Subtropical Agriculture and Environments 73:40-45.2022

Life history of *Euthyrhynchus floridanus* (L.) (Hemiptera: Pentatomidae)

Jesusa Crisostomo Legaspi

United States Department of Agriculture, Agricultural Research Service, Center for Medical, Agricultural and Veterinary Entomology, 6383 Mahan Dr., Tallahassee, FL 32308, U.S.A.

*Corresponding author email: Jesusa.Legaspi@usda.gov

ABSTRACT

The Florida predatory stinkbug (FPS), *Euthyrhynchus floridanus* (L.) (Hemiptera: Pentatomidae) is a beneficial insect found throughout the Southeastern United States, Mexico, Central, and South America into southern Brazil. *E. floridanus* has been evaluated as a potential biological control agent against pests, such as the kudzu bug and citrus weevil. In this study, its life history parameters were studied, which may be useful in determining the potential of the bug to reproduce when used as a biological control agent or for mass-rearing purposes. At 26°C, the time from egg-laying to adult emergence was 64 days. Females laid an average of 128.8 eggs during their lifetimes. Percentage of egg hatch was 83.1% of which 64.1% were female. Males lived an average of 75.4 days, and females lived 64.8 days. Male adults weighed 100.3 mg, which was less than that of females which weighed an average of 224.9 mg. The net reproductive rate (average number of females laid per adult female) of the FPS was measured to be 199.4. The finite rate of increase (rate of increase per female per day) was measured to be 1.31. These life history parameters suggest a high reproductive rate when compared to similar bugs such as the spined soldier bug, *Podisus maculiventris* (Say) (Hemiptera: Pentatomidae). More studies will be needed to evaluate the Florida predatory stinkbug's potential as a biological control agent against pests in the southeastern United States.

Additional index words: adult longevity, egg production, Florida predatory stinkbug; immature survivorship; population growth parameters

---

The Florida predatory stinkbug *Euthyrhynchus floridanus* (L.) (Hemiptera: Pentatomidae) is a beneficial insect found throughout the Southeastern United States (Mead 1976, Mead and Richman 2000), Mexico, Central, and South America into southern Brazil (Briceño 2014, Arellano et al, 2019). This predator has been collected throughout the year, with peaks in the spring and fall (Mead 1976). Its prey range includes southern green stink bug, *Nezara viridula* (L.), (Hemiptera: Pentatomidae); orangedog, *Papilio cresphontes* Cramer (Lepidoptera: Papillionidae), velvetbean caterpillar, *Anticarsia gemmatalis* Hübner (Lepidoptera: Erebidae), Colorado potato beetle, *Leptinotarsa decemlineata* (Say) (Coleoptera: Chrysomelidae), and the West Indian sugarcane rootstalk borer, *Diaprepes abbreviatus* (L.) (Coleoptera: Curculionidae), but usually exhibits minimal roles in the natural control of these pests (Meed and Richman 2000). Courtship and copulatory behavior was studied by Briceño (2014) who described the use of substrate vibrations in both sexes.

When reared on greater wax moth, *Galleria mellonella* (L.) (Lepidoptera: Pyralidae), Mexican bean beetle, *Epilachna varivestis* Mulsant (Coleoptera: Coccinellidae) and tobacco budworm, *Heliothis virescens* (F.) (Lepidoptera: Noctuidae) in the laboratory, the life cycle of *E. floridanus* was recorded at about 89 d (Mead 1976 citing Ables 1975). However, when provided black cutworms, *Agrotis ipsilon* (Hufnagel) (Noctuidae) the life cycle was about 155 d (Oetting and Yonke 1975). Development from egg to adult took 100 d, with the egg stage lasting 33 d and the nymphal stages lasting 67 d. Mead and Richman (2000) generalized time from egg to adult was about 58 d, with the egg stage lasting 18 – 19 d at 26 – 27°C and 14:10 L:D.

Life cycles of the four predatory stinkbugs (Hemiptera: Pentatomidae) *Alcaeorrhynchus grandis* (Dallas), *E. floridanus*, *Podisus maculiventris* (Say), and *Stiretrus anchorago* (F.), were compared under laboratory conditions by Richman and Whitcomb (1978). The stinkbugs were maintained on a diet of assorted larval instars of the cabbage looper, *Trichoplusia ni* (Hübner) and the soybean looper, *Pseudoplusia includens* (Walker) (both Lepidoptera: Noctuidae). Life cycles were completed in one month by *P. maculiventris* and *S. anchorago*, while *A. grandis* and *E. floridanus* required two months. Duration of the egg stages was relatively short for *P. maculiventris* and *S. anchorago*, ranging from 5 – 6 days, while requiring 16 d for *A. grandis*, and 19 d for *E. floridanus*.

Predation experiments in the laboratory showed *E. floridanus* to be a more effective predator on adult citrus weevil, *Diaprepes abbreviatus* (L.) (Coleoptera: Curculionidae) than *P. maculiventris* (Medal and Santa Cruz, 2014). When offered the kudzu bug, *Megacopta cribraria* (F.) (Hemiptera: Plataspidae) as prey, *E. floridanus* was 20 – 40% more efficient than *P. maculiventris* in the laboratory, with or without alternate prey in the form of the soybean looper, *Chrysodeixis includens* (Walker) (Lepidoptera: Noctuidae) (Medal et al. 2018). Similarly, *E. floridanus* females were more effective predators of the kudzu bug than males or nymphs even in the presence of alternate prey consisting of fall armyworm larvae, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) and/or velvetbean caterpillar larvae, *Anticarsia gemmatalis* (Medal et al. 2017). *Euthyrhynchus floridanus* was therefore identified as a potential useful biological control agent against the kudzu bug (Medal et al., 2017, 2018).

Laboratory evaluations against the brown marmorated stinkbug *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae) were performed by Arellano et al. (2019). Females were found to prefer 2nd to 4th instar larvae, whereas males showed no preferences for different larval stages. Females were more effective feeders, perhaps due in part to larger body size. The objective of this study was to determine life history parameters for the Florida predatory stinkbug feeding on the yellow mealworm, *Tenebrio molitor* under laboratory conditions.

MATERIALS AND METHODS

Insect rearing

A colony of *E. floridanus* originated from Dr. Julio Medal since and was kept at the USDA-ARS-CMAVE laboratory in Tallahassee, FL since 2017, and reared in an environmental growth chamber (ThermoForma model 374, Marietta, OH) at 26°C, photoperiod of 14:10 (L:D) h and 40-70% RH. Adult males and females were kept in a 0.6 m x 0.6 m screen cage (Bioquip Products, Inc., Compton, CA) lined with paper towels, plus 2 plastic solo cups (60 ml) (Solo Cup Co., Lake Forest, IL) filled with 2 cotton balls and tap water to serve as a source of moisture for the insects to imbibe. Two egg carton pieces (20 cm x 20 cm) (eggcartons.com) were placed in the cage to serve as egg mass substrates of the *E. floridanus.* Two – three egg masses were separated in individual petri dishes (15 cm diam) (Fisher Scientific International, Inc., Pittsburgh, PA) lined with filter paper plus a plastic petri dish (4 cm diam) with a damp cotton ball to serve as moisture. Newly-laid eggs were observed to be light-orange, while turning dark orange to gray with age (Figure 1). After the eggs hatched and the second-instars (Figure 2) started moving, 2-3 small-sized yellow mealworms, *Tenebrio molitor* L. (Coleoptera: Tenebrionidae) (about 1.3 cm, New York Worms, Long Island, NY) were provided to the *E. floridanus* nymphs until they reached the third instar stage.

Figure 1. Egg mass of *E. floridanus.*

Figure 2. Second-instar nymphs of *E. floridanus* in rearing plastic petri dish.

Thereafter, the nymphs were transferred to screened plastic boxes (18.5 cm length x 10.5 cm width x 13. 5 cm height, Tri-State Plastics, Dixon, KY) with a screen (7 cm diam) on the center of the lid and lined with paper towels plus two plastic solo cups (60 ml) containing 2 cotton balls and tap water. The solo cups were kept upright using cut-up plastic cup trays (Bio-Serve, Troy, MI) and mealworms (about 1.9 cm) were

A B

Figure 3A. Adult male *E. floridanus* in rearing plastic box and **Figure 3B.** Adult female *E. floridanus* in rearing plastic box.

provided *ad libitum* as prey in plastic petri dishes (6 cm diam) until adult stage (Figures 3A and 3B). Thereafter, the adults were transferred to the 0.6 x 0.6 m screen cages and reared as described above (Figure 4).

Figure 4. Adult female *E. floridanus* feeding on yellow mealworm, *T. molitor* in rearing plastic box.

Life history

All experimental treatments described herein and below were kept in an environmental growth chamber (Percival model 136VL, Percival Scientific, Perry, IA) at 26°C, and photoperiod of 14:10 (L:D) h and 40-70% RH. Eight replicates of egg masses were collected from the colony and placed individually in plastic petri dishes (15 cm diam) lined with filter paper plus a plastic petri dish (4 cm diam) with a damp cotton ball until the eggs emerged. After the second-instar nymphs (Figure 2) began to move, small-sized *T. molitor* mealworms were provided to the Florida predatory bugs *ad libitum*. The numbers of eggs and immatures that emerged, and period of emergence until the third instar emergence were recorded. Thereafter, each cohort replicate was transferred to plastic boxes lined with paper towels plus two plastic solo cups (60 ml) containing 2 cotton balls and tap water. Medium-sized mealworms were provided to the Florida predatory stinkbugs *ad libitum* in plastic petri dishes (6 cm diam) until they reached the adult stage. The numbers of the fourth instar to adult stage that emerged, period of emergence, and gender were recorded.

Adult longevity

Ten replicates of 1-2 day old adult male and unmated female *E. floridanus* were collected from the laboratory colony and placed individually in plastic petri dishes (15 cm diam) lined with filter paper plus a plastic petri dish (4 cm diam) with a damp cotton ball to serve as moisture. Medium-sized *T. molitor* mealworms were provided as prey *ad libitum*. The dates the adults died were recorded. In addition, any unfertilized eggs laid by the female were counted and recorded.

Eggs, immature and adult body weights

Ten replicates of 7-day-old egg masses were collected from the colony and weighed using an analytical balance (Mettler Toledo Excellence Plus P model, Columbus, OH). The numbers of eggs and weight (g) per egg mass were recorded. A minimum of 10 replicates of 1st - to 5th instar predators were collected from the laboratory colony. The body weights of individual instars were recorded. Ten replicates of adult males and females (unknown age) were collected from the colony and individual weights were recorded.

Egg production

Fifteen replicates of newly emerged (1-2 day old) paired adult males and females (1-2 day old) were kept individually in plastic petri dishes (15 cm diam) lined with filter paper plus a plastic petri dish (4 cm diam) with a damp cotton ball to serve as moisture. Medium-sized *T. molitor* mealworms were provided to the Florida predatory stinkbugs *ad libitum*. The numbers and period of eggs/egg masses laid by each female were counted and recorded. All egg masses were removed and separated individually until the female died. Any males that died before the female predator were replaced. Egg masses were placed individually in plastic petri dishes (15 cm diam) lined with filter paper plus a plastic petri dish (4 cm diam) with a damp cotton ball until the eggs emerged. The numbers of first-instar nymphs and period of first-instar emergence were recorded.

Population growth parameters

Methods for calculating life history parameters were identical to those described in Legaspi (2004) for the related Pentatomid *Podisus maculiventris*. Net reproductive rate $R_0 = \Sigma l_x m_x$, the summation of survivorship multiplied by age-specific fecundity per female, expressed in units of ♀/♀ where egg numbers were divided by 2 assuming 1:1 sex ratio. The gross reproductive rate was calculated as $GRR = \Sigma m_x$ or the summation of age-specific fecundity per female in ♀/♀. Generation time in days was calculated as $T = \Sigma x l_x m_x / R_0$. Intrinsic rate of increase was calculated as $r \approx (\ln R_0) / T$ in ♀/♀/d. Finite rate of increase was calculated as $\lambda = e^r$ in ♀/♀/d. Finally, doubling time in days was calculated as $DT = \ln(2)/r$.

Statistical analysis

Differences in male versus female weights and longevities were analyzed using *t*-tests. Statistical analyses were performed using Systat 13 Statistical software (Systat Software Inc., Chicago IL).

RESULTS AND DISCUSSION

Time from egg-laying to emergence was 21.5 ± 1.3 d ($\bar{x}$ ± SE). Immature durations were: 1st instar: 7.1 ± 1.5 d; 2nd: 9.8 ± 1.2, 3rd: 9.8 ± 0.8 d, 4th: 4.5 ± 0.9 d and 5th: 11.4 ± 1.0 d. Total time from egg laying to adult emergence was 64.0 ± 1.1 d. Total lifetime fecundity averaged 128.8 ± 18.5 eggs per female (*n* = 15). Percentage of egg hatch was 83.1% of which 64.1% were female. Survivorship of the immature stages displayed a linear decline with time (Figure 5). Mean numbers of eggs laid per female showed slight increase upwards until the female was about 20 d old,

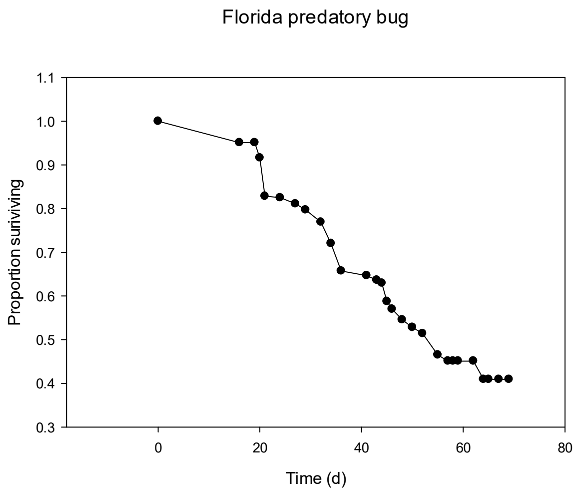

Figure 5. Immature survivorship of *E. floridanus* immatures at 26 °C. Survivorship is plotted on a linear axis.

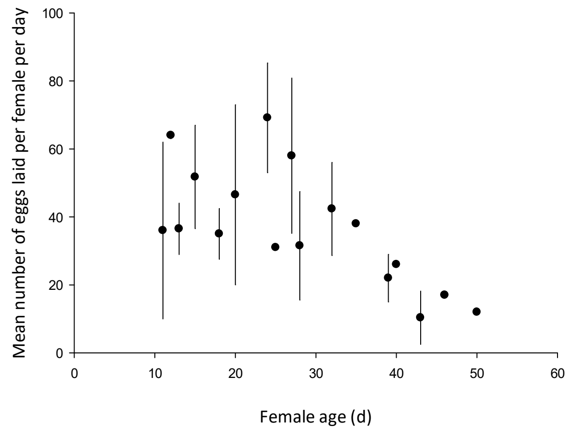

Figure 6. Mean number of eggs laid per *E. floridanus* female by age (mean ± SE; n=number of females laying eggs at age d).

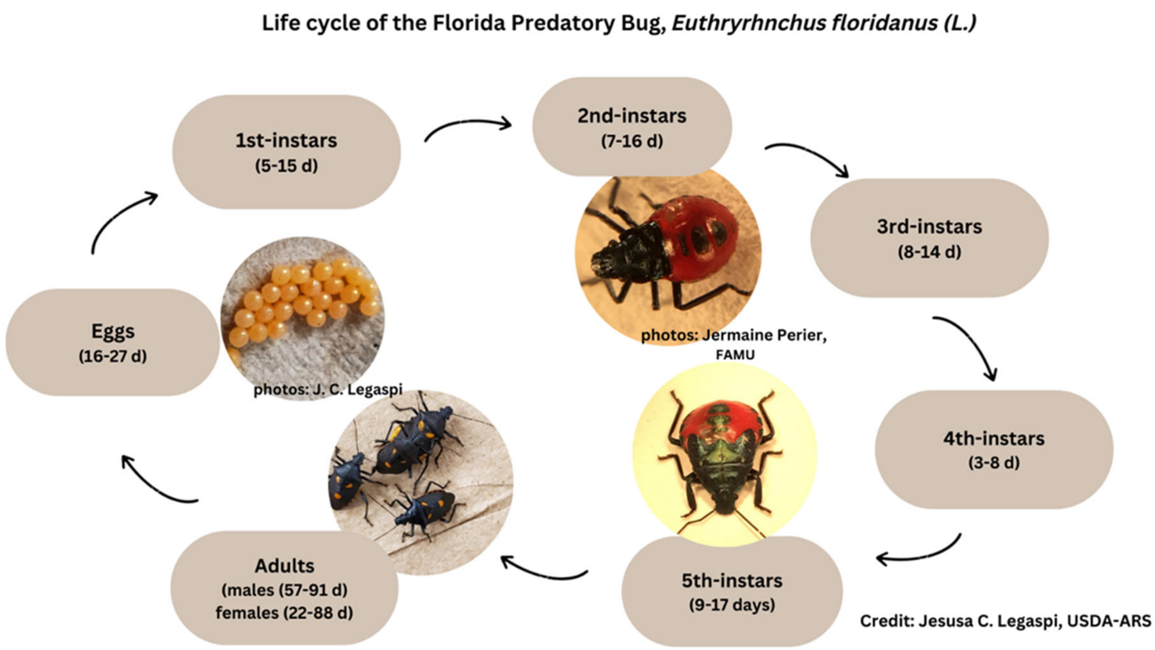

Figure 7. Life cycle of *E. floridanus.* [credit: Jesusa C. Legaspi, USDA-ARS]

followed by a tendency towards decline afterward (Figure 6). Adult male longevity was 75.4 ± 3.8 d ($\bar{x}$ ± SE, n = 10), which did not differ significantly from that of females at 64.8 ± 6.8 (t = 1.35, df =18, P = 0.19). Male adults weighed 100.3 ± 8.4 mg, significantly less than that of females that weighed 224.9 ± 15.1 mg (t = 7.38, df =17, P < 0.01). The life cycle of *E. floridanus* is illustrated in Figure 7.

Individual weights by life stage ($\bar{x}$ ± SE, n = 10 unless stated otherwise) were: egg 0.99 ± 0.16 mg, 1st instar: 1.25 ± 0.1 mg, 2nd instar 2.37 ± 0.2 mg, 3rd instar 11.5 ± 0.52 mg, 4th instar 49.16 ± 2.35 mg, 5th instar male 48.74 ± 10.6 mg (n = 5), and 5th instar female 51.18 ± 4.86 mg (n = 8).

Life history parameters for *E. floridanus* were calculated to be: net reproductive rate R_0 = 199.42 ♀/♀, gross reproductive rate GRR = 313.54 ♀/♀, generation time T = 19.59 d, intrinsic rate of increase r = 0.27 ♀/♀/d, finite rate of increase λ = 1.31 ♀/♀/d, and doubling time DT = 2.57 d. The immature durations were not recorded since the test insects were drawn from a laboratory colony. Calculations were based on 1-d old females and may underestimate true generation time in the field.

There is little information documented on *E. floridanus*. Thus, studies were compared with other similar generalist predators. For example, life table analysis of *P. maculiventris* female adults at 26°C showed R_0 of 47.8 and *GRR* of 156.0 females per female, respectively (Legaspi 2004). Mamduh et al. (2017) reported r =0.087, λ = 1.09, R_0 = 129.6, T = 56.0 and *GRR* = 256.1 for *P.maculiventris* feeding on *G. mellonella* at 24°C, 16:8 D:L and 75% RH. Garlic extract insecticides had no significant effects on the life history parameters of *P. maculiventris* (Mamduh et al. 2017). Similarly, glyphosate-based herbicides were found to be compatible with the related predatory stinkbug *Podisus nigrispinus* Dallas because of minimal effect on measured life history parameters (Zanuncio et al. 2018). In that study, generation time T was measured at 44.8 d, and the intrinsic rate of increase r was 0.08. The finite rate of increase λ was 1.08, and doubling time *DT* was 8.6 d. Based on these comparisons, *E. floridanus* has higher reproductive potential than *P. maculiventris* at 26°C.

The life history parameters reported here for the native insect predator, *E. floridanus,* suggest a high reproductive rate when compared to similar bugs such as the spined soldier bug. The results of the population growth parameter study will be relevant for biocontrol practitioners interested in mass rearing, augmentation, and release of this predator. More studies will be needed to evaluate the Florida predatory stinkbug's potential as a biological control agent against pests in the southeastern United States.

ACKNOWLEDGEMENTS

The *E. floridanus* colony was provided initially by Dr. Julio Medal and Danielle Wolaver (FDACS-DPI, Gainesville, FL). Technical assistance was provided by Neil Miller, James Johnson, III, Latasha Tanner, and Lourdes Perez-Cordero (USDA-ARS-CMAVE). This manuscript was kindly reviewed by Dr. Alvin Simmons (USDA-ARS-U.S. Vegetable Laboratory, Charleston, SC) and 3 anonymous reviewers. This article presents the results of research only. The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the United States Department of Agriculture or the Agricultural Research Service of any product or service to the exclusion of others that may be suitable.

LITERATURE CITED

Ables, J.R., 1975. Notes on the biology of the predacious pentatomid *Euthyrhynchus floridanus* (L.) J. Georgia Ent. Soc. 10: 353 – 356.

Arellano, R., J. Medal, G. Arellano, and J. Pérez. 2019. Feeding responses of *Euthyrhinchus floridanus* (Hemiptera: Pentatomidae) to brown marmorated stinkbug (Hemiptera: Pentatomidae) adults and nymphs. Fla. Entomol. 102: 658 – 659.

Briceño, R. D. 2014. Characterization of the behavioral and vibrational signals in *Euthyrhynchus floridanus* (Hemiptera: Pentatomidae) during courtship and copulation. Rev. Biol. Trop. vol. 62 n.1 San José Jan./Mar. 2014 (Spanish with English abstract)

Legaspi, J. C. 2004. Life history of *Podisus maculiventris* (Heteroptera: Pentatomidae) adult females under different constant temperatures. Environ. Entomol. 33: 1200 – 1206.

Mamduh, Z., V. Hosseininaveh, H. Allahyari and K. Talebi-Jahromi. 2017. Side effects of garlic extract on the life history parameters of the predatory bug, *Podisus maculiventris* (Say) (Hemiptera: Pentatomidae). Crop Prot. 100: 65 – 72.

Mead, F.W. 1976. A predatory stinkbug, *Euthyrhynchus floridanus* (Linnaeus) (Hemiptera: Pentatomidae) Fla. Dept. Agric. & Consumer Serv. Entomol. Circ. No. 174.

Mead, F.W. and D. B. Richman. 2000. Florida Predatory Stinkbug (unofficial common name), *Euthyrhynchus floridanus* (Linnaeaus) (Insecta: Hemiptera: Pentatomidae). EENY-157 Institute of Food and Agricultural Sciences. University of Florida.

Medal, J., and A. Santa Cruz. 2014. New record of predation on adult *Diaprepes abbreviates* (Coleoptera: Curculionidae) by *Euthyrhynchus floridanus* and *Podisus maculiventris* (Heteroptera: Pentatomidae). Fla. Entomol. 97: 830 – 834.

Medal, J., A. Santa Cruz and T. Smith. 2017. Feeding responses of *Euthyrhinchus floridanus* (Heteroptera: Pentatomidae) to *Megacopta cribraria* (Heteroptera: Plataspidae) with *Spodoptera frugiperda* and *Anticarsia gemmatalis* (Lepidoptera: Noctuidae) larvae as alternative prey. J. Entomol. Sci. 52: 87 – 91.

Medal, J., M. Srivastava, S. Sharma, D. Wolaver, A. Santa Cruz, E. Rohrig and A. Howe. 2018. Laboratory feeding responses of *Euthyrhynchus floridanus* and *Podisus maculiventris* (Hemiptera: Pentatomidae) to the kudzu bug, *Megacopta cribraria* (Hemiptera: Plataspidae). Fla. Entomol. 101: 382 – 388.

Oetting R.D., and T.R. Yonke. 1975. Immature stages and notes on the *Euthyrhynchus floridanus* (L.) (Hemiptera: Pentatomidae). Ann. Entomol. Soc. Am. 68: 659 – 662.

Richman, D. B., and W. H., Whitcomb. 1978. Comparative life cycles of four species of predatory stinkbugs. Fla. Entomol. 61: 113 – 119.

Zanuncio, J.C., M. C. Lacerda, R. Alcántara-de la Cruz, B. P. Brügger. A. I.A. Pereira, C. F. Wilcken, J. E. Serrão, and C. Sediyama.

2018. Glyphosate-based herbicides toxicity on life history parameters of zoophytophagous *Podisus nigrispinus* (Heteroptera: Pentatomidae). Ecotoxicol. Environ. Saf. 147: 245 – 250.