been reported that GWSS has two generations per year in Southern California (Blua et al. 1999). Oviposition occurs in late winter to early spring, and again in mid-to-late summer. Adult females live several months and lay small eggs side by side in groups of about 10, ranging from 1 to 27 (Tuner and Pollard 1959). The greenish, sausage-shaped eggs are deposited in the leaf epidermis of the host plants. Our research is focused on the reproductive morphology and physiology of the GWSS. We are examining the seasonal differences in female and male GWSS reproduction between summer and overwintering populations by studying oögenesis and spermatogenesis cycles. This knowledge is important in determining how GWSS might choose plant hosts in the landscape, which and why these host plants are particularly suitable for GWSS ovarian development, and finally how control measures might best be implemented based upon season and stage of reproductive development. Better knowledge of reproductive biology might also lead to better decision support including improved choices of chemical or non-chemical approaches to GWSS control.

OBJECTIVES

1. Collect and prepare GWSS specimens for studying the morphology and anatomy of female GWSS.
2. Study and describe the musculature associated with the female ovipositor.
3. Characterize the reproductive cycle of female GWSS.
4. Study effects of location on female GWSS reproductive cycle.
5. Study effect of host plant type on female GWSS fecundity.

RESULTS AND CONCLUSIONS

Female and male GWSS were collected from June 2001 to October 2001. Due to some problems with specimen preservation, only specimens collected after September 2001 were useful for dissection purposes. Samples were taken on monthly or bimonthly intervals, and a random subsample of 10 females per month were dissected to determine ovarian development of the specimens. The stages of ovarian development were arbitrarily set from 1 to 8, with 1 being the least developed stage associated with youngest adult females and 8 being the fully developed stage associated with the oldest adult females. Stage 1 has 2 small oöcytes per ovariole and no corpus luteum present. Stage 2 has 3 small oöcytes per ovariole and no corpus luteum. Stage 3 has 2 small oöcytes per ovariole and one large ova per ovariole. Stage 4 has 1 small and 1 medium oöcyte, and 1 large ova per ovariole. Stage 5 has 2 small oöcytes per ovariole with a corpus luteum present. Stage 6 has 1 small oöcyte and 1 large ova per ovariole with, or without, a corpus luteum present. Stage 7 has 1 small oöcyte per ovariole with a corpus luteum present. In stage 8 there are only large ova present. Stage 1 and 2 are previtellogenic. Stages 3 to 8 are reproductively active females who are in the process of oviposition (Stages 3, 4, 6 and 8), or have already oviposited at least once (Stages 5 and 7). The average ovary rank per sampling date from October 2001 to June 2002 is plotted in Figure 1. We are still attempting to determine which generations are present on each sampling date. The presence of two generations of insects at most times of the year has led to variation in the ovarian development among the dissected specimens and we are planning to dissect 10 additional specimens for each sampling date. This will result in a total of 20 specimens dissected per sampling date.

The oögenesis and spermatogenesis cycles will be further studied using histological and cytochemical methods as well as transmission electron microscopy (TEM). This study has recently been expanded to include a site in Ventura County, CA to examine possible location effects in California.

Muscles of Ovipositor:
Musculature of the female ovipositor was determined using gross dissection techniques and drawings (Figure 2). Muscle 1 is a dilator, it originates on the VIII tergite (T) and inserts on the common oviduct. Muscle 2, a retractor, connects the pygofer to the VIII T. Muscle 3, a depressor, originates on the VIII T and inserts on the first valvifers (vlf). Muscle 4, a dilator, originates on the pygofer and inserts on the third valvula (vl). Muscle 5, also a dilator, originates on dorsal-posterior portion of the first vlf and inserts on dorsal portion of second vlf. Muscle 6, a retractor, originates on the apodeme of the pygofer and inserts on the dorsal-most portion of second vlf. This muscle consists of two portions: 6a, which originates on the posterior edge of the pygofer apodeme; and 6b, which inserts on the apodeme ridge. Finally, muscle 7 is a protractor, it originates on the dorsal-posterior portion of the pygofer and inserts on the ventral-most portion of the second vlf. The other muscles illustrated are associated with movement of the abdominal segments and are not directly associated with oviposition.

The hypothesized sequence of muscle action during oviposition is described as follows. 1) The contraction of muscle 2 retracts the pygofer by pulling it toward the body and away from the tip of the ovipositor. 2) By the contraction of muscle 4, the paired third valvulae are dilated ventrally to further expose the ovipositor (to reduce friction with the body). 3) Muscle 3 contracts to pull the first vlf dorsally and subsequently causes the first vl to depress and tilt away from body. 4) a. Muscle 7 contracts causing the second vl to protract away from the body, and b. simultaneous contraction of muscles 3 and 7 result in the ovipositor being pushed away from the body. 5) Muscle 6a contracts pulling the second vl toward the body. 6) Muscle 6b contracts resulting in the rotation of the ovipositor. 7) Muscles 3 and 7 will relax as muscle 6a contracts causing the ovipositor to move toward the body again, thus beginning the sawing motion**.** Muscles 3 and 7 will contract once again, and the seesawing action continues. When muscles 6 and 7 work oppositely, the second vl. – sawing portion – will move toward and away from the body. The simultaneous contraction of muscles 3 and 7 will accentuate the seesawing action of the ovipositor (second vl. slides on a groove in the first vl.). 8) Once a slit has been made in the leaf, muscles 1 and 5 contract causing the opening up of the paired second valvifers, which expands the genital chamber to allow an egg to pass or for copulation. 9) Once the orifice of the common oviduct into the genital chamber has been dilated, the egg will be deposited into the genital chamber and further slide through the opening now present between the paired second valvifers. The egg will then slide down the middle groove of the ovipositor that is present between the paired first and second valvulae.

Oögenesis study:
The details of reproductive cycle of the female GWSS are still not clear based on our limited data. Our data suggest that from October to February, there is a gradual decrease in mean ovarian development rank, indicating that there is probably a shift toward a higher proportion of younger insects in the population during the period. The ovarian rank begins ascending in March, indicating that the population largely consists of older female GWSS (Figure 1).

Host Plant Study:
The greenhouse study conducted this summer has shed light on differences in female fecundity reared on different host plants. In this study adult female and male GWSS were caged on citrus, grape, or oleander and allowed to mate and oviposit on the plants. We were successful in obtaining oviposition and in rearing GWSS from egg stage to adult stage on all three types of host plants. Data are still being collected, and have yet to be summarized for analysis.

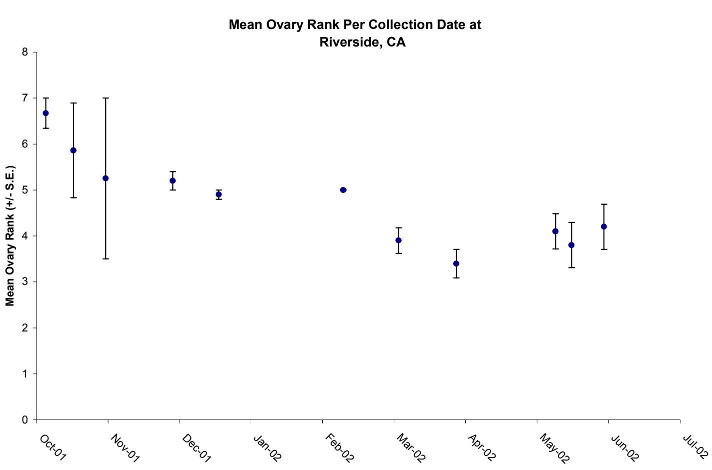

Figure 1. Mean (±S.E.) ovary rank per collection date at Riverside, California.

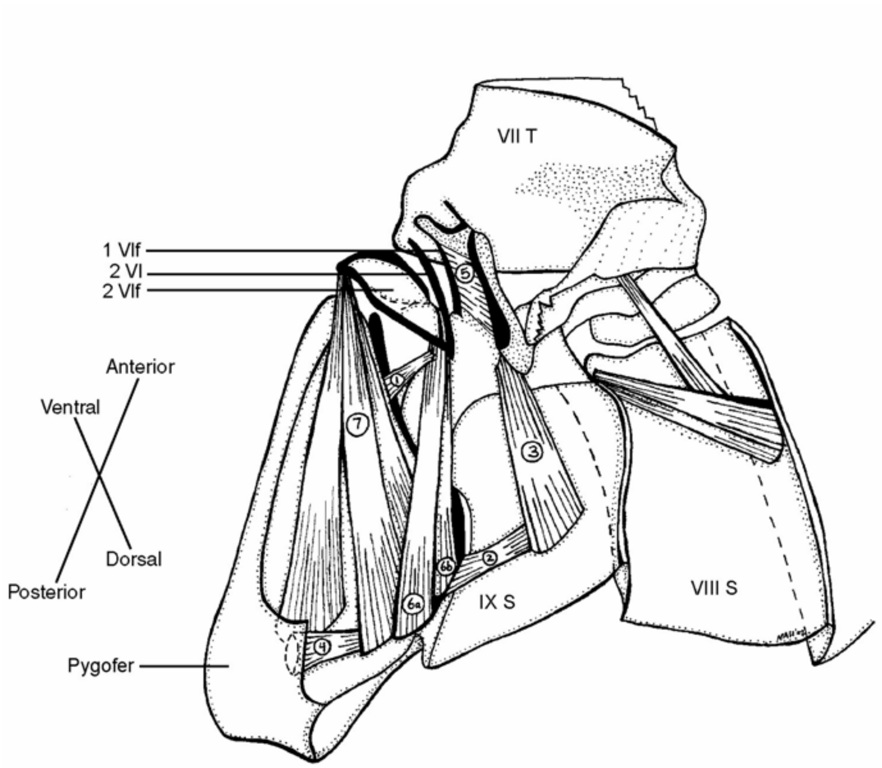

Figure 2. Lateral view of the musculature associated with the female *Homalodisca coagulata* ovipositor.

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