Realized lifetime parasitism of glassy-winged sharpshooter egg masses by *Gonatocerus ashmeadi* (Hymenoptera: Mymaridae)

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ABSTRACT

Oosorption and egg maturation results suggested that *G. ashmeadi* is a pro-synovigenic species and females mature more eggs during their lifetime. In the absence of hosts, oosorption was initiated on day 7, where the number of reabsorbed eggs increased at a rate of 1-4 eggs per day. In the presence of hosts female *G. ashmeadi* matured 3-27 eggs per day.

INRODUCTION

The self introduced *G. ashmeadi* (Vickerman et al. 2004) is the key natural enemy of glassy-winged sharpshooter (*Homalodisca vitripennis*) (GWSS) egg masses in CA at present (Pilkington et al. 2005). Over summer, parasitism levels of GWSS egg masses and individual eggs in masses by *G. ashmeadi* can approach 100% but parasitism levels of the spring generation of GWSS are substantially lower, and parasitism generally averages ~19-20% (Pilkington et al., 2005; Triapitsyn and Phillips 2000). Naturally occurring populations of *G. ashmeadi* in CA have been augmented with mass reared individuals from populations found in the southeastern U.S.A. and northeastern Mexico which encompasses the home range of GWSS (CDFA 2003).

Substantial laboratory work with *G. ashmeadi* has been conducted in an attempt to understand and parameterize basic aspects of this parasitoid's reproductive biology, and host selection behaviors. Irvin and Hoddle (2005a) have evaluated oviposition preferences of *G. ashmeadi* when presented GWSS eggs of various ages. Interspecific competition between *G. ashmeadi* with *G. triguttatus* and *G. fasciatus* for GWSS egg masses of different ages has been assessed (Irvin and Hoddle 2005b; Irvin et al. 2005) along with factors influencing the sex ratio of offspring (Irvin and Hoddle 2006a). The effect of resource provisioning and nutrient procurement on the longevity of *G. ashmeadi* has also been determined (Irvin and Hoddle 2006b). Furthermore, Pilkington and Hoddle (2006) have assessed laboratory-level fecundity rates of *G. ashmeadi* under different constant temperature regimens.

The GWSS-*Gonatocerus* system has benefited from this intensive laboratory study to generate a basic understanding of factors influencing host selection and parasitism success. The next step that is now required is to test hypotheses generated from lab studies in the field. Field level assessments will help determine the most important aspect of the GWSS biological control program: "How big an impact do individual female *G. ashmeadi* parasitoids have on GWSS population growth via parasitization of eggs?" Addressing this question will allow us to form a much better understanding of the levels of control we can expect from *G. ashmeadi* individually and collectively on GWSS population growth in the field during the spring and summer generations.

OBJECTIVES

To measure real life time contributions of individual female *G. ashmeadi* to the parasitism of GWSS egg masses in citrus orchards. Before field assessments can be conducted, laboratory studies will be run to ascertain and verify four critical factors outlined below. Answers to these four critical factors will allow us to develop a composite index that describes the correlative relationship of these four factors that will predict parasitoid age and egg load in the field and to assess the contribution of individual female parasitoids to GWSS suppression under field conditions. The four critical factors are:

A. Determine the relationship between adult female *G. ashmeadi* size as measured by right hind tibia length (HTL) and 24-hr egg load for spring and summer generations (this work was completed and reported in Hoddle et al. 2005).
B. Ascertain the extent to which oosorption occurs, and the length of time without ovipositing that is required to initiate this physiological response if it does occur.
C. Determine whether female parasitoids can mature eggs in excess of those they are born with.

D. Estimate parasitoid age using near infrared spectroscopy (NIRS) (Perez-Mendoza et al. 2002) and develop an alternative measure for comparison by developing a wing deterioration index that estimates parasitoid "age" through visually grading the severity of 'wear and tear' (i.e., numbers of broken setae) of setae on wings (this work was completed and reported in Hoddle et al. 2005).

RESULTS AND DISCUSSION

Hoddle et al. (2005) reported the relationship between *G. ashmeadi* size (tibia length) and <24 hr egg load and described two methods of identifying female age through a wing wear index and using NIRS. Research reported here details oosportion and egg maturation rates for *G. ashmeadi.* These results are preliminary as we are still working on more thorough statistical analyses. With this information we aim to develop a composite index that describes the correlative relationship of the four factors listed above that will predict parasitoid age and egg load in the field and this will allow us to assess the contribution of individual female parasitoids to GWSS suppression under field conditions at time of death.

Oosorption

Gonatocerus parasitoids are generally classified as strictly pro-ovigenic (Jervis and Copland, 1996) where females emerge with a full load of mature eggs and do not mature more eggs as they age (Quicke, 1997). Results obtained so far suggest that *G. ashmeadi* may be partially syn-ovigenic. Completed studies suggest that females emerge with ~30 mature eggs and can mature more over the course of their life time (Fig. 1). *G. ashmeadi* females that have access to 50% honey-water but not GWSS eggs developed 4-8 mature eggs per day up to around 7 days of age before egg load in females began to decline at a rate of 1-8 eggs per day because of oosorption (Fig. 1). In the absence of hosts, females appear to reabsorb mature eggs theoretically enabling them to redirect energy into host seeking and survival, a characteristic of syn-ovigenic species (Jervis et al., 1996). Figure one demonstrates that female *G. ashmeadi* oosorption was initiated on day 7, and the number of reabsorbed eggs increased at a rate of 1-4 eggs per day, to 12 eggs on day 13. In this species, oosorption is obligatory because egg maturing continues in the absence of hosts (Quicke, 1997). However, results also show that the total number of eggs present in *G. ashmeadi* ovaries (potential fecundity) over their lifetime was similar to the predicted <24 hr potential fecundity as estimated from hind tibia length (using data from objective A above). This demonstrates that in the absence of hosts, female *G. ashmeadi* do not mature more eggs than what they emerge with, a characteristic of pro-ovigenic species. In this study, parasitoid age can be converted to physiological age using day-degree estimates (Pilkington and Hoddle, 2006).

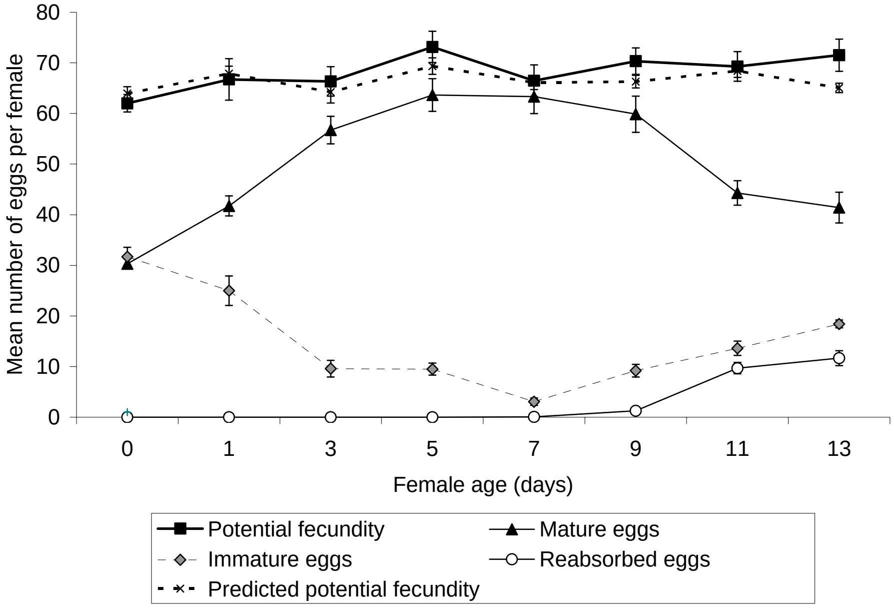

Fig. 1: The effect of age on the mean number of mature eggs, immature eggs, reabsorbed eggs, potential fecundity and predicted potential fecundity (as predicted from hind tibia length) in ovaries of female *G. ashmeadi* presented with no hosts for 13 days.

Egg Maturation

Figure 2 shows that on day 13, potential fecundity was 77 eggs higher than the predicted <24 hr potential fecundity as estimated from hind tibia length. This suggests that *G. ashmeadi* mature more eggs as they parasitize hosts during their lifetime and indicates that this species is partially syn-ovigenic. Potential fecundity (realized fecundity + eggs present in ovaries) data demonstrates that in the presence of hosts female *G. ashmeadi* matured 3-27 new eggs per day. It is possible that potential fecundity was underestimated in this study because some eggs oviposited by females may be unaccounted for due to superparasitism or early larval death. The potential fecundity of females given hosts for one day after emergence was 26 eggs lower than the predicted <24 hr potential fecundity. This may indicate that 26 eggs were lost due to superparasitism or early larval death.

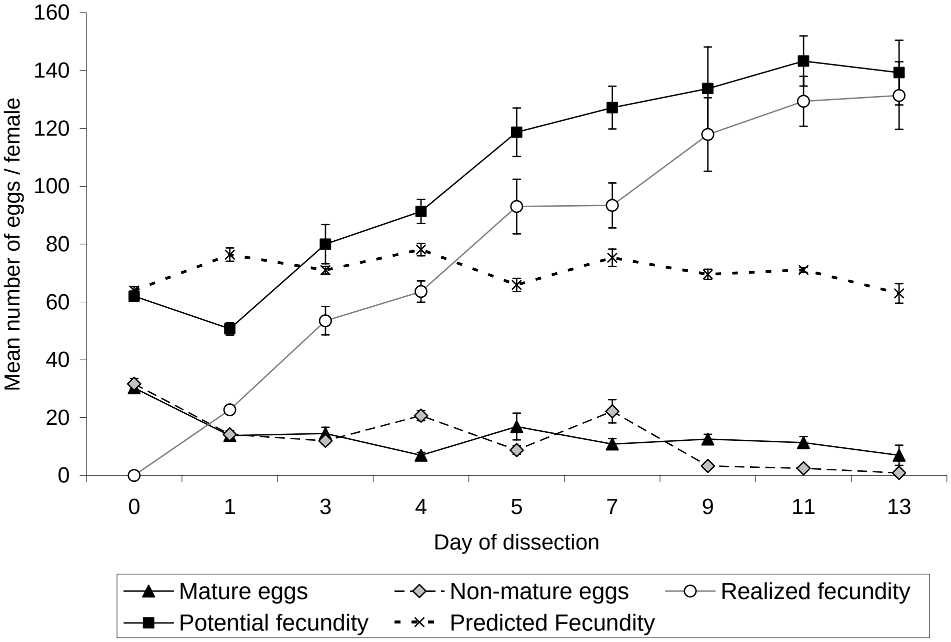

Fig. 2: The number of mature and non-mature eggs present in ovaries, realized fecundity (successful parasitism), potential fecundity (realized fecundity + eggs present in ovaries) and predicted fecundity (estimated from hind tibia length) of female *G. ashmeadi* offered hosts daily for 0-13 days after female emergence.

CONCLUSIONS

Oosorption and egg maturation results suggest that *G. ashmeadi* is a pro-synovigenic species. Females have the ability to mature eggs in excess of those they emerge with over their lifetime. In the absence of hosts, oosorption was initiated on day 7, where the number of reabsorbed eggs increased at a rate of 1-4 eggs per day. In the presence of hosts, female *G. ashmeadi* matured 3-27 new eggs per day. Together with previous data (the relationship between adult female *G. ashmeadi* size and 24-hr egg load, and a wing deterioration index that estimates parasitoid age), these components will be used to develop a composite index that will predict parasitoid age and egg load in the field and help determine how many eggs individual female *G. ashmeadi* parasitize in the field up to the time of death. In 2006 we collected ~ 20 dead female *G. ashmeadi* from the field using funnel traps loaded with dry ice. Females will be aged and egg load at time of emergence will be estimated from hind tibia length. The egg load at time of death (when oosorption and egg maturation are figured into the model) will allow us to estimate the average number of GWSS eggs females parasitize before dying. These estimates of realized field fecundity will allow us to form a much better understanding of what levels of control individual *G. ashmeadi* in the field are achieving.

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