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NATURAL ENEMIES OF THE AVOCADO LACE BUG, *Pseudacysta perseae* (HETEROPTERA: TINGIDAE) IN FLORIDA, USA

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Past studies in Florida have demonstrated that the avocado lace bug, (ALB), *Pseudacysta perseae* (Heteroptera:Tingidae) has several natural enemies. Two egg parasitoids, *Oligosita* spp.(Hymenoptera: Trichogrammatidae) and a unidentified mymarid (Hymenoptera: Mymaridae), the predators, green lace wing, *Chrysoperla rufilabris* (Neuroptera: Chrysopidae) and a predaceous mirid, possibly, *Hyaliodes vitripennis* (Heteroptera: Miridae). Both the green lace wing and the predaceous mirid, caused at least 30% reduction of nymphs and eggs. During 1996-1998 the egg parasitoid *Oligosita* spp., was the most frequent during the first major peak of *P. perseae*. However, recent surveys conducted between 2005 and 2007 suggest that the mymarid, *Erythmelus* spp., might be more important than *Oligosita* spp. Besides these parasitoids, the current predators, *Paracarniella cubana* (Heteroptera: Miridae), *Sthetoconus praefectus* (Heteroptera: Miridae) and a new genus and undescribed species of Cecidomyiidae appear to be the major predators of this pest. In other countries where *P. perseae* has been found, i.e., Cuba, Dominican Republic, there has not been any reports of parasitoids of this lace bug. We report the population dynamics of the pest and its natural enemies and discuss the potential of each of them in Florida, USA

Key Words: *Pseudacysta, Chrysoperla, Erythmelus, Stethoconus,* cecidomyiidae, parasitoids, predators

ENEMIGOS NATURALES DEL CHINCHE DE ENCAJE DEL AGUACATE, *Pseudacysta perseae* (HETEROPTERA: TINGIDAE) EN FLORIDA, USA

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En estudios realizados en el pasado, se identificaron varios enemigos naturales del chinche de encaje del aguacate, *Pseudacysta perseae* (Heteroptera: Tingidae): Dos parasitoides de huevos, *Oligosita* spp.(Hymenoptera: Trichogrammatidae) y un mimarido (Hymenoptera: Mymaridae), los depredadores, *Chrysoperla rufilabris* (Neuroptera: Chrysopidae) y un mirido, identificado posiblemente como *Hyaliodes vitripennis* (Heteroptera: Miridae). Tanto *C. rufilabris* y el depredador mirido redujeron en un 30% las densidades de ninfas y huevos de *P. persea.* Durante 1996-1998 el parasitoide *Oligosita* spp., fue el más frecuente durante los puntos poblacionales más

altos de *P. perseae*. Sin embargo, estudios recientes realizados entre 2005 y 2007 sugieren que el mimarido, *Erythmelus* spp., puede ser más importante que *Oligosita* spp. Además de estos parasitoides, los depredadores actuales, *Paracarniella cubana* (Heteroptera: Miridae), *Sthetoconus praefectus* (Heteroptera: Miridae) y un nuevo género y especies de Cecidomyiidae son los mayores depredadores de esta plaga en Florida. En otros países donde se ha encontrado *P. perseae*,i.e., Cuba, República Dominicana, Venezuela, no ha habido reportes de parasitoides. Se presentan aquí resultados de la dinámica poblacional del chinche de encaje, tablas de vida de éste y estudios preliminares sobre la frecuencia de los enemigos naturales en Florida, USA.

INTRODUCTION

The avocado lace bug (ALB), *Pseudacysta perseae* (Heteroptera: Tingidae) was described in 1908 as *Acysta perseae* from Florida specimens and considered a minor pest of avocados (Heidemann, 1908). For almost a century the distribution of this pest species was limited to the U.S.A and Mexico. (Brailovsky and Torre, 1986). However, persistent populations outbreaks of *P.* perseae became common in Florida during the 90s. During the same decade it was found in several islands of the Caribbean such as Bermuda (Henry and Hiburn, 1990), Puerto Rico (Medina-Gaud *et al*., 1991), República Dominicana (Abud Antun, 1991), Cuba (Almaguel et al., 1999). Later, it was found in Venezuela, northern south America, during 2000 (Sandoval, 2004) and during 2005 in French Guyana (Streito and Morival, 2005). *P. perseae* was discovered in California in San Diego County, USA in September 2004 (Hoddle et al., 2005). Besides, avocado, *Persea Americana,* the other common hosts of *P. perseae* are camphor, *Cinnamomum camphora* (L.), red bay, *Persea borbonia* (L.). The life cycle of *P. perseae* was reported by Abud-Antun (1991) and by Morales (2000) to require from 40 to 21 days from egg stage to adult depending on the temperature. The most complete description of adults and late instar nymphs was elaborated by Heidemann (1908).

Pseudacysta perseae confines its attack to the lower surface of the foliage causing chlorosis, necrosis and severe defoliation. Leaf photosynthesis is reduced by 50% when leaves sustain 40% to the foliar area (Peña et al., 1998). Almaguel *et al*. (1999) indicate that during 1996 this lacebug caused yield reductions close to 50%. Morales y Grillo (2004) consider *P. perseae* as the worst pest of Cuban avocados.

During a survey conducted between 1995 and 1997 in Florida, Peña et al., (1998) found 4 major biological control agents. Two egg parasitoids, *Oligosita* spp. (Hymenoptera: Trichogrammatidae) (identified by M. Schauff, USDA) and an unidentified mymarid (Hymenoptera: Mymaridae), the green lace wing, *Chrysoperla rufilabris*, and a predaceous mirid, identified as *Hyaliodes* spp. Peña et al (1998) hypothesized that the inadvertent and indiscriminate reductions of parasitoids and predators by applications of pyrethroids may have caused the outbreaks observed during the 90s in Florida.

The objective of the present study was to determine the current importance of predators and parasitoids and to revise role of the beneficial fauna affecting densities of *P. perseae.*

MATERIALS AND METHODS

Survey for natural enemies. Direct visual observations of ALB occurrence on 10 trees on 1 avocado orchard located in Miami-Dade County were made monthly and bimonthly at key times when the population was building up during 2006 and 2007. The samples were collected from 10 January, 2006 to June 27, 2006 and from 7 December 2006 to 26 June 2007. In each site, samples were randomly chosen. Twenty five leaves with different stages of ALB were individually placed in containers and transported to the laboratory for observation under the microscope. The number of adults, eggs, nymphs and, predators present per leaf were recorded. Predators were identified and reared. Eggs present in the sample were placed in individual 5 ml test tubes and their fate determined 8 days after.
An additional survey took place between December 2006 and February 2007 to determine the presence of predators in 3 avocado groves in Miami –Dade County. Approximately, 20 avocado leaves were collected following the same methodology as expressed above.

RESULTS AND DISCUSSION

Avocado Lace Bug. During the first six months of 2006 a minimum of 44.38 ± 5.03 eggs per leaf were collected on June 2006 and a maximum of 79.62 ± 7.64 eggs/leaf were collected in May 2006. During 2007, the highest egg densities (37.82 ± 2.62) were collected in March and the lowest densities (21.12 ± 2.23) were collected in June (Figure 1 top).

Egg Parasitoids and Predators. The number of parasitoids emerging from eggs was almost negligible. The most common parasitoid was *Erythmelus* spp (Hymenoptera: Mymaridae), and the least common a Trichogrammatidae, which was previously identified as *Oligosita* spp. (Hymenoptera:Trichogrammatidae). However, because few specimens of the latter (n = 2) were collected, there is not certainty that it falls into this genus or on another genus (J. Pinto, pers. Communication). During the first six months of 2006, *Erythmelus* was only collected during January, February and June (Fig 1, bottom) . During the first six months of 2007, *Erythmelus* was collected almost every month, with the exception of May, when we observed the lowest egg densities of *P. perseae* (Figure 1 bottom). *Erythmelus* emerges from ALB eggs in the same manner as do the ALB nymphs; therefore, it was necessary to rear parasitoids from eggs present on field collected leaves. This is opposite of what we observed during 1998 (Peña et al., 1998)
The genus *Erythmelus* has been collected from other Tingids. For instance *Erythmelus* sp., was collected from parasitized eggs of *Corythuca ciliate* (Say) (Horn et al., 1983). To our knowledge, this is the first report of egg parasitism for *Pseudacysta perseae.*

Predators .
The predators *Chrysoperla rufilabris* (Neuroptera: Chrysopidae) *,* an unidentified chrysopid (Neuroptera: Chrysopidae), *Paracarniella cubana* (Hemiptera: Miridae), *Stethoconus praefectus* (Hemiptera: Miridae) and a new species of a cecidomyiidae

(Diptera: Cecidomyiidae) (R. Gagné, pers. Comm.) were observed preying on *P. perseae.*

The effectiveness of *Chrysoperla rufilabris* as a predator of *P. persae* nymphs has shown that *C. rufilabirs* can consume up to 73% of the nymphal stages during a 20-day exposure period (Peña et al., 1998). The effectiveness of the unidentified crhysopid has not been determined yet.

Chrysoperla rufilabris has also been identified as a predator of other tingids, such as the azalea lace bug, *Stephanitis pyriodes* (Scott) (Stewart et al. 2002).

During the 90s, *P. cubana* was erroneously identified as *Hyaliodes* spp (Peña et al., 1998). *Paracarniella cubana* has been described by Henry and Fiuza Ferreira (2003). Alayo (1974) , cited by Henry and Fiuza Ferreira (2003) found it on *Pothomorphe peltata* (Piperaceae) infested with aphids and on citrus infested with black flies (Aleyrodidae). *P. cubana* feeds on eggs and nymphs of ALB, causing 30% reduction of *P. perseae* immature forms during a 4 –day observation period (Peña et al., 1998). *P. cubana* then, might be a generalist preying on different species and insect orders.

Stethoconus praefectus (Heteroptera: Miridae) is native to Africa and South East Asia. *S. praefectus* has been found in India preying on *Telenemia scrupulosa* and on *Stephanitis typicus* (Heteroptera: Tingidae) (Visalakshy and Jayanth, 1994; Mathen and Kurian, 1972).

On March 21, 2006, *S. praefectus* was discovered in Miami-Dade County, Florida by DL. Immature stages were reared in the laboratory at 26 ℃ and 78% RH., on nymphs and eggs of *P. perseae.* Eggs of *S. praefectus* are inserted individually on the mid and lateral veins on the adaxial surface of the leaf. Egg size is approximately 0.3 mm, they are elongated and almost transparent with a color change when they are close to eclosion. Eggs eclose 7 to 15 days after oviposition. Five instars were observed. The nymphal stage lasts 12-15 days. All nymphal instars preyed on nymphs and adults of the avocado lace bug. The last nymphal instar preyed on approximately 15-20 nymphs and adults of the avocado lace bug per day. Adults of *S. praefectus* feed on nymphs and adults of the lace bug. *S. praefectus* has only been reported preying on members of the family Tingidae. This might indicate that it could be considered a more specific predator than *P. cubana.* A range of 0.8 ± 0.31 to 0.26 ± 0.12 *S. praefectus* /leaf was found in 3 avocado groves in Miami –Dade county during December 2006 and February 2007. This might demonstrate that *S. praefectus* is well established in avocado groves in southern Florida (Table 1).

The new species of a gall midge (Diptera: Cecidomyiidae) was collected by FA. Single eggs were observed among colonies of *P. perseae* on avocado. Newly hatched amber-colored larvae crawled to the lace bugs and inserted their mouthparts usually under the more anterior abdominal segments. After their initial feeding, larvae turned reddish-orange. Larvae were commonly observed feeding in a position perpendicular to the prey. A larva was once found with its mouthparts inserted into the distal antennal segment of an

immobilized third instar nymph. Larvae appeared more often to feed on lace bug nymphs, but larger larvae were also observed feeding on lace bug adults. When full grown, larvae spun orange-colored cocoons close to the leaf midvein. Adults emerged 6-8 days later and lived 2-4 days under laboratory conditions.

CONCLUSIONS

Because of their low densities, parasitoids collected in the USA parasitizing eggs of *P. perseae*, might not be key mortality factors of this pest. However, the presence of different predators, such as *C. rufilabris* (Neuroptera: Chrysopidae), an unidentified chrysopid (Neuroptera: Chrysopidae),
two mirids, *Paracarniella cubana* and *Stethoconus praefectus* and the presence of a new species of a cecidomyiid, indicate that predators might be the key elements on maintaining populations of *P. perseae* under low levels in Florida. Further studies are underway to determine specificity of the newly discovered predators and their efficacy.

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Table 1. Densities of *S. praefectus* in different sites in Miami-Dade Co, Florida, December 2006 and February 2007.

Site	ALB Eggs /leaf X ± SE	ALB Nymphs/leaf X ± SE	ALB Adults/leaf X ± SE	*S. praefectus* /leaf X ± SE	Unidentified Cecidomyiid X ± SE	Other Predators X ± SE
Miami USDA	4.6 ± 2.90	7.4 ± 2.11	1.46 ± 0.71	0.26 ± 0.12	0.33 ± 0.16	0.0 ± 0.0
Princeton	3.32 ± 1.24	8.4 ± 1.62	0.56 ± 0.164	0.28 ± 0.09	0.08 ± 0.05	0.04 ± 0.04
Homestead Brooks	8.64 ± 2.12	2.28 ± 0.57	0.2 ± 0.08	0.8 ± 0.31	0.12 ± 0.09	0.04 ± 0.04

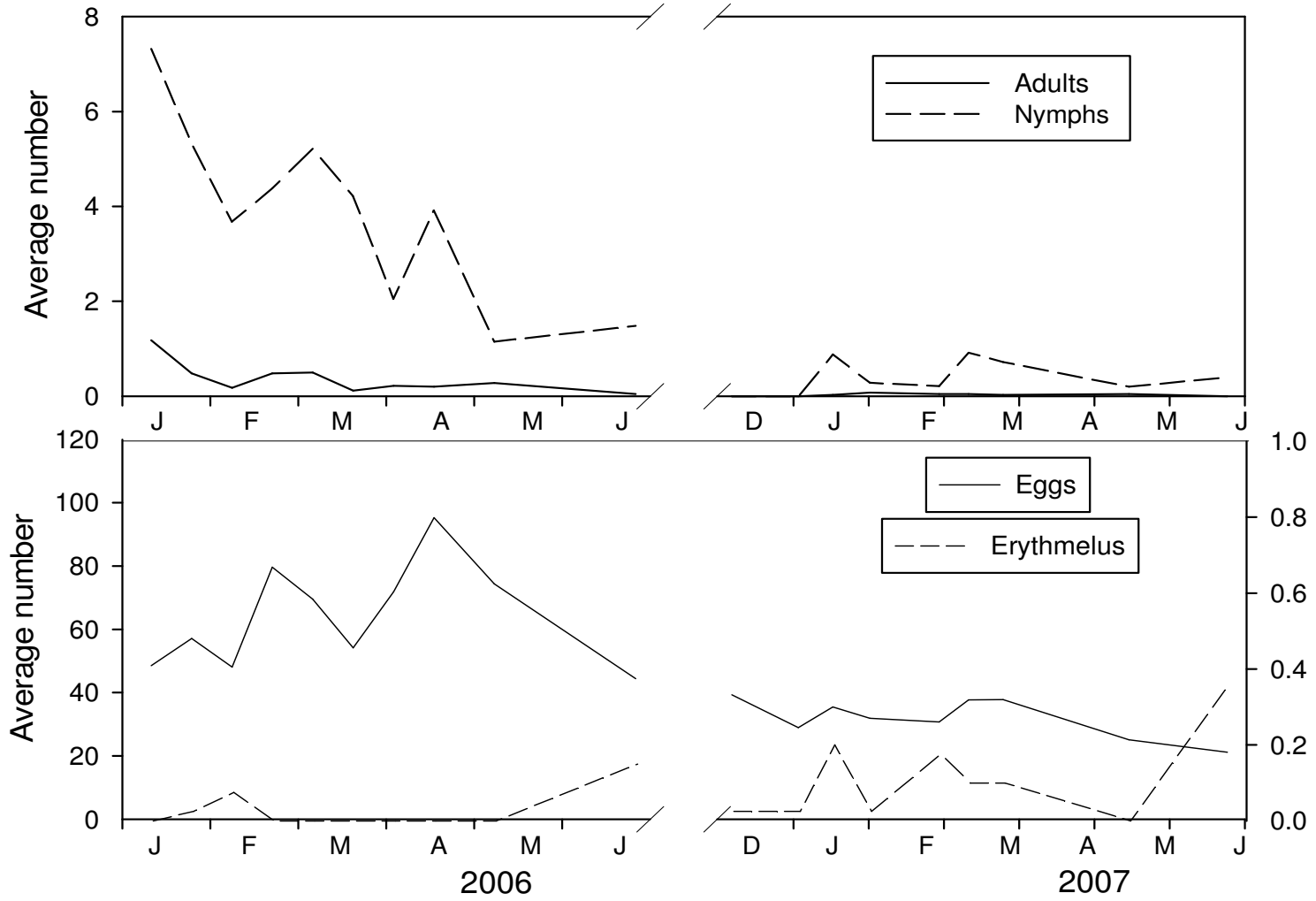

Figure 1. (Top): Seasonality of *P. perseae* adults and nymphs during the years 2006 and 2007 in Homestead, Florida. (Bottom). Seasonality of *P. perseae* eggs and egg parasitoids during 2006 and 2007 in Homestead, Florida.