BIOLOGY OF *STETHOCONUS PRAEFECTUS* (DISTANT) (HETEROPTERA: MIRIDAE), A NEWLY ESTABLISHED PREDATOR OF THE AVOCADO LACE BUG, *PSEUDACYSTA PERSEAE* (HETEROPTERA: TINGIDAE), IN FLORIDA

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ABSTRACT

The Asian plant bug *Stethoconus praefectus* (Distant) (Heteroptera: Miridae) was recently discovered in Florida preying on the avocado lace bug, *Pseudacysta perseae* (Heidemann) (Heteroptera: Tingidae). Its life cycle and effectiveness as a predator of *P. perseae* were investigated at 26 ± 1°C, 60 ± 5 RH, and 12: 12 (L: D) under laboratory conditions. *Stethoconus praefectus* developed from egg to adult in 16.5 ± 0.2 d. On average, the first 4 instars consumed 2 to 4 prey per day, whereas the last 2 instars consumed 2 to 7 lace bugs per day. *Stethoconus praefectus* was observed in the field from Aug through Dec 2007.

RESUMEN

Se descubrió recientemente en Florida a *Stethoconus praefectus* (Distant) (Heteroptera: Miridae) depredando el chinche de encaje del aguacate, *Pseudacysta perseae* (Heidemann) (Heteroptera: Tingidae). Se investigaron bajo condiciones de laboratorio tanto el ciclo biológica como su efectividad como depredator de *P. perseae*. El desarrollo de *S. praefectus* desde huevo hasta adulto duro 16.5 ± 0.2 dias a 26 ± 1°C, 60 ± 5 HR, y 12: 12 de horas luz. Los primeros cuatro instares consumieron 2 a 4 presas por dia mientras que los últimos dos instares consumieron un promedio de dos a 7 chinches de encaje por día. *Stethoconus praefectus* se encontró en el cmapo desde el mes de Agosto, hasta diciembre, 2007.

Translation by the authors.

The avocado lace bug, *Pseudacysta perseae* (Heteroptera: Tingidae), is a secondary pest of avocado and other Lauraceae in Florida, and other states within the continental United States (Peña et al.1998; Wysoki et al. 2002; Hoddle et al. 2005), and in the Caribbean and northern South America (Streito & Morival 2005; Etienne & Streito 2008). Due to a resurgence of *P. perseae* densities in the 1990s, a survey for natural enemies was conducted in 1997 (Peña et al. 1998). During this survey, *Chrysoperla rufilabris* (Burmeister) (Neuroptera: Chrysopidae) and *Paracarniella cubana* (Bruner) (erroneously identified then as *Hyaliodes vitripennis* (Say)) (Heteroptera: Miridae) were observed as the most common predators of *P. perseae* in south Florida (Peña et al. 1998). In 2006, two additional predators were discovered, a new lestodiplosine midge (Diptera: Cecidomyiidae), *Tingidoletes praelonga* (Gagné et al. 2008), and an adventive Asian plant bug, *Stethoconus praefectus* (Distant) (Heteroptera: Miridae) (Henry et al. in press), the latter of which is treated in this paper.

Species of *Stethoconus* are considered obligate lace bug predators (Mathen & Kurian 1972; Henry et al. 1986; Neal et al. 1991; Wheeler 2001). For example, *S. japonicus* Schumacher preys on the lace bug *Stephanitis pyriodes* (Scott) (Neal et al. 1991), *S. pyri* (Mella) (as *S. cryptopeltis* Flor) preys on *Tingis pyri* Fabricius (Gautier 1927), and *S. praefectus* has been recorded preying on the coconut lace bug, *Stephanitis typicus*, in India (Mathen & Kurian 1972). The life history of *S. praefectus* feeding on *S. typicus* was studied by Mathen & Kurian (1972). The potential importance of *S. praefectus* in Florida prompted us to investigate its life cycle and efficacy as a predator of *P. perseae*.

MATERIALS AND METHODS

A laboratory colony of *S. praefectus* was established with adults collected from avocado plants in a greenhouse located at the University of Florida, Tropical Research and Education Center (TREC), Homestead, FL (25E30' N,

80E30', 1 m altitude). The conditions of the rearing and laboratory experiments were 26 ± 1°C, 60 ± 5 RH, and 12:12 (L:D). Adults and nymphs of *P. perseae* and nymphs of *S. praefectus* were transferred into clear Plexiglass® cages (30 × 30 × 30 cm) with avocado leaves held in a vial of water as a food source and as an oviposition substrate. Every other day, sections of leaves containing newly deposited *S. prafectus* eggs were removed and placed in large petri dishes (5 × 1.5 cm) lined with a disk of paper filter and an avocado leaf. Newly emerged nymphs of *S. praefectus* were transferred to individual petri dishes, containing sections of an avocado leaf. Approximately 10 each of *P. perseae* nymphs and adults were introduced on the petri dish as food. Every 2 d, leaves and dead lace bugs were removed and replaced until *S. praefectus* adults emerged.

Development Time of *S. praefectus* and Efficacy of Nymphs as Predators

Stethoconus praefectus adults (females and males) that were 1 d old were confined in clear Plexiglass cages and provided with avocado lace bugs as described above. After 24 h, *S. praefectus* adults were removed and 32 eggs were chosen randomly and labeled. Avocado leaf sections containing *S. praefectus* eggs were placed in petri dishes (3 × 1 cm) layered with a filter paper and observed until eclosion. Once eggs hatched, newly emerged nymphs were placed in small, individual petri dishes (3 × 1 cm), with a layer of agar (1.2 g of agar in 100 mL of water) covering the bottom, topped with a circular section of an avocado leaf, and sealed with punctured Clingwrap®. A total of 10 adults and nymphs of the avocado lace bug were provided daily as food. The petri dish was turned upside down to simulate the natural *P. perseae* feeding conditions on the abaxial leaf side. Dead *P. perseae* were counted and removed daily and the development of *S. praefectus* was recorded. Fresh sections of avocado leaves were renewed every 2-3 d following the same procedure as described above. Developmental time from egg to adult, sex ratio, and avocado lace bugs eaten per instar were recorded. The experiment was replicated 32 times. Data were analyzed by one-way ANOVA for unequal replication by the Student-Newman-Keuls Test (SAS Institute 1999). Data are expressed as mean ± standard error.

Predator Efficacy of *S. praefectus* Adults

Newly emerged *S. praefectus* adults were isolated for 24 h on avocado leaves with lace bugs in a clear Plexiglass cage. After sex determination, males and females were placed in petri dishes with a disk of filter paper covering the bottom and topped with a section of an avocado leaf as described above. Mixed instars of avocado lace bugs (n = 15) were provided as food. Every other day, dead lace bugs were counted and removed until all *S. praefectus* adults died. The results were analyzed by a t-test for 2 groups with Proc. TTEST (SAS Institute 1999). Data are expressed as mean ± standard error.

Densities of *S. praefectus* in Florida

Twenty avocado leaves with symptoms of *P. perseae* feeding were collected monthly (May-Dec 2007) from the avocado orchard of the USDA, ARS, Subtropical Horticulture Research Station, Miami, Florida (25E38'40.69"N, 80E17'50.47"). Leaves were placed in a cooler and brought to the laboratory and inspected for the presence of *P. persea,* as well as eggs, nymphs, or adults of any predators. Egg predators were placed in 5-mL sealed vials as described above. Nymphs were identified to species.

Results and Discussion

Developmental Time

Eggs of *S. praefectus* are inserted individually on the mid and lateral veins on the adaxial surface of avocado leaves (Henry et al. 2009). Eggs hatched within 7.2 ± 0.1 d. There were from 5 to 6 instars for both sexes. The development time for *S. praefectus* from egg to adult for the 5-instar group was 14.3 to15.8 d for females and males, respectively, and 17.6 to 19.4 d for the 6-instar group (Table 1).

The duration of the life cycle when *S. praefectus* fed on *P. perseae* was similar to that of this lace bug when it fed on *Stephanitis typicus* (Mathen & Kurian 1972). The only major difference between the two studies is that we observed 5 to 6 instars, whereas Mathen & Kurian (1972) observed only 5. Variation in number of instars in Heteroptera has been found for other predacious mirids (Liquido & Nishida 1985), as well as for phytophagous species (Slansky & Rodriguez 1987).

Predator Efficacy of *S. praefectus* Nymphs

Predation by *S. praefectus* nymphs increased from the first to the last instar. Last instars (either fifth or sixth) killed significantly more *P. perseae* nymphs and adults than any preceding instar (F = 12.70; df 5, 291, P = 0.05). On average, the first 4 instars consumed 2 to 4 prey per d, whereas the last 2 instars consumed 2 to 7 lace bugs per d (Table 2). These results differ from those of Mathen & Kurian (1972), who found that fewer prey were consumed by the fifth instar.

TABLE 1. DEVELOPMENT TIME (MEAN ± SE) FOR *S. PRAEFECTUS* (DAYS).

Instar	F (*n*)	M (*n*)	Combined (*n*)
Egg	7.2 ± 0.14 (16)	7.3 ± 0.18 (16)	7.2 ± 0.11 (32)
N1	1.9 ± 0.06 (16)	2.1 ± 0.06 (16)	2.0 ± 0.05 (32)
N2	1.2 ± 0.11 (16)	1.2 ± 0.10 (16)	1.2 ± 0.07 (32)
N3	1.4 ± 0.13 (16)	1.4 ± 0.13 (16)	1.4 ± 0.09 (32)
N4	1.4 ± 0.13 (16)	1.3 ± 0.12 (16)	1.4 ± 0.09 (32)
N5	2.6 ± 0.22 (16)	2.5 ± 0.18 (16)	2.5 ± 0.14 (32)
N6	3.7 ± 0.75 (4)	1.8 ± 0.40 (6)	2.6 ± 0.05 (10)
Total	16.7 ± 0.25	16.5 ± 0.26	16.5 ± 0.18

TABLE 2. DAILY CONSUMPTION BY EACH INSTAR OF *S. PRAEFECTUS* AND NATURAL MORTALITY (MEAN ± SE).

		Day						
Instar	*n*	1	2	3	4	5	6	Total mean
N1	32	1.9 ± 0.15	1.3 ± 0.142	3.0*				3.0 ± 0.23
N2	32	1.1 ± 0.17	1.8 ± 0.260					1.7 ± 0.18
N3	32	1.8 ± 0.22	4.0 ± 0.340					3.4 ± 0.38
N4	32	2.1 ± 0.25	4.1 ± 0.693	3.0*				3.8 ± 0.51
N5	32	4.9 ± 0.53	2.1 ± 0.334	3.4 ± 0.42	2.0 ± 2.0	6.0*		7.8 ± 0.83
N6	10	4.8 ± 0.83	1.8 ± 0.595	3.2 ± 0.66	7.0 ± 0.0	0	0	7.5 ± 1.82
Control	30							0.6 ± 0.09

*No Standard error.

Longevity and Predator Efficacy of *S. praefectus* Adults

Adult females of *S. praefectus* lived longer and consumed more prey than adult males (Table 3). According to Neal et al. (1991) and Mathen & Kurian (1972), the total number of prey killed by adults of the genus *Stethoconus* is higher because adulthood lasts longer than immature stages.

Densities of *S. praefectus* Under Field Conditions

The number of *P. perseae* increased from Jul through Sep and decreased during the fall of 2007 (Fig. 1). *Stethoconus praefectus* was not observed until Aug and the population peaked in Oct (Fig. 1). Our results indicate that *S. praefectus* is an important predator of *P. perseae* and, together with other predators, could cause significant cumulative mortality. For instance the chrysopid *C. rufilabris* causes a cumulative mortality of 75% of *P. perseae*, preferring nymphs over eggs and adults (Peña et al. 1998); the plant bug *Paracarniella cubana* feeds on eggs and nymphs, causing a 30% reduction of *P. perseae* during a 4-day observation period (Peña, unpublished data). No data are available on the effectiveness of the other newly discovered predator, the cecidomyiid *Tingidoletes praelonga* (Gagné et al.2008), but it likely contributes to the overall mortality of *P. perseae*. As a consequence, *S. praefectus*, together with other predators present in the area, might be responsible for keeping densities of *P. perseae* at low levels in Florida compared with other localities,

TABLE 3. LONGEVITY (DAYS) AND PREDATOR EFFICACY OF *S. PRAEFECTUS* MALES AND FEMALES, AND NATURAL MORTALITY OF *P. PERSEA* IN THE ABSENCE OF *S. PRAEFECTUS* (MEAN ± SE).

Treatment	n	Longevity Mean - Range	Consumption Total
Female	12	12.2 ± 2.53 a 1-30	55 ± 10.77 a
Male	10	5.7 ± 0.76 b 1-9	30.4 ± 3.78 b
Control	0.9 ± 0.25		

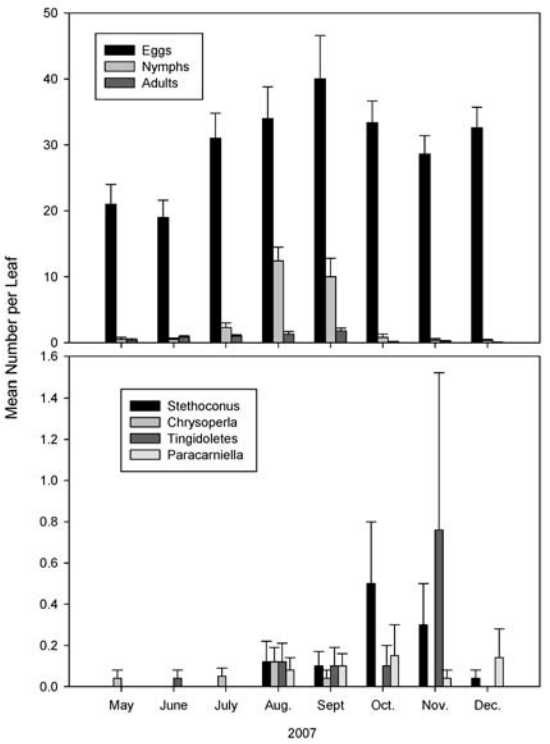

Fig 1. *Pseudacysta perseae* and predators found per avocado leaf at the USDA, Miami, Florida (mean ± SE) (May-Dec 2007).

such as Puerto Rico and the Dominican Republic (Etienne & Streito 2008) where the apparent lack of natural enemies makes *P. perseae* a serious problem.

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