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

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ABSTRACT

The relationship between female *Gonatocerus ashmeadi* size (hind tibia length) and <24-hr egg load was determined for spring and summer *G. ashmeadi* generations in Riverside, CA. Female size was positively correlated with egg load for both spring and summer generations with egg load varying from 23-108 eggs per female in spring and 29-118 eggs per female in summer. The use of near infrared spectroscopy (NIRS) and a wing deterioration index to estimate parasitoid age was also investigated and preliminary results demonstrated that both techniques may show potential for estimating the age of field collected *G. ashmeadi*.

INRODUCTION

The self introduced *G. ashmeadi* (Vickerman et al. 2004) is the key natural enemy of glassy-winged sharpshooter (*Homalodisca coagulata*) (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* approaches 100% but parasitism levels of the spring generation of GWSS are substantially lower (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has been assessed (Irvin and Hoddle 2005b, 2005c) along with factors influencing the sex ratio of offspring (N.A.I., unpublished data). The effect of resource provisioning and nutrient procurement on the longevity of *G. ashmeadi* has also been determined (N.A.I., unpublished data). Furthermore, Hoddle and Pilkington (2004) 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 the 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.

a) Determine the relationship between adult female *G. ashmeadi* size as measured by right hind tibia length (HTL) and 24-hr egg load (mature + non-mature eggs) for spring and summer generations.
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.

RESULTS AND DISCUSSION

During the reporting period described above, we have conducted 100's of dissections of female *G. ashmeadi* emerging from GWSS and smoke tree sharpshooter (STSS) (*Homalodisca lacerta*) eggs collected from the field to obtain different sized adults and determine the relationship between HTL and <24-hr egg load for both spring and summer generations. We have also determined a wing wear index for laboratory aged *G. ashmeadi* and have compiled initial data on the estimation of parasitoid age using NIRS. Results reported here are preliminary as we are still working on more thorough statistical analyses. Research on oosportion and egg maturation rates for *G. ashmeadi* is ongoing.

<u>Relationship between *G. ashmeadi* size and egg load:</u>

The <24-hr egg load of female *G. ashmeadi* emerging from GWSS and STSS eggs collected from the field was positively correlated with mean HTL for both spring (R^2= 0.36, n = 214; F = 121.50, df = 1, p < 0.0001) and summer generations (R^2 = 0.49, n = 162; F = 155.00, df = 1, p < 0.0001) (Figs. 1 & 2). Egg load varied from 23-108 eggs per female in spring and 29-118 eggs per female in summer. The summer generation (mean = 0.36 mm ± 0.00) contained on average significantly smaller females than the spring generation (0.34 mm ± 0.00) (t = 5.82, df = 374, p < 0.0001), whereas, egg load was statistically equivalent between seasons (spring mean = 62.3 ± 1.3; summer = 65.2 ± 1.5; t = -1.41, df = 374, p = 0.08). Female *G. ashmeadi* emerging from GWSS eggs over spring and summer were on average 12% larger and contained 40% more eggs than those emerging from STSS eggs (Table 1). This can be attributable to the smaller size of STSS eggs in comparison to GWSS eggs.

Table 1: Mean hind tibia length (± SEM) and <24-hr egg load (± SEM) for female *G. ashmeadi* emerging from GWSS and STSS eggs collected from the field.

	GWSS	STSS	t	df	p
Hind tibia length (mm)	0.36 ± 0.00	0.33 ± 0.00	-12.23	375	< 0.0001
<24-hr egg load	69.2 ± 1.2	49.2 ± 1.0	-10.06	375	< 0.0001

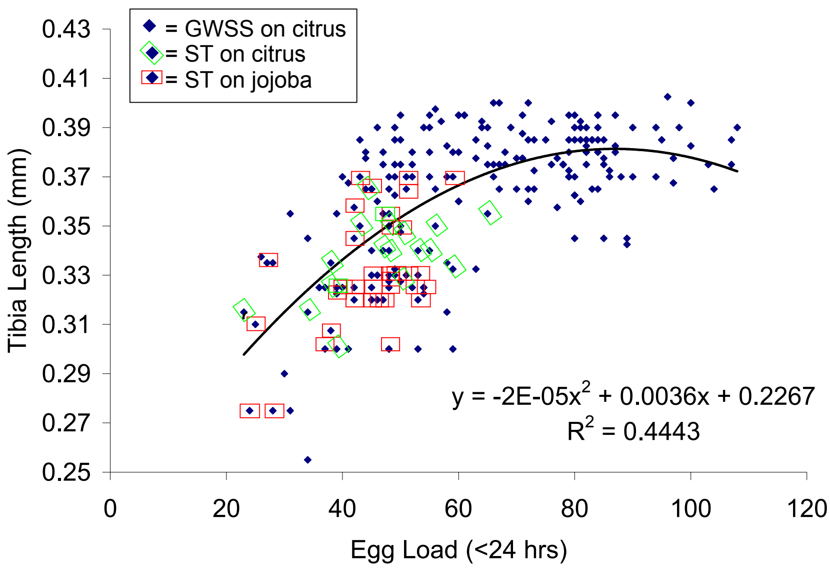

Figure 1: Relationship between hind tibia length (y) and the 24-hour egg complement (x) of female *G. ashmeadi* emerging from GWSS and STSS eggs laid on citrus and jojoba in the field during spring (April-June, 2005).

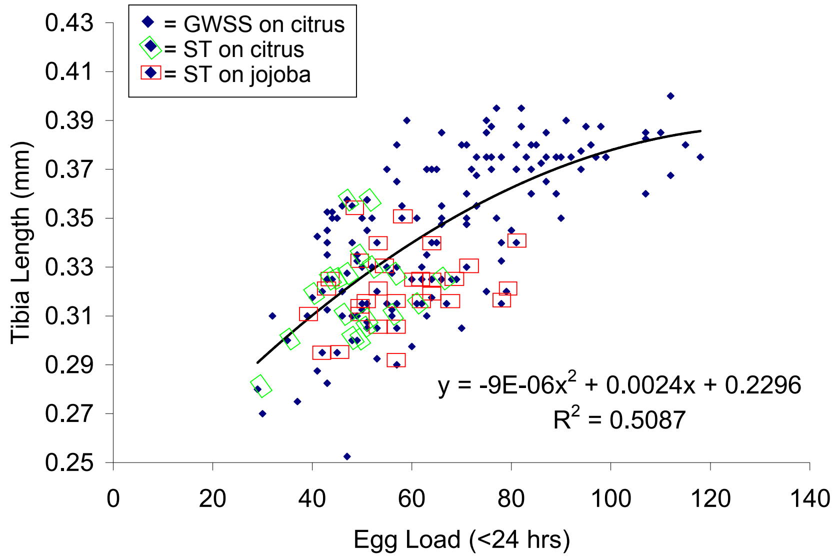

Figure 2: Relationship between hind tibia length (y) and the 24-hour egg complement (x) of female *G. ashmeadi* emerging from GWSS and STSS eggs laid on citrus and jojoba in the field during summer (August 2005).

<u>Age estimates of *G. ashmeadi*</u>
Female parasitoids were aged in cages with citrus trees at 26°C and destructively sampled at set intervals. There was a strong positive linear correlation between the mean number of broken setae (hairs) on the forewings of female *G. ashmeadi* and parasitoid age (R^2= 0.96; F = 107.27, df = 1, p < 0.001) (Fig. 3). This suggests that wing wear may be useful for predicting the "age" of adult *G. ashmeadi* in the field. However, further research is underway to determine how laboratory results correlate to field-aged *G. ashmeadi* since laboratory and field conditions vary significantly. The mean number of broken setae per female *G. ashmeadi* aged in the laboratory ranged from 3.6 to 8.4, whereas, wing damage in the field may be more severe. Field collected parasitoids are being analyzed now for wing wear. We anticipate being able to develop a "physiological age" wing wear index using degree-day models developed for *G. ashmeadi* by Pilkington and Hoddle (see report in this proceedings).

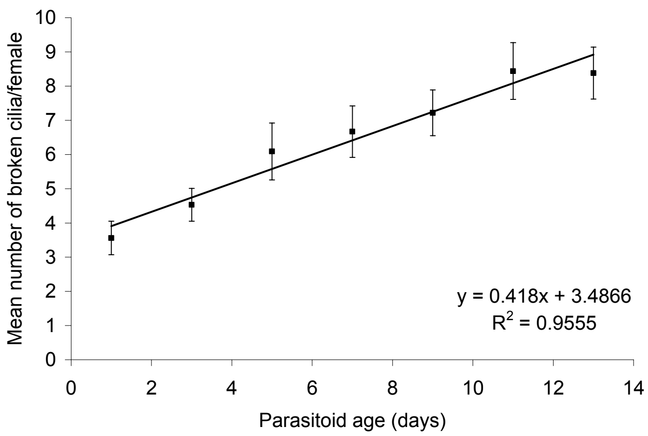

Figure 3: The relationship between mean number of broken setae (hairs) on the forewings of female *G. ashmeadi* and parasitoid age (error bars indicate ± SEM).

Preliminary analyses conducted with 15 female *G. ashmeadi* of each of the age categories 1, 4, 7, 10, 13 and 16 demonstrated that NIRS may show potential as a predictor of parasitoid "age" (R^2 = 0.99; F = 436.22, df = 1, p < 0.0001) (Fig. 4). An analysis containing a further 50 parasitoids for each age category is currently underway to strengthen this relationship.

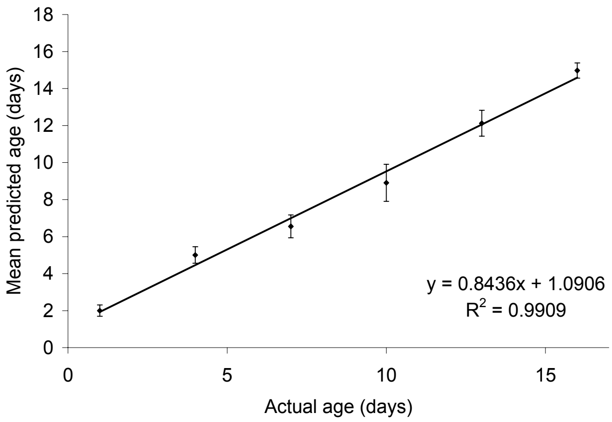

Figure 4: The relationship between mean age, as predicted by NIRS, and the actual age of female *G. ashmeadi* reared in the laboratory at 26^{o}C (error bars indicate ± SEM).

CONCLUSIONS

Female size was positively correlated with egg load for both spring and summer generations with egg load varying from 23-108 eggs per female in spring and 29-118 eggs per female in summer. The use of near infrared spectroscopy (NIRS) and a wing deterioration index to estimate parasitoid age was also investigated and preliminary results showed that both techniques may show potential for estimating the age of field collected *G. ashmeadi*. Together with oosportion and maturation data, 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 will be collecting dead parasitoids from the field, aging them, assessing size, and estimnating egg load at time of birth. 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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