Mortality Factors of the Avocado Lace Bug, *Pseudacysta perseae* (Heteroptera: Tingidae), in Florida

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**ABSTRACT**

The avocado lace bug (ALB), *Pseudacysta perseae* (Heidemann) (Heteroptera: Tingidae), is a pest of avocado, *Persea americana*, in Florida, the Caribbean Basin, California and northern South America. Different biotic mortality factors, i.e., the egg parasitoids *Erythmelus (Erythmelus) klopomor*, a new species of Trichogrammatidae, and the predators, *Chrysoperla rufilabris*, *Paracarniella cubana*, *Stethoconus vitripennis*, and *Tingidoletes praelonga*, have been reported as natural enemies of *P. perseae* in Florida. We determined the effect of these biotic factors during 3 seasons, by exposing *P. perseae* cohorts to known biotic factors, and compared their survival to cohorts protected from these factors. The total percent mortality caused by biotic factors was 16 to 90% above the mortality caused by abiotic factors during 3 seasons.

**Key Words:** *Erythmelus, Chrysoperla, Paracarniella, Stethoconus, Tingidoletes, Pseudacysta, avocado*

**RESUMEN**

El chinche de encaje del aguacate, *Pseudacysta perseae* (Heidemann) (Heteroptera: Tingidae), es una plaga de aguacate, *Persea americana*, en Florida, en las islas del Caribe, California y en la parte norte de Suramérica. Varios factores bióticos de mortalidad, tales como los parasitoides de huevos, *Erythmelus (Erythmelus) klopomor* y una nueva especie de Trichogrammatidae y los depredadores *Chrysoperla rufilabris*, *Paracarniella cubana*, *Stethoconus vitripennis*, y *Tingidoletes praelonga* han sido reportados como factores de mortalidad de *P. perseae* en la Florida. Se determinó el efecto de los factores de mortalidad durante 3 estaciones al exponer grupos de individuos de *P. perseae* a estos y se comparó esta mortalidad con la causada cuando grupos de *P. perseae* no estaban expuestos a los enemigos naturales. El porcentaje de mortalidad causado por los factores bióticos tuvo un rango del 16 al 93% de mortalidad al compararlo con el efecto de los factores abióticos durante las tres estaciones.

The avocado lace bug (ALB), *Pseudacysta perseae* (Heidemann) (Heteroptera: Tingidae), is a stenophagous insect originally found in Mexico and southeastern North America affecting plants of the genus *Persea* (Laurales: Lauraceae), i.e., *Persea americana*, *P. borbonia* and *P. pallustris*. During the last 15 years it has spread to most of the islands in the Caribbean region, northern South America, i.e., Venezuela and French Guyana and to southern California. (Mead & Peña 1991; Peña et al. 1998; De la Torre et al. 1999; Morales 2000). In 2006, an additional survey for natural enemies was initiated and 2 additional predators were discovered, and as well as 2 parasitoid species. Predators include a new lestodiplosine midge (Diptera: Cecidomyiidae), *Tingidoletes praelonga* Gagné (Gagné et al. 2008), and an adventive Asian plant bug, *Stethoconus praefectus* (Distant) (Heteroptera: Miridae) (Henry et al. 2009; Holguin et al. 2009). The egg parasitoids were the mymarid, *Erythmelus (Erythmelus) klopomor* S. Triapitsyn (Triapitsyn et al. 2007) and a new

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undescribed species of Trichogrammatidae (J. D. Pinto, pers. comm.)

The reduction or lack of biotic mortality agents of the lace bug in Florida has been suspected as one of the reasons why the lace bug became a serious problem in this state only during mid-90s. One of the possible reasons for the outbreaks (Peña et al. 1998) was heavy application of pesticides during the 1980s and 1990s, in that case, pyrethroids, that may have decimated the natural enemies responsible for regulating P. perseae populations. With the exception of Cuba (De la Torre et al. 1999), no report of natural enemies has been published from an area recently invaded by P. perseae. Our goal in this study was to determine if biotic factors may have an effect on the population densities of P. perseae in Florida.

MATERIALS AND METHODS

Three experiments were conducted at the Univ. of Florida, Tropical Research and Education Center, Homestead, Florida in an unsprayed avocado grove. Two experiments were conducted during the fall (Oct-Nov) of 2006 and 2007) and 1 during the spring of 2008 (Feb-Mar). Twenty seven avocado cv. ‘Lula’ branches each with young, but hardened leaves (n = 8-12) were selected. Each branch was enclosed with a 50 × 30 cm white cotton bag and 10 P. perseae (2 males: 8 females, collected the same day from foliage of avocados held under greenhouse conditions) were placed on the foliage. Each bag was then sealed and numbered. One day after bagging, each leaf within each branch was examined for egg deposition, a circle around the area where the eggs were deposited was drawn with an ultra fine pointed Sharpie® Permanent Marker, and the number of eggs within each cohort was counted. Pseudacysta perseae adults were removed. The leaves with approximately one half of the eggs were covered with cotton bags as explained above (exclusion treatment) and the leaves of the other half were left exposed, i.e., not bagged. Therefore, in the bagged treatment the P. perseae population was exposed to abiotic factors only, while in the exposed treatment the P. perseae population was exposed to both biotic and abiotic factors. The fate of each P. perseae stage was observed every two d for approx. 2 mo or until the cohorts reached adulthood. All eggs on each leaf were used as a single replication. Parasitized eggs were determined by counting the number of hatched nymphs. The tiny emerged mymarid or trichogrammatid egg parasitoids were not counted, because they cannot be observed without the aid of a microscope. Once hatched, P. perseae nymphs tend to aggregate and remain on the leaf where they had hatched; migration to different leaf areas seldom occurs. If adults from foreign cohorts appeared on the experimental area, these were immediately removed. At the end of the 2007 fall trial, leaves were collected and leaf tissue injured by the cohorts was cut out and placed on a drawing paper and the area measured. A paired t-test (SAS 2008) was used to determine differences between the leaf area damaged by cohorts exposed to biotic plus abiotic factors and the area damaged by cohorts on leaves where biotic factors were excluded.

Life Tables

An instantaneous life table (Waters 1969) was used to determine the number of dying individuals of P. perseae from the 3 experiments at a given time (fall 2006, fall 2007, and spring 2008) and to differentiate the amount of mortality caused by biotic plus abiotic factors (non-exclusion treatment) from abiotic factors (exclusion treatment) (Waters 1969; Bellows et al. 1992). Then, the difference in the amount of mortality between the biotic and abiotic factors determined.

RESULTS AND DISCUSSION

Densities of eggs either exposed or protected from predators were similar during each test conducted across different seasons. During fall 2006 and fall 2007, lower densities of third, fourth and fifth P. perseae instars as well as adults were recorded (t-test, P = 0.05) when these cohorts were exposed to biotic mortality factors than when not so exposed (Fig. 1). During spring 2008, lower

Fig. 1. Trend of Pseudacysta perseae cohorts when exposed to natural enemies, and when natural enemies were excluded at Homestead, Florida, USA.
densities of fourth-fifth instars and adults were observed on those cohorts that were exposed to both biotic and abiotic factors compared to those in the exclusion treatment ($t$-test, $P = 0.001$) (Fig. 1).

Life tables for cohorts exposed to biotic and abiotic factors showed that the number of eggs not hatching represented the life stage with the highest values of dying individuals for both treatments (especially during fall 2006 and fall 2007) (Table 1). Egg mortality caused by natural enemies was nil during fall 2006, but increased to 38% and 33% during fall 2007 and spring 2008, respectively (Table 1). This indicates that egg parasitoids are likely to be a key egg mortality factor during certain yr, but unreliable in other yr. There were some differences among yr or seasons regarding exclusion vs. non-exclusion treatment results. For instance, mortality in the non-exclusion treatment was considerably greater in 2 of 3 tests (i.e., 2007 and 2008). Within the exclusion treatment in 2006, mortality was considerably greater than in the same treatment during the 2007 and 2008 studies, suggesting that predators had not been effectively eliminated by the exclusion bags during the 2006 test. With the exception of the egg stage, most of the stages were unaffected when cohorts were protected from biotic factors. A significantly ($t$-test, $F = 26.40; P = 0.0001$) lower estimate of leaf area damage was obtained (0.83 ± 0.68 cm²) when the $P. perseae$ cohorts were not protected from naturally occurring mortality factors compared to the damaged leaf area (5.28 ± 2.50 cm²) when predators and parasitoids were excluded from the $P. perseae$ cohorts. These results may demonstrate the value of the natural enemies (especially predators) in preventing damage caused by this pest. During spring 2008, the effect of biotic factors observed for the eggs and all instars fluctuated from 7.07% to 25% (Table 1), while the percent of the cohorts dying from abiotic factors fluctuated from 1.3% to 11.61% (Table 1).

With only one exception (i.e., third instar nymphs, fall 2006) the percent mortality caused by biotic factors was 16%, 71% and 90% during fall 2006, fall 2007 and spring 2008, respectively (Table 1). Until now, parasitoids collected in Florida (Peña et al. 2009) parasitizing eggs of $P. perseae$, have not been considered to be key mortality factors of this pest. However, after studying their effects during different seasons, we suggest

### Table 1. Life tables of Pseudacysta perseae during 3 different seasons when cohorts were either exposed to or protected from biotic factors.

| Stage          | Natural Enemies Not-excluded | Natural Enemies Excluded |
|----------------|------------------------------|--------------------------|
|                | $L_x_1$  | $d_x_1$  | $100q_x_1$  | $^{1}d_x_1$  | $L_x_2$  | $d_x_2$  | $100q_x_2$  | $^{2}d_x_2$  | $^{3}(d_x_1 - d_x_2)$ |
| FALL 2006      |          |          |            |            |          |          |            |            |                         |
| Egg            | 80.0     | 45.0     | 56.3       | 56.3       | 95.0      | 54.0     | 56.8       | 56.8       | -0.5                  |
| Nymph 1        | 35.0     | 5.0      | 14.3       | 6.3        | 41.0      | 4.0      | 9.8        | 4.2        | 2.1                   |
| Nymph 2        | 30.0     | 26.0     | 86.7       | 32.5       | 37.0      | 17.0     | 45.9       | 18.0       | 14.5                  |
| Nymph 3-4      | 4.0      | 0.0      | 0.0        | 0.0        | 20.0      | 9.0      | 45.0       | 9.5        | -9.5                  |
| Nymph 4-5      | 4.0      | 0.0      | 0.0        | 0.0        | 11.0      | 0.0      | 0.0        | 0.0        | 0.0                   |
| Adult          | 4.0      | 0.0      | 0.0        | 0.0        | 11.0      | 0.0      | 0.0        | 0.0        | 0.0                   |
| Total          | 76.0      | 95.0     |            |            | 84.0      | 88.5     | 6.6        |            |                       |
| FALL 2007      |          |          |            |            |          |          |            |            |                         |
| Egg            | 155.0    | 89.0     | 57.4       | 57.4       | 135.0     | 26.0     | 19.3       | 19.3       | 38.2                  |
| Early 1st instar | 66.0   | 7.0      | 10.0       | 4.5        | 108.0     | 2.0      | 1.8        | 1.5        | 3.0                   |
| Late 1st instar | 59.0   | 17.0     | 28.0       | 11.0       | 106.0     | 1.0      | 0.9        | 0.7        | 10.3                  |
| 2nd instar     | 42.0     | 23.0     | 54.0       | 14.8       | 105.0     | 1.0      | 1.0        | 0.7        | 14.1                  |
| 3rd instar     | 19.0     | 0.0      | 0.0        | 0.0        | 104.0     | 1.0      | 1.0        | 0.7        | -0.7                  |
| 4th instar     | 19.0     | 10.0     | 52.0       | 6.5        | 103.0     | 1.0      | 1.0        | 0.7        | 5.8                   |
| Adult          | 9.0      | 0.0      | 0.0        | 0.0        | 102.0     | 0.0      | 0.0        | 0.0        | 0.0                   |
| Total          | 146.0    | 94.2     |            |            | 32.0      | 23.6     | 70.6       |            |                       |
| SPRING 2008    |          |          |            |            |          |          |            |            |                         |
| Egg            | 166.0    | 41.0     | 25.3       | 25.3       | 155.0     | 18.0     | 11.6       | 11.6       | 13.7                  |
| Nymph 1        | 125.0    | 35.0     | 28.0       | 21.1       | 137.0     | 6.0      | 4.4        | 3.9        | 17.2                  |
| Nymph 2        | 90.0     | 34.0     | 37.7       | 20.4       | 131.0     | 6.0      | 4.6        | 3.9        | 16.5                  |
| Nymph 3        | 56.0     | 29.0     | 51.4       | 11.3       | 125.0     | 5.0      | 4.0        | 3.2        | 8.1                   |
| Nymph 4        | 27.0     | 12.0     | 44.4       | 7.1        | 120.0     | 4.0      | 3.3        | 2.6        | 4.5                   |
| Nymph 5        | 15.0     | 12.0     | 80.0       | 7.1        | 116.0     | 2.0      | 1.7        | 1.3        | 5.8                   |
| Adult          | 3.0      | 0.0      | 0.0        | 0.0        | 114.0     | 0.0      | 0.0        | 0.0        | 0.0                   |
| Total          | 163.0    | 92.2     |            |            | 41.0      | 26.5     | 65.7       |            |                       |

$^{1}d_x_1$ as percent of the initial number.  
$^{2}d_x_2$ as percent of the initial number.  
$^{3}$Differences of mortality caused by biotic (cohorts exposed) and abiotic factors (cohorts bagged), i.e., mortality caused by natural enemies.
that they may be key mortality factors during certain seasons or yr. The presence of different predators, such as C. rufilabris (Neuroptera: Chrysopidae), an unidentified chrysopid (Neuroptera: Chrysopidae), 2 mirids, P. cubana and S. praefectus and the presence of a new species of a cecidomyiid, T. praelonga, suggest that predators are the key constant element in maintaining populations of P. perseae at low levels in Florida. However, more tests should be conducted during different seasons and yr to determine the ‘key age’ interval of P. perseae that is most susceptible to biotic mortality factors.

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REFERENCES CITED

Abud-Antun, A. 1991. Presence of avocado lacebug Pseudacysta perseae (Heidemann) (Hemiptera: Tingidae) in Dominican Republic. Primera Jornada de Proteccion Vegetal, Universidad de Santo Domingo, Dominican Republic. Abstract, p. 4.

Belows Jr., T. S., Van Driesche, R. G. and Elkinton, J. S. 1991. Life table analysis in the evaluation of natural enemies. Annu. Rev. Entomol. 37: 587-612.

De La Torre, P., Almanquez, L., and Blanco, E. 1999. Daños, distribución y enemigos naturales de la chinche de encaje del aguacate Pseudacysta perseae (Heidemann) (Hemiptera: Tingidae). Fitosanidad 3: 65-67.

Etienne, J., and Streito, J. C. 2008. Premier signalé en Guadeloupe et en Martinique de Pseudacysta perseae (Heidemann) (Hemiptera: Tingidae). Bull. Soc. Entomol. France 113: 121-122.

Gagné, R., Peña, J. E., and Acevedo, F. 2008. A new lepidodiplosine (Diptera: Cecidomyiidae) preying on the avocado lacebug, Pseudacysta perseae (Heteroptera: Tingidae) in Southern Florida. Florida Entomol. 91: 43-48.

Henry, T., Peña, J. E., Acevedo, F., and Long, D. 2009. Stethoconus praefectus (Hemiptera: Miridae): First North American records of an Old World predatory plant bug preying on avocado lace bug, Pseudacysta perseae (Hemiptera: Tingidae), in Florida. Proc. Entomol. Soc. Washington 111: 98-105.

Hoddle, M., Morse, J., Stouthern, R., Triaptsyn, S., Humeres, E., Bender, G., Kellum, D., Dowell, R., Roltsch, W., Phillips, P., and Whitney, G. 2005. Biology and management of avocado lacebug in California. Semiannual Report California Avocado Growers. Downloaded as: www.avocado.org/growers/pdf/2005_midyear/HoddleLaceBugProgress05.pdf

Holglin, C., Peña, J. E., Henry, T., and Acevedo, F. 2009. Life cycle and effectiveness of Stethoconus praefectus (Heteroptera: Miridae), a predator of the avocado lace bug, Pseudacysta perseae (Heteroptera: Tingidae). 92: 54-57.

Mead, F., and J. E. Peña. 1991. Avocado lace bug, Pseudacysta perseae (Hemiptera: Tingidae). Florida Dept. Agr. & Consumer Serv., Div. Plant Industry Entomol. Circ. 346.

Medina-Gaud, S., A. Segarra, and R. Franqui. 1991. The avocado lacewing bug, Pseudacysta perseae (Heidemann) (Hemiptera: Tingidae). J. Agric. Univ. Puerto Rico 75: 185-188.

Moraes, L. 2000. Estudios bioecológicos de Pseudacysta perseae (Heid.) (Heteroptera: Tingidae). Tesis Facultad de Ciencias Agropecuarias. Universidad Central Marta Abreu de las Villas Santa Clara. Villa Clara, Cuba.

Peña, J. E., Sundharia, S., Hunsberger, A., Duncan, R., and Schaffer, B. 1998. Monitoring, damage, natural enemies and control of the avocado lace bug, Pseudacysta perseae (Hemiptera: Tingidae). Proc. Florida State Hort. Soc. 111: 330-334.

Peña, J. E., Triaptsyn, S. V., Long, D., Evans, G. A., and Roltsch, W. 2009. First record of Erythmelus klopo mor (Hymenoptera: Mymaridae) as a parasitoid of the avocado lace bug, Pseudacysta perseae (Heteroptera: Tingidae) Florida Entomol. 92: 394-395.

Sandoval, M. F. 2004. Presencia de Pseudacysta perseae (Heid.) (Insecta: Hemiptera: Tingidae) en Venezuela En Resumen V Seminario Científico Internacional de Sanidad Vegetal. 24-28 Mayo, La Habana, Cuba.

SAS Institute. 2008. SAS System for Windows, release 9.1. SAS Institute, Cary, North Carolina.

Streito, J. C., and Morival, T. 2005. Premiere capture en Guyane Française de Pseudacysta perseae (Heidemann, 1908), un ravageur de l’avocatier (Heteroptera:Tingidae). Nouv. Reuev Entomol. 22: 191-192.

Triaptsyn, S. V., Berezovskyi, V. Y., Hoddle, M. S., and Morse, J. G. 2007. A review of the Nearctic species of Erythmelus (Hymenoptera: Mymaridae), with a key and new additions to the New World fauna. Zoozax. 1641: 1-64.

Waters, W. R. 1969. The life table approach to analysis of insect impact. J. Forestry 67: 300-304.

Wysoki, M., Van De Berg, M. A., Ish-Am, G., Gazit, G., Peña, J. E., and Waite, G. K. 2002. Pests and pollinators of avocado, pp. 223-293 In J. E. Peña, J. L. Sharp, J. L., and M. Wysoki [eds.], Tropical Fruit Pests and Pollinators: Biology, Economic Importance, Natural Enemies and Control. CABI Publ., Wallingford, UK. 430 pp.