Black cherry as a host plant for stink bugs (Hemiptera: Pentatomidae) in agroecosystems in Georgia, USA

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Abstract

Stink bugs (Hemiptera: Pentatomidae) are polyphagous pests that disperse from woodland habitats into crops following food availability. Black cherry (*Prunus serotina* Ehrh.; Rosaceae) is common in the southeast US. In this 3-yr study, our principal objective was to determine if black cherry acts as a reproductive host as well as a source of food for stink bugs in woodland habitats adjacent to crops in Georgia, USA. Each yr, black cherry trees were examined visually for stink bug species and stages in addition to using pheromone-baited canopy and ground traps to capture them. In 2016, we compared the number of stink bugs captured in canopy traps versus ground-based traps. *Chinavia hilaris* Say, *Euschistus servus* (Say), *Euschistus tristigmus* (Say), and *Nezara viridula* (L.) (all Hemiptera: Pentatomidae) were detected in traps each yr of the study. Total number of stink bugs was significantly higher in ground traps (1.53 ± 0.07) compared to canopy traps (0.71 ± 0.07) in the 2016 test. Only *C. hilaris* (99.2%) and *N. viridula* (0.8%) were found on trees during visual sampling. Over both types of sampling methods, egg masses, most instars, and both sexes of adults of *C. hilaris* were detected in black cherry. The nymph to adult ratio for this species was 1:1 in traps and nymph biased in visual samples. *Anastatus reduvii* (Howard) (Hymenoptera: Eupelmidae) (44%), *Trissolcus edessae* Fouts (Hymenoptera: Scelionidae) (35%), and *Ooencyrtus* sp. (Hymenoptera: Encyrtidae) (21%) emerged from *C. hilaris* egg masses. The nymph to adult ratio for *N. viridula* was adult biased. Both nymphs and adults of *E. servus* and *E. tristigmus* were captured in traps; however, the majority of individuals were adults. We conclude that black cherry is a significant reproductive host and a food source for *C. hilaris*. However, our results indicate that it serves as a food source more so than a reproductive host for the other 3 stink bug species.

Key Words: *Euschistus servus*; *Euschistus tristigmus*; *Chinavia hilaris*; *Nezara viridula*; *Prunus serotina*; non-crop host; pheromone-baited trap

Resumen

Las chinches hediondas (Hemiptera: Pentatomidae) son plagas polífagas que se dispersan de los hábitats de los bosques a los cultivos según la disponibilidad de alimentos. La cereza negra (*Prunus serotina* Ehrh.; Rosaceae) es común en el sureste de EE. UU. En este estudio de 3 años, nuestro principal objetivo fue determinar si la cereza negra actúa como hospedero reproductivo y como fuente de alimento para las chinches en los hábitats de bosques adyacentes a los cultivos en el Estado de Georgia, EE. UU. Se examinaron visualmente los cerezos negros cada año en busca de especies y estadios de chinches hediondas, además de utilizar un dosel cebado con feromonas y trampas de tierra para capturarlas. En el 2016, comparamos la cantidad de chinches hediondas capturadas en trampas de dosel con trampas terrestres. Se detectaron *Chinavia hilaris* Say, *Euschistus servus* (Say), *Euschistus tristigmus* (Say) y *Nezara viridula* (L.) (todos Hemiptera: Pentatomidae) en las trampas cada año del estudio. El número total de chinches hediondas fue significativamente mayor en las trampas terrestres (1,53 ± 0,07) en comparación con las trampas de dosel (0,71 ± 0,07) en la prueba del 2016. Solo *C. hilaris* (99,2%) y *N. viridula* (0,8%) se encontraron en árboles durante el muestreo visual. En ambos tipos de métodos de muestreo, se detectaron masas de huevos, la mayoría de los estadios y ambos sexos de adultos de *C. hilaris* en cereza negra. La proporción de las ninfas a adultos para esta especie fue de 1:1 en trampas y sesgada hacia las ninfas en muestras visuales. *Anastatus reduvii* (Howard) (Hymenoptera: Eupelmidae) (44%), *Trissolcus edessae* Fouts (Hymenoptera: Scelionidae) (35%) y *Ooencyrtus* sp. (Hymenoptera: Encyrtidae) (21%) emergieron de las masas de huevos de *C. hilaris*. La proporción de ninfas a adultos para *N. viridula* estaba sesgada hacia los adultos. Tanto las ninfas como los adultos de *E. servus* y *E. tristigmus* fueron capturados en trampas; sin embargo, la mayoría de los individuos fueran adultos. Concluimos que la cereza negra es un hospedero reproductivo importante y una fuente de alimento para *C. hilaris*. Sin embargo, nuestros resultados indican que la cereza negra sirve más como un fuente de alimento que un hospedero reproductivo para las otras 3 especies de chinches hediondas.

Palabras Clave: *Euschistus servus*; *Euschistus tristigmus*; *Chinavia hilaris*; *Nezara viridula*; *Prunus serotina*; hospedero no agrícola; trampa con cebo de feromonas

Stink bugs (Hemiptera: Pentatomidae), including *Chinavia hilaris* Say, *Euschistus servus* (Say), *Euschistus tristigmus* (Say), and *Nezara viridula* (L.) (all Hemiptera: Pentatomidae), are polyphagous pests that traverse inhabited ecosystems in search of food and reproductive hosts. In the southeast US, agroecosystems are diverse; agricultural field margins as well as woodlands often contain multiple non-crop hosts of stink bugs that provide not only food resources, but also support reproduction (Jones & Sullivan 1982; Panizzi 1997; Tillman & Cottrell 2016a; Tillman 2019). As a result, non-crop hosts near crop fields are an unmanaged source of stink bugs that later disperse into crops (Ehler 2000; Venugopal et al. 2014; Tillman & Cottrell 2016a). In addition, the diversity of the agroecosystem supports overwintering adults

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in grass clumps, leaf litter, and under tree bark at field margins and in woodlands near crops (Borden et al. 1952; Rolston & Kendrick 1961; Jones & Sullivan 1981). It is their propensity to inflict economic injury to a variety of crops (McPherson & McPherson 2000), which necessitates characterizing host plants that commonly occur in habitats near those crops. This action is important to link patterns of dispersal with local habitat composition.

Black cherry (*Prunus serotina* Ehrh.; Rosaceae) is a fruiting tree that commonly grows in woodland and marginal habitats in the southeast US. Previously, black cherry was identified as a reproductive host for *C. hilaris* in South Carolina, USA (Jones & Sullivan 1982). As a non-crop host, black cherry had a significant role in the early-season buildup of *C. hilaris* populations and subsequent colonization of soybean later in the season in that state. In that study, late-instar *C. hilaris* first appeared from late May to the third wk of Jun with peak nymphal density occurring 2 wk later. Additionally, black cherry was reported to be a host plant for *E. servus*, but details regarding its development on this host were not provided.

Several studies have shown that pyramid traps baited with commercially available lures of aggregation pheromone(s) attract specific stink bug species and effectively capture adults and nymphs in the field. The aggregation pheromone of *Euschistus* spp., methyl (2*E*,4*Z*)-decadienoate, attracts males, females, and nymphs of *Euschistus* spp., including *E. servus* and *E. tristigmus*, in the field (Mizell &Tedders 1995; Cottrell et al. 2000; Johnson et al. 2002; Leskey & Hogmire 2005; Tillman & Cottrell 2016b). In addition, males and females of *Plautia stali* Scott (Hemiptera: Pentatomidae) are attracted to its aggregation pheromone, methyl (2*E*,4*E*,6*Z*)-decatrienoate (Sugie et al. 1996). Presently, pheromone lures specific to *C. hilaris* are not available commercially. However, *C. hilaris* is cross-attracted to methyl (2*E*,4*E*,6*Z*)-decatrienoate under field conditions (Tillman et al. 2010), and pyramid traps baited with methyl (2*E*,4*E*,6*Z*)-decatrienoate have been shown to capture *C. hilaris* along peanut and cotton field edges (Tillman & Cottrell 2016b). Stink bug nymphs do not enter traps randomly; instead they are attracted to traps that contain the synthetic aggregation pheromones attractive to their species (Khrimian et al. 2014; Weber at al. 2014; Tillman & Cottrell 2016c). Therefore, pheromone-baited traps can be used to monitor adult and nymph populations.

In this study, our goal was to determine if black cherry in woodland habitats adjacent to cotton and peanut fields is a reproductive host as well as a source of food for stink bugs in Georgia, USA. A combination of canopy and ground-based pheromone-baited pyramid traps were used to capture stink bugs on focal trees and provide estimates on seasonal abundance, foraging habits, and the presence of nymphs as an indication of suitable host plant development. Capture of stink bugs in trees may vary depending on the location where the trap is placed, either in the canopy or on the ground at the base of a tree. Therefore, we compared the number of stink bug species captured in canopy and ground-based traps. In addition, trees were examined visually for stink bug egg masses, nymphs, and adults during fruit production to determine whether this tree species is a reproductive host of stink bugs in Georgia.

Materials and Methods

MONITORING STINK BUGS USING PHEROMONE-BAITED TRAPS

From 2016 to 2018, stink bugs were trapped at black cherry trees located in woodlands adjacent to cotton and peanut fields in Irwin County, Georgia, USA. A stink bug trap consisted of an insect-collecting device made from a 2.8 L clear plastic PET jar (United States Plastic Corp., Lima, Ohio, USA) with a screw-cap lid (10.2 mm in diam) seated atop a 1.22 m tall yellow pyramid base (Cottrell et al. 2000). The insect-collecting device was baited with a lure of the aggregation pheromone of *Euschistus* spp. (methyl [2*E*,4*Z*]-decadienoate) and a lure of the aggregation pheromone of *P. stali* (methyl [2*E*,4*E*,6*Z*]-decatrienoate). Methyl (2*E*,4*Z*)-decadienoate was purchased from Bedoukian Research, Inc. (Danbury, Connecticut, USA), and lures were produced following the procedures in Cottrell and Horton (2011). Methyl (2*E*,4*E*,6*Z*)-decatrienoate lures were purchased from AgBio, Inc. (Westminster, Colorado, USA). An insecticidal ear tag (10% λ-cyhalothrin and 13% piperonyl butoxide) (Saber extra insecticide ear tags, Sagebrush Tags, De Smet, South Dakota, USA) also was placed in each device to decrease the likelihood of stink bug escape (Cottrell 2001). Once per wk, lures were replaced, and stink bugs captured in traps were placed in reclosable bags (US Plastics, Lima, Ohio, USA) and stored at the USDA Southeast Watershed Unit in Tifton, Georgia, for identification.

At 1 site in 2016, an experiment was conducted to compare trap capture of ground-based traps versus traps in the canopy of black cherry trees adjacent to a cotton field. For each of 10 trees, a trap was deployed on the ground at the base of a tree and another trap was hung from a limb in the middle of the canopy. Traps were sampled on 11, 19, and 26 Aug and 2 Sep. In 2017, traps were deployed in the canopy of trees at 9 sites for a total of 27 traps and sampled for 28 consecutive wk starting on 2 Jun. In 2018, traps were deployed in the canopy of trees at 7 sites for a total of 14 traps and sampled for 14 wk staring on 25 May. In general, stink bug females oviposit egg masses on leaves where early instars feed while older instars disperse to feed on leaves, stems, and fruit (Funayama 2002; Bernon 2004; Nielsen & Hamilton 2009). Accordingly, the presence of younger nymphs in traps in or near a plant species can be used to estimate where adults oviposit eggs and to identify plants that may serve as reproductive hosts that facilitate the growth and development of nymphs. Thus, in 2017 and 2018, traps were deployed in trees to capture nymphs in the canopy of black cherry.

MONITORING STINK BUGS USING VISUAL EXAMINATION OF TREES

In each yr of the study, black cherry trees were examined visually weekly through the period of fruit production on trees for all stages and species of stink bugs. Traps were not deployed in these scouted trees. In 2016, 19 trees were sampled at 7 locations for 8 wk starting on 12 May. In 2017, 31 trees were sampled at 9 sites for 8 wk starting on 3 May. In 2018, 12 trees were sampled at 4 sites for 8 wk starting on 6 Jun. On the date of scouting, fruit development was categorized and recorded by phenological stages: immature (green to green-pink in color), maturing (green-red to red in color), and mature (red-purple to purple in color). Three lower limbs and foliage were examined visually on each tree for stink bug egg masses, nymphs, and adults. The number of stink bugs in each development stage was recorded for each stink bug species detected. Because color change in *E. servus* from green to reddish brown is an indicator of reproductive diapause (Borges et al. 2001), reddish brown *E. servus* and *E. tristigmus* adults captured in traps were considered to be overwintering adults.

STINK BUG EGG PARASITOIDS

Egg masses which were collected from black cherry tree foliage were transported to the Southeast Watershed Research Laboratory in Tifton, Georgia, where they were held in an environmental chamber (12: 12 h [L:D] photoperiod; 25 ± 2 °C; 50 ± 10% RH) until parasitoid emergence. Afterwards, each individual egg in an egg mass was dissected to check for dead immature parasitoids. Determination of parasitoid immature stages was based on descriptions of *Trissolcus basa-*

lis (Wollaston) (Hymenoptera: Scelionidae) immatures in Volkoff and Colazza (1992) and on descriptions of *T. basalis* and *Anastatus reduvii* (Howard) (Hymenoptera: Eupelmidae) every 24 h from oviposition in *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae) eggs to pupation (PGT, unpublished). Parasitoid species that emerged from collected *C. hilaris* egg masses were identified. *Trissolcus* species adults were identified using the Talamas et al. (2015) key. *Anastatus* species adults were identified using the Burks (1967) key. Voucher specimens of parasitoids are deposited in the Florida State Collection of Arthropods, Gainesville, Florida, USA.

DATA ANALYSIS

All data were analyzed using SAS statistical software (SAS 2016). Chi-square analyses were used to compare overall frequency of stink bug species in trap and scout samples (PROC FREQ). Seasonal means for the number of adult stink bugs per trap were calculated (PROC MEANS). For comparison of ground and canopy traps for 2016, stink bug count data were modeled using a Poisson distribution. Generalized linear mixed effects models were fit using PROC GLIMMIX, with the KENWARD-ROGER option and the LINK=LOGIT function specified in the model statement. Model fit was evaluated with the Pearson chi-square/df statistic provided by PROC GLIMMIX (Littell et al. 2006). Fixed effects included trap location (canopy or ground) and stink bug species. Random effects were replicate and residual error. The location by species interaction was insignificant for density data; therefore, the interaction term was excluded from our final model. Means were back transformed using the ILINK option in the LSMEANS statement and compared using Tukey's honestly significant difference (HSD).

Results

STINK BUGS IN PHEROMONE-BAITED TRAPS

The same 4 species of plant-feeding stink bugs, *E. servus*, *E. tristigmus*, *C. hilaris*, and *N. viridula*, were detected on black cherry in pheromone-baited traps every yr of the study. For traps over all yrs, *E. servus* was the most prevalent species (58.2%) followed by *E. tristigmus* (32.6%), *C. hilaris* (6.8%), and *N. viridula* (2.4%) ($\chi^2 = 3159.7$; df = 3; $P < 0.0001$). For scout samples collected in 2016 and 2018, *C. hilaris* and *N. viridula* were the only 2 stink bug species detected. The predominant species was *C. hilaris* (99.2%) ($\chi^2 = 511.1$; df = 1; $P < 0.0001$) followed by *N. viridula* (0.8%). In 2017 scout samples, a single adult *C. hilaris* was detected on the lower limb of a black cherry tree, presumably due to an early-season hard frost that resulted in low fruit production that season.

For pheromone-baited traps, *C. hilaris* nymph:adult ratio was approximately 1:1, but skewed in favor of adults for *E. servus*, *N. viridula*, and *E. tristigmus* (1:207, 1:30, and 1:28, respectively). For 2016 and 2108 visual scout data, more *C. hilaris* nymphs than adults (24:1) were detected on black cherry.

In 2016, both canopy and ground-based pyramid traps captured *E. servus*, *E. tristigmus*, and *C. hilaris*. A single female *N. viridula* was captured in a canopy trap. The total number of stink bugs captured in traps varied by trap location ($F = 52.3$; df = 236; $P < 0.0001$) and stink bug species ($F = 134.72$; df = 236; $P < 0.0001$). The number of stink bugs was significantly higher in ground traps (1.53 ± 0.07) compared to canopy traps (0.71 ± 0.07). In general, more *C. hilaris* nymphs, *E. servus* adults, and *E. tristigmus* nymphs and adults were captured in ground traps than in canopy traps. Significantly more *E. tristigmus* (3.71 ± 0.22) were captured in pyramid traps than *E. servus* (0.66 ± 0.09) and *C. hilaris* (0.45 ± 0.07).

The mean total number of *Euschistus* spp. captured in traps varied across the season and by yr. Overall, in 2016, more adult *E. tristigmus* were captured than *E. servus* adults (Fig. 1A), whereas the reverse was observed in 2017 and 2018 (Fig. 1B, C). In 2017, the mean number of adult *E. servus* captured in traps peaked in Sep and again in mid-Oct through late Nov (Fig. 1B). Adults identified as overwintering were detected in traps from 27 Oct 2017 through the end of the trapping period; 13.8% of the adults during this time were overwintering. In 2018, the mean number of adult *E. servus* peaked in Jun with a peak in Aug similar to the one observed in 2017 (Fig. 1C). In 2017, the mean number of trapped adult *E. tristigmus* steadily increased until mid-Sep, then slightly decreased with a smaller peak in mid-Nov (Fig. 1B). Adults identified as overwintering were detected in traps on 3 and 10 Nov during the last peak; 16.2% of the adults in traps during this time were overwintering. In general, nymphs were captured in lower numbers than adults in pheromone-baited traps (Fig. 1).

CHINAVIA HILARIS IN PHEROMONE-BAITED TRAPS AND TREE CANOPY

Using both types of sampling methods, egg masses, most instars, and both sexes of adults of *C. hilaris* were detected on black cherry each yr (except in 2017 for visual sampling as stated above) (Figs. 2, 3). Across yr, the mean number of adult *C. hilaris* in traps was low during fruit production (Fig. 2), but at times increased later in the yr, likely due to mid-season build-up of populations in adjacent crops and early fall dispersal into the overwintering habitat (Fig. 2). Second instars were present early in the season with nymphal development continuing to fifth instars and new adults for 8 to 9 wk (Fig. 2). In 2016, *C. hilaris* egg masses were detected visually in early season from 19 May through 16 Jun and on 6 and 13 Jun in 2018 (Fig. 3). For both 2016 and 2018, nymphs developed as the fruit matured. All instars and both sexes of adults were observed feeding on fruit. In 2018, timing of presence and development of *C. hilaris* from visual sampling was similar to that for trap data (Figs. 2, 3).

STINK BUG EGG PARASITOIDS

A total of 15 *C. hilaris* egg masses were detected during tree scouting in 2016 (*n* = 5) and 2018 (*n* = 10). The majority of egg masses were found when fruit were immature; however, in 2016, two egg masses were detected on flowering trees (Figs. 2, 3). No *C. hilaris* egg masses were found after the fruit fell from trees. Thirteen of the 15 egg masses were collected; 11 were laid on leaves, 2 on fruit. For the remaining egg masses that yr, parasitism per egg mass averaged 14.4% (0–69.2%). In 2018, average parasitism per egg mass was 33.7% (1–100%). *Anastatus reduvii* (44%), *T. edessae* (35%), and *Ooencyrtus* sp. (21%) emerged from *C. hilaris* eggs.

Discussion

Four stink bug species, *C. hilaris*, *E. servus*, *E. tristigmus*, and *N. viridula* were detected on black cherry trees. However, the presence of *C. hilaris* egg masses and developing nymphs suggests that this tree species is a more significant reproductive host for *C. hilaris* than for the other 3 species. In the current study, *C. hilaris* and *N. viridula* were detected in both pheromone-baited traps and on lower limbs and foliage during visual sampling. However, only 4 *N. viridula* adults, no nymphs, were detected on trees, and mostly adults were captured in traps. In an earlier 2-yr study, an occasional late instar *N. viridula* was found in sweep samples (Jones & Sullivan 1982). Thus, *N. viridula* can reproduce on black cherry, but this stink bug species is likely using black cherry a

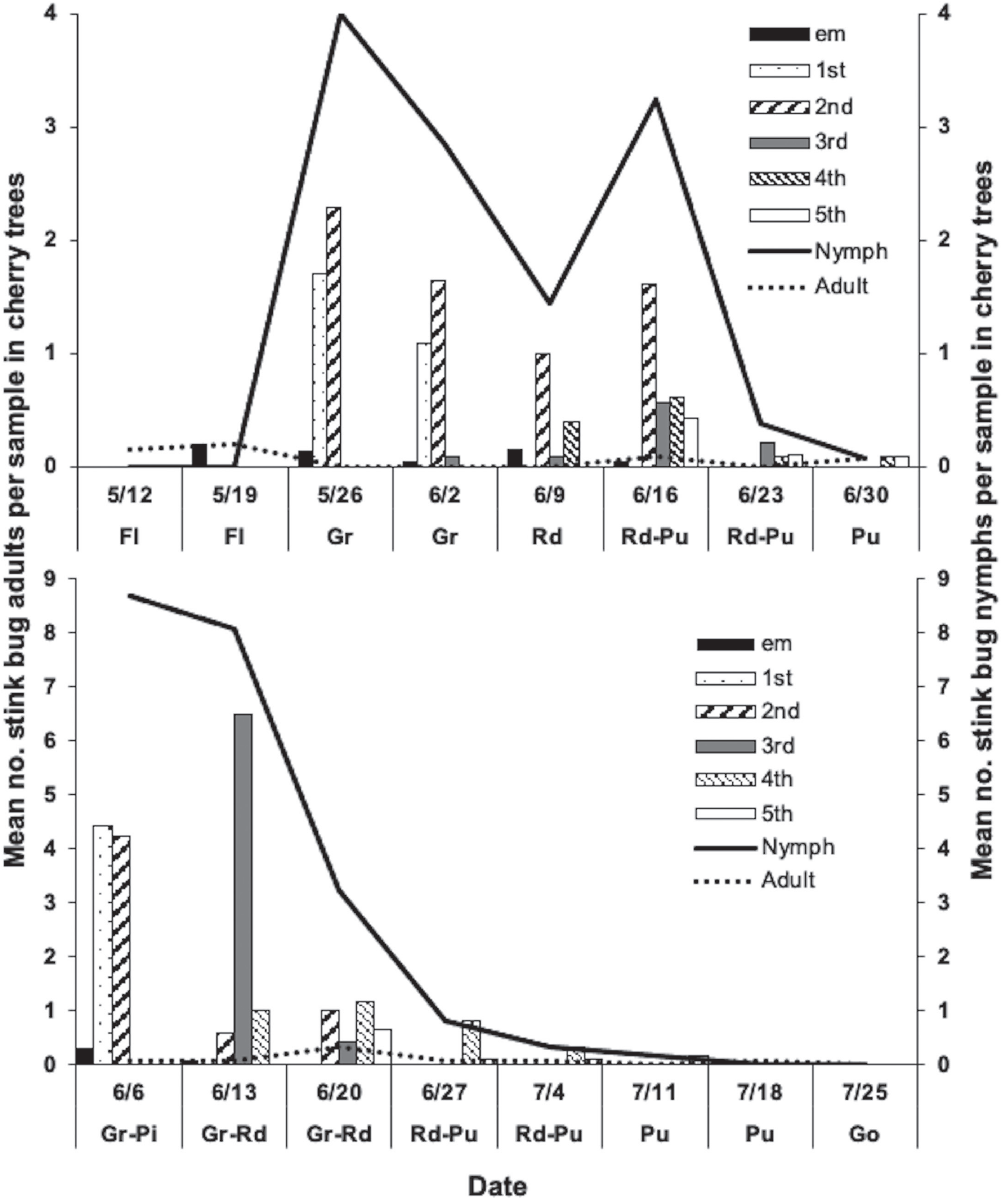

Fig. 1. Mean number of *Euschistus servus* and *Euschistus tristigmus* adults and nymphs captured per pheromone-baited trap in black cherry in 2016 (A), 2017 (B), and 2018 (C).

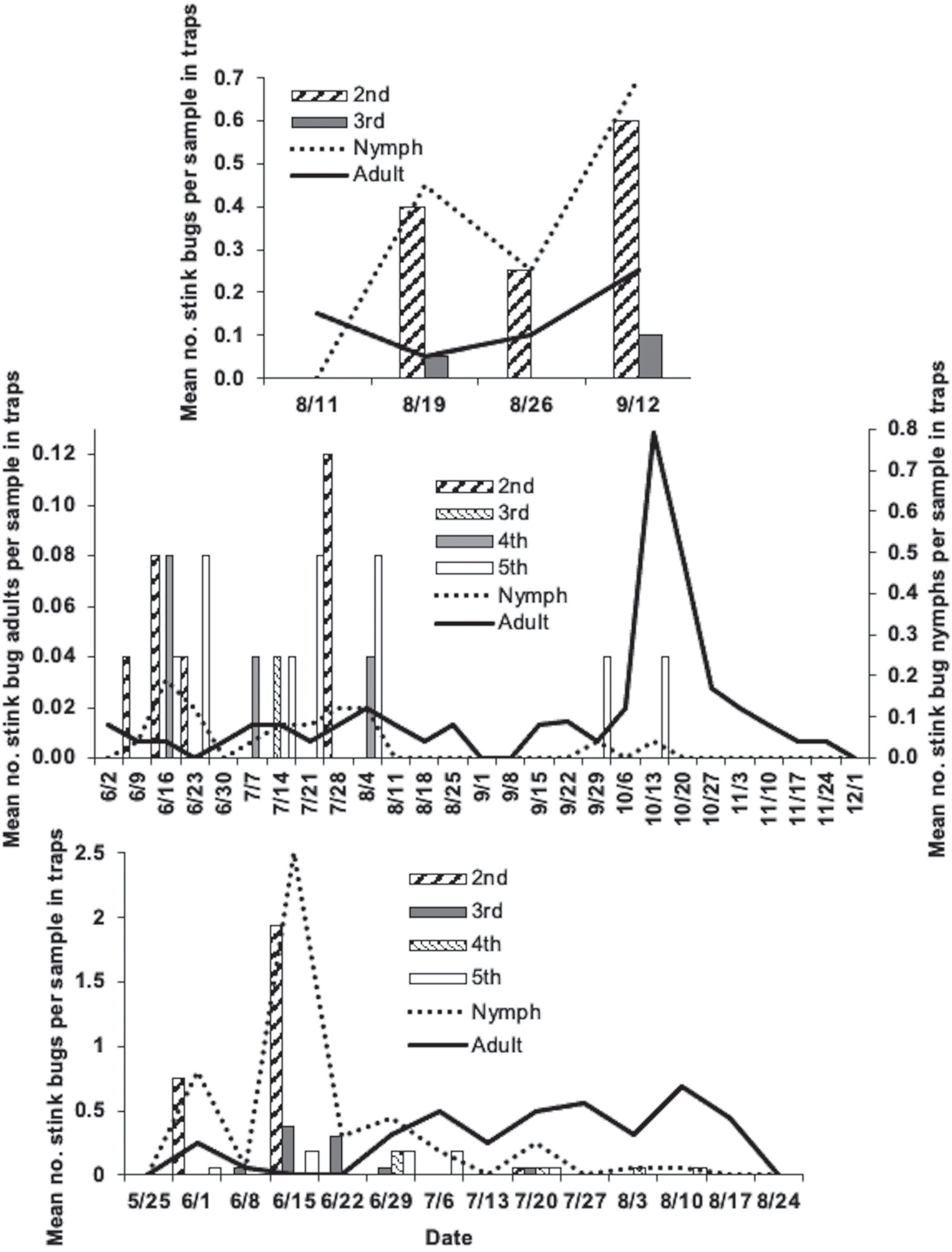

Fig. 2. Mean number of *Chinavia hilaris* adults and nymphs captured per pheromone-baited trap in black cherry in 2016 (A), 2017 (B), and 2018 (C).

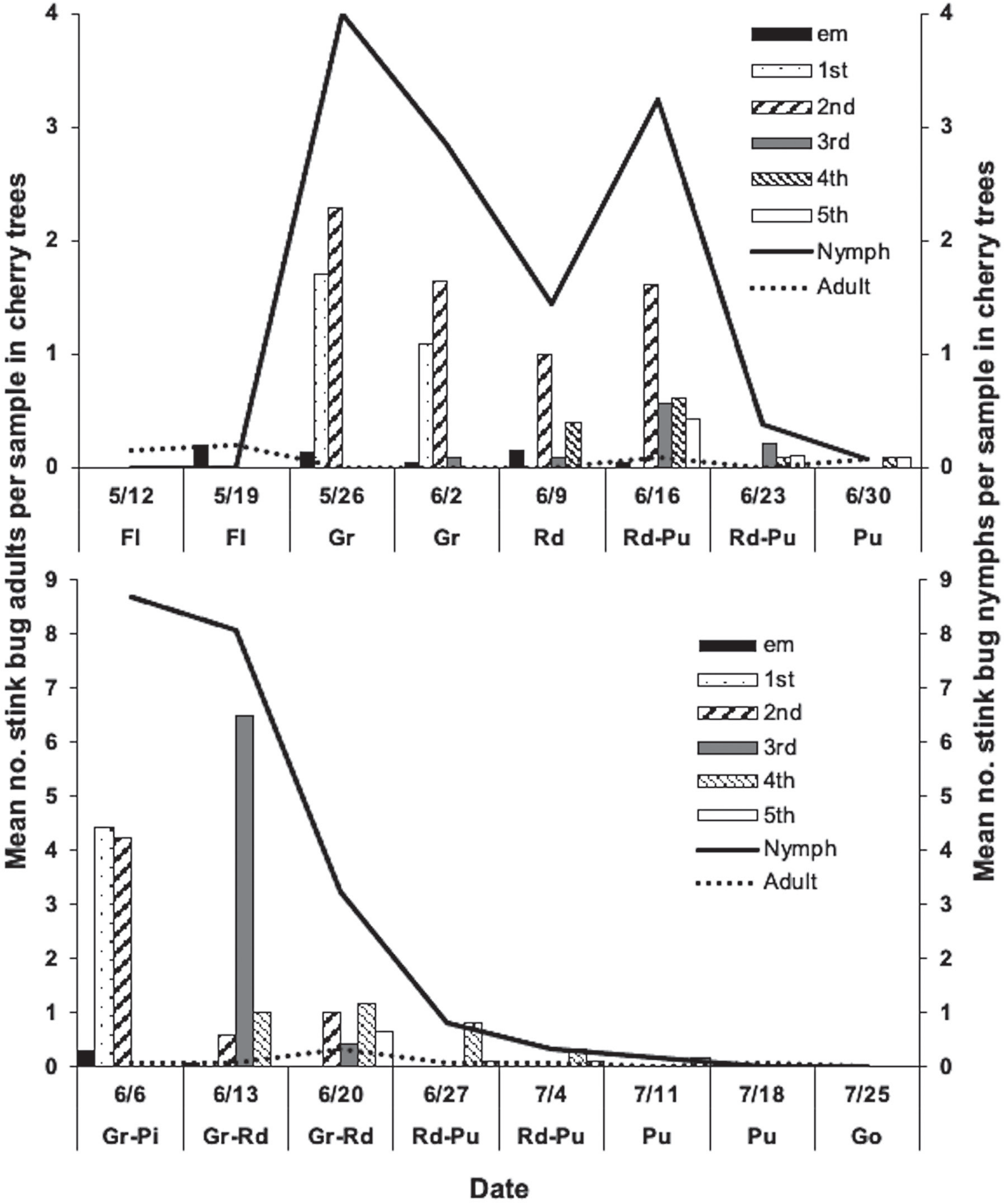

Fig. 3. Mean number of *Chinavia hilaris* adults and nymphs detected per scout sample in black cherry tree in 2016 (A) and 2018 (B). Fl = flowering; Gr = green fruit; Pi = pink fruit; Rd = red fruit; Pu = purple fruit; Go = fruit gone.

source of food for adults rather than a reproductive host. In contrast, *C. hilaris* females oviposited egg masses on black cherry and subsequent nymphs fed and developed on fruit into adults. In addition, the nymph to adult ratio was 1:1 in traps and nymph biased in visual sampling. These results are similar to those reported earlier by Jones and Sullivan (1982). We conclude that black cherry is a reproductive host plant as well as a food source for *C. hilaris* adults in agroecosystems of Georgia. Many of the black cherry trees in our region are located in woodland borders, and as an early-season non-crop host has the potential to be a source of this stink bug into nearby mid-season crops such as cotton. Jones and Sullivan (1982) suggested that early-season development of *C. hilaris* on black cherry and elderberry (*Sambucus canadensis* L.; Adoxaceae) in South Carolina led to large populations of this stink bug species entering mid-season soybean.

Nymphs and adults of *E. tristigmus* and *E. servus* were captured in traps but were not detected in black cherry scout samples. Their presence in traps may be due to a preference for infesting black cherry fruits higher in the canopy of trees rather than those located on lower limbs that were a part of the visual inspection. Alternatively, both species may be highly attracted to the pheromone-baited traps, which were placed higher in the canopy. Although nymphs of both stink bug species were captured in traps, approximately 88% and 99.5% of the *E. tristigmus* captures were adults in 2016 and 2017, respectively; no nymphs were captured in 2018. For *E. servus*, less than 4% of the individuals captured were nymphs. In South Carolina, black cherry was reported to be a host plant of *E. servus*, but no information on nymphal development of this stink bug species was presented, and no *E. tristigmus* were detected (Jones & Sullivan 1982). We conclude that both *Euschistus* species can develop on black cherry, but this tree likely serves more as a food source than a reproductive host for the 2 species.

Interestingly, the number of stink bugs were higher in ground traps compared to canopy traps. Therefore, ground traps may be better for estimating the relative abundance of stink bugs on trees in agroecosystems. Indeed, in general, ground traps are used for monitoring stink bugs in agricultural landscapes (Mizell & Tedders 1995; Cottrell et al. 2000; Johnson et al. 2002; Leskey & Hogmire 2005; Tillman & Cottrell 2016b). A recent study has shown that the influence of trap height, including on the ground and at various heights within the tree canopy, on trap capture can vary by stink bug species (TEC, unpublished). However, if the goal is to document occurrence and timing of development of stink bugs in trees, canopy traps should be used because stink bug nymphs from other non-crop hosts on the ground can crawl into the ground traps (Tillman & Cottrell 2016c). Also, many growers in this region are averse to using ground traps to monitor stink bugs because they interfere with regular agronomic practices in or near crops. Numerically higher numbers of *C. hilaris* and *E. tristigmus* nymphs were present in ground traps versus canopy traps. This may be due to nymphs that drop out of trees and enter ground traps or nymphs that develop on nearby non-crop hosts and are subsequently captured in ground traps. In 2016, more *E. tristigmus* were captured in traps compared to the other stink bug species captured. However, this difference in trap capture by stink bug species may change over yr; for example *E. servus* generally was higher than *E. tristigmus* in traps in 2017 and 2018 during a similar span of time traps were deployed in 2016.

In 2017, overwintering individuals of *E. servus* and *E. tristigmus* were detected in traps late season, and trap capture for both species increased during this time period. This pattern indicates that overwintering adults of these stink bug species likely disperse into woodland edges with black cherry trees late season. The percentage of overwintering individuals in late-season traps was similar for both stink bug species. In an earlier study on overwintering habitat preferences by stink bug species (Jones & Sullivan 1981), *E. servus* adults preferred to overwinter in open habitats, whereas *E. tristigmus* adults overwintered inside and along borders of deciduous woods (Jones & Sullivan 1981). Similarly, in a recent study in peach landscapes, *E. servus* was found commonly in peach orchards while *E. tristigmus* tended to prefer woodland habitats (Grabarczyk et al. 2021).

The influence of woodland habitats on stink bug density in crops has been investigated previously for several stink bug species. For native stink bugs and the invasive brown marmorated stink bug, *H. halys*, colonizing adults are frequently more common near woodland edges than in field interiors (Olson et al. 2012; Tillman et al. 2014; Venugopal et al. 2014). Non-crop hosts which support reproductive populations of stink bugs are present in woodlands (Jones & Sullivan 1982; Nielsen & Hamilton 2009; Tillman & Cottrell 2016a; Tillman 2019). Thus, wooded habitats with non-crop hosts play an important role in serving as sources of stink bug populations that colonize crops. In addition, diversity of egg parasitoids and percentage of parasitism can be higher in woodland habitats compared with those observed in crops (Cornelius et al. 2016; Tillman 2016; Dieckhoff et al. 2017; Jones et al. 2017; Tillman et al. 2020). In the current study, parasitism per egg mass averaged 14.4 and 33.3% in 2016 and 2018, respectively. Previous studies have shown that *T. edessae* is the primary parasitoid species emerging from wild eggs of *C. hilaris* in non-crop host plants in woodlands (46% parasitism per egg mass) and late season crops like soybean and cotton (21% parasitism per egg masses) in the southeast (Tillman 2016, 2019; Tillman & Cottrell 2016a). *Anastatus reduvii* also frequently parasitizes *C. hilaris*, as well as *E. servus* and *H. halys*, in woodlands in the southeast (Tillman 2016, 2019; Tillman and Cottrell 2016a; Tillman et al. 2020). Previous studies reported high emergence of *Anastatus* spp. from *H. halys* eggs in other regions of the US (Cornelius et al. 2016; Dieckhoff et al. 2017; Jones et al. 2017). Thus, parasitism of stink bug egg masses in woodlands potentially can reduce the population of stink bugs dispersing into crops, especially if provided additional food and shelter resources.

In summary, black cherry is a significant reproductive non-crop host as well as a source of food for *C. hilaris* in the southeast US. *Nezara viridula* likely is using black cherry as a source of food for adults. Populations of *E. servus* and *E. tristigmus* can develop on black cherry. However, the majority of individuals captured in pheromone-baited traps were adults, indicating that black cherry is serving more as a food source for these 2 stink bug species in woodlands.

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