Density and Egg Parasitism of Stink Bugs (Hemiptera: Pentatomidae) in Mimosa

Author: Tillman, P. Glynn

Source: Florida Entomologist, 102(1) : 227-230

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.102.0137

Density and egg parasitism of stink bugs (Hemiptera: Pentatomidae) in mimosa

P. Glynn Tillman[1,*]

Abstract

Stink bugs (Hemiptera: Pentatomidae) are primary pests in most fruit, vegetable, grain, and row crops worldwide. The polyphagous habits of these pest species compels them to forage within and between closely associated non-crop and crop habitats across farmscapes in response to changing food resources. The exotic mimosa tree, *Albizia julibrissin* Durazz (Fabaceae), commonly grows in thickets along roadsides and in woodlands adjacent to agricultural crops across the southeastern USA. Thus, the objective of this study was to determine if mimosa was a host plant of stink bugs in southwest Georgia. *Chinavia hilaris* (Say) (Hemiptera: Pentatomidae) fed and developed on mimosa during early Jul through mid-Aug. Nymphs and adults of *C. hilaris* fed more frequently on fruit than on leaves of mimosa. Other stink bugs viz., *Euschistus servus* (Say), *E. tristigmus* (Say), *E. obscurus* (Palisot), *Nezara viridula* (L.), *Thyanta custator custator* (F.), and *Loxa flavicollis* (Drury) (all Hemiptera: Pentatomidae), also were detected on mimosa, but only as adults feeding on fruit. *Trissolcus edessae* Fouts (Hymenoptera: Scelionidae) was the most prevalent parasitoid of *C. hilaris* eggs on mimosa, but *Anastatus reduvii* (Howard) (Hymenoptera: Eupelmidae) also emerged from eggs of this stink bug. Overall, 46.6% of the *C. hilaris* eggs found on mimosa were parasitized. In conclusion, *C. hilaris* is the primary stink bug species developing on mimosa in southwest Georgia, serving as a potential source of this stink bug into nearby crops.

Key Words: *Chinavia hilaris*; Scelionidae; *Trissolcus edessae*; *Anastatus reduvii*

Resumen

Las chinches hediondas (Hemiptera: Pentatomidae) son plagas primerias en la mayoría de los cultivos de frutas, vegetales, granos y cultivos en hileras en todo el mundo. El hábito polífago de estas especies de plagas los obligan a forrajear dentro y entre hábitats estrechamente relacionados y no relacionados en campos agrícolas en respuesta a los cambios en los recursos alimenticios. El árbol exótico mimosa, *Albizia julibrissin* Durazz (Fabaceae), crece comúnmente en matorrales por las carreteras y en los bosques adyacentes a cultivos agrícolas en todo el sureste de los EE. UU. Por lo tanto, el objetivo de este estudio fue determinar si el árbol mimosa es una planta hospedera de chinches hediondas en el suroeste de Georgia. *Chinavia hilaris* (Say) (Hemiptera: Pentatomidae) se alimentó y se desarrolló sobre el árbol mimosa desde el principio de julio hasta el medio de agosto. Las ninfas y los adultos de C. *hilaris* se alimentaron con mayor frecuencia sobre las frutas que las hojas del árbol mimosa. Otras chinches hediondas, *Euschistus servus* (Say), *E. tristigmus* (Say), *E. obscurus* (Palisot), *Nezara viridula* (L.), *Thyanta custator custator* (F.) y *Loxa flavicollis* (Drury) (todos Hemiptera : Pentatomidae), también se detectaron en el árbol mimosa, pero solamente los adultos se alimentaron de las frutas. *Trissolcus edessae* Fouts (Hymenoptera: Scelionidae) fue el parasitoide más frecuente de los huevos de *C. hilaris* en el árbol mimosa, pero *Anastatus reduvii* (Howard) (Hymenoptera: Eupelmidae) también emergió de los huevos de este insecto. En todo, el 46,6% de los huevos de *C. hilaris* encontrados en el árbol mimosa estaban parasitados. En conclusión, *C. hilaris* es la especie principal de las chinches hediondas que se desarrolla en el árbol mimosa en el suroeste de Georgia, y sirve como fuente potencial de este chinche en los cultivos cercanos.

Palabras Clave: *Chinavia hilaris*; Scelionidae; *Trissolcus edessae*; *Anastatus reduvii*

Numerous stink bug species (Hemiptera: Pentatomidae), including *Chinavia hilaris* (Say), *Euschistus servus* (Say), *E. tristigmus* (Say), and *Nezara viridula* (L.), cause economic injury to many agronomic crops (McPherson & McPherson 2000). Stink bugs feed on developing cotton seeds and lint, which can cause shedding of young bolls, yellowing of lint, yield reduction, and transmission of the bacterial pathogen *Pantoea agglomerans* (Enterobactacteriaceae) that can damage seed and lint (Barbour et al. 1990; Medrano et al. 2009).

The plant-feeding habits of stink bug pests compels them to move within and between closely associated non-crop and crop habitats across farmscapes in response to changing food resources. Mimosa, *Albizia julibrissin* Durazz (Fabaceae), was introduced in the mid-1700s as an ornamental in the US. This exotic tree commonly grows in thickets along roadsides and in woodlands adjacent to agricultural crops across the southeastern USA. The fruit (i.e., pod) of this legume is 8 to 20 cm long and, in general, yields 5 to 16 seeds, each about 6 to 12 mm in length (Meyer 2010). *Chinavia hilaris* previously has been reported on mimosa in South Carolina, USA (Jones & Sullivan 1982). In southwest Georgia, the capture of *C. hilaris* adults and nymphs in stink bug pheromone-baited traps near mimosa in field borders adjacent to crops, and the spatial distribution of *C. hilaris* in these crops, indicated that this tree was a source of this stink bug dispersing into crops, primarily to cotton (Cottrell & Tillman 2015). This study was conducted to investigate the seasonal abundance and feeding habits of stink bug species in mimosa, and to provide estimates of parasitism of naturally occurring stink bug eggs on this tree.

Materials and Methods

This field study was conducted from 2013 through 2018. Over the 6-yr study, uncultivated mimosa trees in woodlands adjacent to com-

[1]USDA, ARS, Crop Protection and Management Research Laboratory, P.O. Box 748, Tifton, Georgia 31793, USA
*Corresponding author; E-mail: Glynn.Tillman@ars.usda.gov

mercial cotton fields were sampled for stink bugs at 4 sites: Grainbin (31.5656°N, 83.2979°W), Redbarn (31.5543°N, 83.3132°W), Palm (31.5369°N, 83.3321°W), and Starr (31.5719°N, 83.2969°W), in Irwin County, Georgia, USA. The number of sites and trees per site varied among yr because some of the trees were accidentally killed or hurt by growers, or did not produce fruit during a season due to drought conditions. Also, additional sites were included as mimosa trees were detected at other sites. With only 1 exception, mimosa trees were sampled weekly. In 2013, 4 trees were sampled for 5 wk at 'Grainbin' from 25 Jul to 22 Aug. In 2014, 3 trees were examined for 8 wk at 'Grainbin' from 10 Jul to 28 Aug. In 2015, 2 trees at 'Starr', 5 at 'Grainbin', and 7 at 'Palm' were sampled for 5 wk from 15 Jul to 12 Aug. In 2016, 9 trees at 'Palm' were sampled for 2 wk, on 28 Jul and 4 Aug. In 2017, 2 trees at 'Starr', 3 at 'Grainbin', 4 at 'Redbarn', and 5 at 'Palm' were examined for 7 wk on 29 Jun and from 20 Jul to 24 Aug. In 2018, 2 trees at 'Starr', 4 at 'Redbarn', and 6 at 'Palm' were sampled for 13 wk from 7 Jun to 30 Aug. For each mimosa sample, a whole plant, including foliage and fruiting structures, was examined for the presence of stink bugs. When necessary, a 1.5-m long cattle show stick with a small hook at the end was used to gently pull down a branch to look for insects. Species and developmental stages of stink bugs were recorded in the field using a HP iPAQ pocket personal computer (Hewlett-Packard Co., Palo Alto, California, USA). At the Grainbin site, feeding (i.e., proboscis inserted into the food source) by stink bug nymphs and adults was recorded by the plant part (i.e., leaf, stem, or fruit) each individual fed on for each tree for each sampling date in 2013 and 2014.

Naturally occurring stink bug egg masses detected in the field were brought into the laboratory and held in a walk-in environmental chamber (27 °C, 60% relative humidity, 14:10 h [L:D] photoperiod) for emergence of adult parasitoids. *Trissolcus* species (Hymenoptera: Scelionidae) were identified using a key to Nearctic species of *Trissolcus* (Talamas et al. 2015). Females of *Anastatus* (Hymenoptera: Eupelmidae) were identified using a key to North American species of this genus (Burks 1967). There is no key to *Anastatus* males. *Anastatus reduvii* (Howard) and *A. mirabilis* (Walsh & Riley) are the only 2 Eupelmidae parasitoids known to emerge from stink bug eggs in southwest Georgia, and only 1 species emerges from a single egg mass (Tillman 2016). Therefore, *Anastatus* males emerging with *Anastatus* females were assumed to be the same species. Predation of eggs was assessed as described in Tillman (2011). Voucher specimens of all insects were deposited in the USDA, ARS, Crop Protection & Management Research Laboratory in Tifton, Georgia.

All data were analyzed using SAS statistical software (SAS Institute 2010). Chi-square analyses were used to compare frequencies of parasitoid species parasitizing *C. hilaris* egg masses on mimosa, frequencies of plant parts fed on by nymphs of this stink bug, and frequencies on location of egg masses on mimosa (PROC FREQ). Seasonal means for the number of *C. hilaris* egg masses, nymphs, and adults per tree were calculated and graphed for 2013, 2014, 2015, 2017, and 2018 (PROC MEANS). Only data on stink bug species, and parasitism and predation of *C. hilaris* egg masses, are presented for the 2016 data set.

Results

Over the 6 yr study, 7 plant-feeding stink bug species were detected on mimosa. *Chinavia hilaris* was the predominant stink bug species (63.5%) (χ^2 = 1617.7; df = 5; P < 0.001) followed by *N. viridula* (12.9%), *E. tristigmus* (10.3%), *E. servus* (9.7%), *Thyanta custator custator* (F.) (3.0%), *E. obscurus* (Palisot) (0.4%), and *Loxa flavicollis* (Drury) (0.2%). *Chinavia hilaris*, *E. servus*, and *E. tristigmus* were consistently present on mimosa over each yr of the study. However, *E. obscurus* and *T. c. custator* were detected on mimosa only for 3 yr and *N. viridula* for only 2 yr. Two females of *L. flavicollis* were found on mimosa in 2018. Only *C. hilaris* developed from nymphs to adults on mimosa. For the remaining stink bug species, only adults were detected, generally feeding on fruit.

Populations of *C. hilaris* were present on mimosa in Jul and Aug (Fig. 1). Observations of feeding by *C. hilaris* on mimosa in 2013 and 2014 revealed that nymphs (second through fifth instars) fed more frequently on fruit (98.5%) than on leaves (1.5%) (χ^2 = 121.1; df = 1; P < 0.001). Adults (n = 41) fed only on fruit, and females laid egg masses more often on fruit (77.4%) than on leaves (22.6%) (χ^2 = 9.3; df =1; P < 0.002). No *C. hilaris* were observed feeding on stems of mimosa. On 29 Jun 2017, only small seeds were present in small pods, and no *C. hilaris* were detected on trees. In 2018, trees flowered from early to mid-Jun. Small seeds were present in small pods from mid- to late Jun. No *C. hilaris* were detected on mimosa trees until pods with medium-sized seeds were sampled on 5 Jul. Only early instars (i.e., first, second, and third instars) were present on mimosa on 10 Jul 2014, and 5 Jul and 12 Jul 2018. In addition, some egg masses were detected on mimosa on 15 Jul 2015 and 12 Jul 2018. Altogether, these results strongly indicate that *C. hilaris* occurred and developed on fruiting mimosa. In 2017 and 2018, adult numbers decreased as pods with large seeds began senescing (i.e., drying out and turning brown). Numbers of nymphs (principally fourth and fifth instars late season), though, increased around mid-Aug, decreasing when pods senesced. A similar pattern occurred for *C. hilaris* numbers in Aug 2014 and 2015. Numbers of *C. hilaris* nymphs were relatively low in Aug in 2013 compared to the other yr, perhaps due to the drought conditions.

Only 2 species of parasitoids parasitized naturally occurring egg masses of *C. hilaris*. *Trissolcus edessae* Fouts (Hymenoptera: Scelionidae) was the most prevalent parasitoid of *C. hilaris* eggs on mimosa (87.8%) (χ^2 = 136.1; df = 1; P < 0.001). *Anastatus reduvii* (Howard) (Hymenoptera: Eupelmidae) also emerged from eggs (12.2%) of this stink bug. Overall, 46.6% of the eggs were parasitized and 10.5% were preyed upon.

Discussion

Chinavia hilaris fed and successfully developed to adults on mimosa fruit (i.e., pods), confirming mimosa as a reproductive host plant for this stink bug. However, mimosa was not a reproductive host plant for the other stink bug species detected on this tree, and served solely as a source of food for adults. Similar to the results of the current study, populations of *C. hilaris* were present on mimosa from mid-Jul through Aug in South Carolina (Jones & Sullivan 1982). In the current study, adults of *C. hilaris* decreased in number on mimosa as nymphs began to peak early to mid-Aug, indicating that new adults developing from nymphs on the tree dispersed from this woodland food source to seek a new host plant. Timing of senescence of mimosa and likely dispersal of *C. hilaris* adults from this host plant coincides with the presence of fruit (i.e., bolls) on cotton, suggesting that mimosa could be a source of this stink bug in this crop. Indeed, the capture of *C. hilaris* adults and nymphs in pheromone-baited traps near mimosa, and subsequent presence of *C. hilaris* in crops near mimosa in an earlier study indicated that this tree was a source of this stink bug dispersing into cotton (Cottrell & Tillman 2015). Mark-recapture studies in the same woodland habitats of the current study demonstrated that elderberry (*Sambucus nigra* subsp. *canadensis* [L.] R. Bolli), a non-crop host plant of *C. hilaris*, was a source of this stink bug moving into cotton (Tillman & Cottrell 2016). Similarly, damage to apple by *C. hilaris* was greatest near woodlands (Mundinger & Chapman 1932), and infestations of this stink bug in soybean were consistently found on border rows next to woodlands

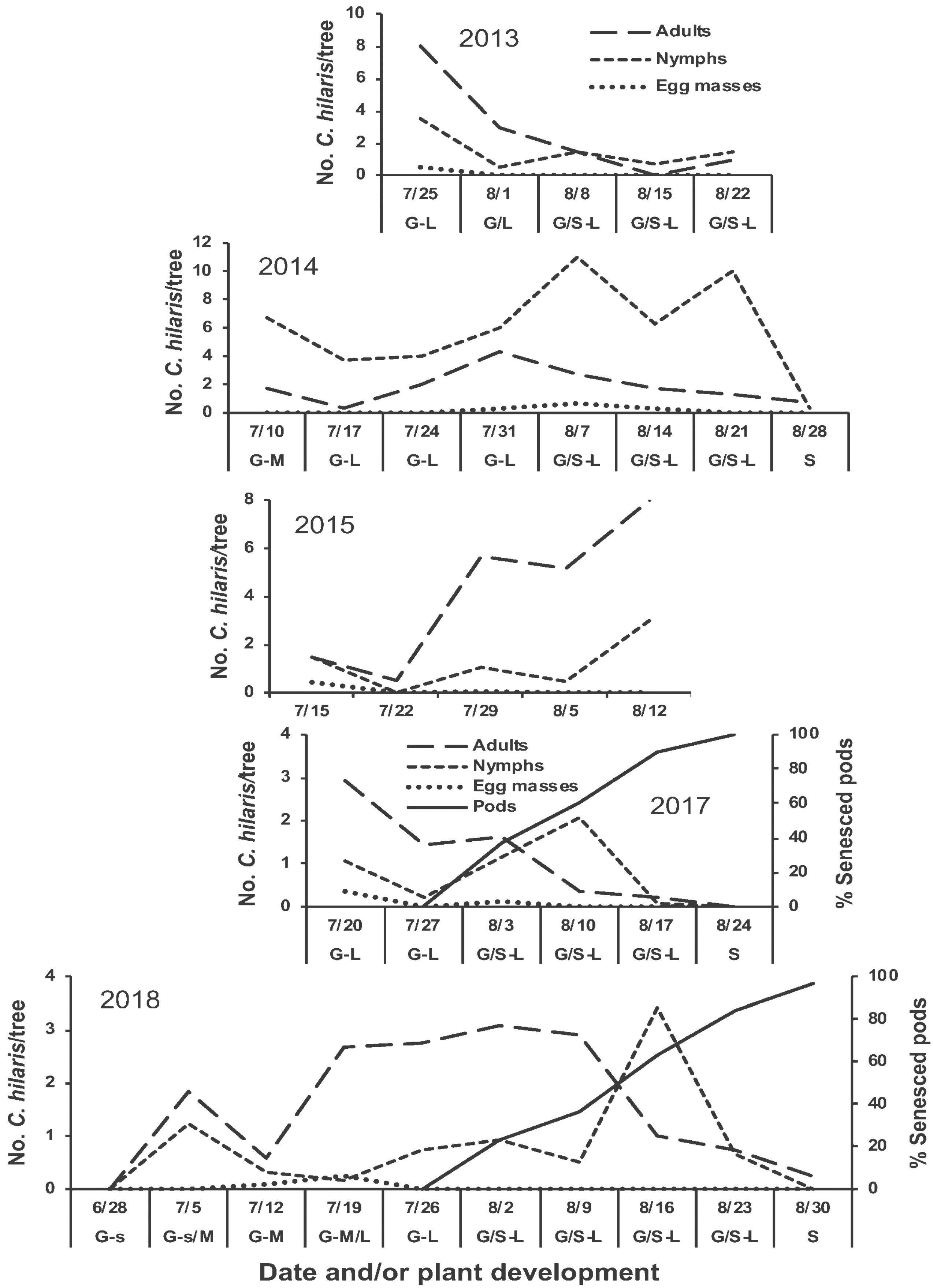

Fig. 1. Mean number of *C. hilaris* egg masses, nymphs, and adults on mimosa over time in 2013, 2014, 2015, 2017, and 2018, and percentage of senesced pods over time in mimosa in 2017 and 2018. G = green pod; S = senesced pod; s = small-sized seeds in pods; M = medium-sized seeds in pods; L = large seeds in pods.

(Miner 1966), suggesting that host plants in woodlands were sources of *C. hilaris* in apple and soybean.

Based on the results of the current study and previous studies, overall percent parasitism of *C. hilaris* eggs ranges from 16 to 49% on various host plants (Yeargan 1979; Orr et al. 1986; Jones et al. 1996; Koppel et al. 2009; Tillman & Cottrell 2016). In an earlier study, diversity of egg parasitoids emerging from *C. hilaris* was greater, and percent parasitism was higher in woodland habitats (41%) compared with those observed in crops (21%) (Tillman 2016). Four species of parasitoids, *T. edessae*, *A. reduvii*, *A. mirabilis* (Walsh & Riley), and *Ooencyrtus* sp. parasitized egg masses of *C. hilaris* in wooded areas, but only *T. edessae* parasitized eggs of this stink bug in crops. In the current study, both *T. edessae* and *A. reduvii* parasitized eggs of *C. hilaris* in mimosa. *Trissolcus edessae* was the principal parasitoid emerging from *C. hilaris* egg masses on *Sesbania punicea* (Cav.) Benth, another non-crop host plant of this stink bug in wetland habitats (Tillman 2015). In elderberry, these 2 parasitoid species, as well as *A. mirabilis*, parasitized *C. hilaris* in woodlands (Tillman & Cottrell 2016).

Conservation of *T. edessae* and *A. reduvii* in woodland habitats has the potential to enhance biological control of *C. hilaris* in agricultural ecosystems. The importance of nectar provision on parasitoid fitness has been demonstrated for various hymenopteran parasitoid species (Berndt & Wratten 2005; Araj et al. 2006). Incorporating buckwheat near soybean increased parasitism of *E. servus* egg masses by *Telenomus podisi* Ashmead in adjacent cotton (Tillman et al. 2015). Nectar provision along field edges could provide a food source to parasitoids in their woodland habitats and as they disperse from woodlands into crops. *Anastatus* species were the most prevalent parasitoids emerging from naturally occurring eggs of *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae) in ornamental nurseries in Maryland, USA (Jones et al. 2014). *Trissolcus edessae* and *A. reduvii* are 2 prevalent egg parasitoids of *H. halys* in the southeastern US (Tillman unpublished data). Providing nectar to *T. edessae* and *Anastatus* species near woodlands is one of many management strategies available for managing *C. hilaris* and, potentially, *H. halys*.

Acknowledgments

Thanks to Kristie Graham (USDA, ARS, Crop Protection & Management Research Laboratory, Tifton, Georgia) for her technical assistance in the field.

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