Sweepnet Captures of *Lygus hesperus* (Hemiptera: Miridae) Adult Genders and Age-Classes in Cotton[1]

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Abstract Management of the western tarnished plant bug, *Lygus hesperus* Knight, in cotton usually relies on population estimates obtained using the sweepnet. Recent studies indicated adult *L. hesperus* gender and physiological age influence feeding behavior, within-plant distribution, and injury to cotton. Whether these differences in behavior also influence capture by the sweepnet is not known. We evaluated the sweepnet for sampling *L. hesperus* adults of known gender and age class in Pima and Acala Upland cotton. Adults of 4 classes (females, prereproductive or reproductive; males, prereproductive or reproductive) marked with fingernail polish to prevent flight were released into assigned sample rows. Captures of marked adults declined seasonally in all experiments. In Pima cotton, the sweepnet was least effective for sampling prereproductive female *L. hesperus*, and most effective for collecting reproductive males. Captures of reproductive females and prereproductive males were intermediate. We suggest the influence of adult gender and age class on sweepnet captures in Pima cotton corresponds to a propensity for prereproductive adults to reside within plant terminals substantially shielded by foliage. Similar differences in Upland cotton were not observed, probably because the comparatively open structure of the Upland terminal minimized the effects of gender and age class on collection efficiency. Finally, dissection of native *L. hesperus* indicated an age structure dominated by reproductive maturity. Therefore, future mark-release-recapture studies of factors influencing sweepnet sampling for *L. hesperus* adults in cotton may maximize relevance by focusing on reproductively mature adults.

Key Words western tarnished plant bug, *Lygus hesperus*, sampling efficiency, reproductive development

The plant bug complex (western tarnished plant bug, *Lygus hesperus* Knight, in the West; tarnished plant bug, *Lygus lineolaris* [Palisot de Beauvois], in the MidSouth) is the most important insect pest complex in U.S. cotton (*Gossypium* spp.; Williams 2009). Efforts to manage lygus in cotton are primarily based on conventional chemical controls applied according to nominal treatment guidelines. Improvements in lygus management strategies will require increased knowledge of the mechanisms, timing, and consequences of lygus feeding, combined with better understanding and interpretation of population estimates obtained by standard sampling methods.

Several reports attempt to relate lygus population estimates from relative sampling methods to those obtained by absolute methods (Byerly et al. 1978, Ellington et al.

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1984, Fleischer et al. 1985, Snodgrass and Scott 1997, Zink and Rosenheim 2004). However, respective results of those studies are not directly comparable because of differences in experimental procedures. More recent studies have used a mark-release-recapture approach to estimate sweepnet collection efficiency (the proportion of insects present that are captured) for adult lygus and to correlate captures with known population levels (Spurgeon 2009). Compared with approaches relying on naturally-occurring insect populations, in which differences among experimental units (sampled areas) in population density are unknown, the mark-release-recapture method allows establishment of experimental units with equivalent populations. This ability has facilitated examination of factors influencing sweepnet captures of lygus adults, such as the interval between bug release and sampling (Cooper and Spurgeon 2010) and the extent of variation among samplers (Spurgeon and Cooper 2011). Because the mark-release-recapture approach allows control of experimental populations, it seems particularly well suited to studies of the influences of insect behavior or physiological condition on population estimates.

Lygus injure cotton by inducing shed of flower buds (squares) and fruit (bolls) (Scales and Furr 1968, Maredia et al. 1994). Although the relationships between lygus stage or population level and injury to cotton have been extensively studied (Jubb and Carruth 1971, Gutierrez et al. 1977, Mauney and Henneberry 1979, Armstrong et al. 2005, Zink and Rosenheim 2005, Rosenheim et al. 2006), results have been highly variable. Cooper and Spurgeon (2011) documented differences in feeding behavior and trivial movement among classes of adult lygus representing combinations of gender and physiological age class (reproductive state), and suggested these differences may have contributed to the variability in earlier studies. Subsequent greenhouse experiments using intact plants demonstrated differences in within-plant distribution and plant injury among combinations of adult gender and age class, that were consistent with previously observed differences in behavior (Cooper and Spurgeon 2012). Recognition of these differences suggested that the sweepnet may not sample the respective adult classes with equivalent effectiveness. Therefore, our objective was to determine whether adult *L. hesperus* physiological age and gender influence population estimates obtained by the sweepnet in cotton.

Materials and Methods

Experimental design. Three separate studies were conducted in fields of Pima (*G. barbadense* L.) and Acala Upland (*G. hirsutum* L.) cotton. Study fields were planted to 1.02-m rows on raised beds and were furrow irrigated as needed. The 2010 study was conducted in the Pima cultivar PHY800 (Dow AgroSciences, Indianapolis, IN) planted on 6 May, and 2011 studies were conducted in the Pima cultivar PHY805RF and the Acala Upland cultivar PHY725RF, both planted on 26 April. No insecticides were applied during the studies.

Each experiment used a randomized block design with 3 replications on each sample date. Experimental treatments included the 4 combinations of adult lygus gender and physiological age class (prereproductive, reproductive), and sample date. Physiological age class was based on seminal vesicle condition in males, and ovary condition in females. Reproductive males had seminal vesicles that were filled or distended with sperm; whereas, the ovaries of reproductive females contained at least oocytes with yolk, and most contained eggs (Spurgeon and Cooper 2012). Males or females exhibiting earlier stages of reproductive development were classified as prereproductive.

Sampling areas (blocks) were composed of 20 adjacent 10-m long row sections. Each block within a field was separated from the field margin by ≥4 rows, and from each other by a 2-m long alley from which plants were removed. A given row was sampled only once during the experiment. Therefore, 4 - 5 blocks were established in each field to ensure the availability of sample rows that contained plants of similar size and development within a block on each date.

Experimental insects, marking procedure, and releases. Adult *L. hesperus* of known gender and age class (reproductive status) were obtained from a laboratory colony reared on pods of green bean (*Phaseolus vulgaris* L.) and raw sunflower seeds (*Helianthus annuus* L.). Insects in the colony originated from local fields of alfalfa (*Medicago sativa* L.) and were ≤6 generations removed from the field population. Temperature conditions during rearing varied daily from ≈26 - 30°C, and a photoperiod of 14:10 (L:D) h was provided by fluorescent lights.

To ensure experimental insects were of known age, each collection of adults for release followed a day on which all adults were removed from the colony. On the day of collection, experimental insects were considered to be 0- to 1-d old. When production by the colony was sufficient to provide the needed insects in a period of ≤2 days, adult *L. hesperus* assigned to the reproductive class were held in mixed-sex groups of <300 insects within 3.78-L plastic rearing buckets with shredded paper and green bean pods. The reproductive insects were held in an environmental chamber at 27 ± 1°C with a photoperiod of 14:10 (L:D) h until release 7 - 10 d after their collection. Insects assigned to the prereproductive class were similarly held but at a temperature of 23.9 ± 1°C, and were separated into single-sex groups when they were marked 1 - 2 d before sampling. These prereproductive insects were moved to an environmental chamber maintained at 27 ± 1°C on the morning of the day of release into the field, which was ≤4 days after their collection. When colony production did not permit collection of the needed insects over a short period of time, adults assigned to either age class were collected and pooled in environmental chambers maintained at 12.8 ± 1°C. Adults were accumulated and maintained at this temperature for ≤5 days. The respective groups were then transferred to their assigned temperature regimes as previously described.

Adults were marked on the dorsum with colored fingernail polish 1 - 3 d before release. A given color was used only once in each sample area. To facilitate marking, aliquots of 5 - 10 adults were aspirated into plastic vials with screened lids. The insects were lightly anesthetized with CO_2 and then decanted into the bottom of a 100 × 15-mm Petri plate lined with moistened filter paper. The moistened filter paper minimized the frequency with which freshly-marked insects became glued to the Petri plate. Anesthetized adults were positioned to provide access to the dorsum, and a small drop of polish was applied near the posterior tip of the scutellum. The drop of polish contacted both wings so as to prevent flight. Newly-marked adults were separated by gender, covered with a screened lid, and set aside to dry. All insects released on a single date were marked with the same color, except that males received a second mark (a small white dot) within the first mark. The second mark allowed males and females to be distinguished when they were aspirated for release.

Beginning ≈2 h before insects were released, 10 marked adult *L. hesperus* of each combination of gender and age class were aspirated into each of 18 - 20 labeled plastic vials (55.5-ml, No. 55 - 15, Thornton Plastics, Salt Lake City, UT). Each vial contained a section of green bean pod and was closed with a plastic lid penetrated by a hole (≈0.8 cm diam) near the rim of the lid. The hole was closed with a rubber stopper until the insects were released.

On each sample date, each combination of gender and age class was randomly assigned without replacement to a single row in each of 3 sampling areas (blocks) within a field. Treatment assignments, however, stipulated that adjacent rows were not used on the same date. A population density of 5 adults per row meter (50 adults per row) was used on all sample dates. Vials of marked insects, segregated by gender and age class, were packaged into labeled paper bags, which were transported to the field in an insulated cooler. Beginning after 1900 h (PDT), marked adults were released onto upper leaves at locations spaced as evenly as possible within each assigned row. Marked *L. hesperus* that were dead, injured, missing appendages, or that were not clearly marked, were immediately destroyed and replaced.

As marked insects were released into sample rows, four 1-m sections of row (retention rows) were selected near the sample area based on similarity of plant size and development to the sampled rows. Plants immediately adjacent to each 1-m row section were removed so that each retention row was separated by ≈1 m from other plants in the same row. After marked insects were released into the 10-m sample rows, 10 marked adults (5 of each gender) were released into each 1-m retention row section. Two retention row sections were assigned to each prereproductive adults and reproductive adults.

Collection of sampling data. Between 0900 - 1000 h on the morning following insect release, each assigned row was sampled with 10 pendulum sweeps using a standard 38-cm diameter sweepnet. Contents of each 10-sweep sample were placed in a labeled sealable plastic bag, which was held in an insulated cooler until it was transported to a refrigerator in the laboratory. Marked *L. hesperus* adults were counted and dissected in the laboratory to determine mating status and age class. In both 2011 studies, unmarked (native) adults were also dissected for comparison with age classes of marked adults.

Collected adults were dissected in saline (0.7% NaCl [wt:vol]). When the abdominal cuticle was soft, as is typical of prereproductive adults, the dissection procedure described by Spurgeon and Brent (2010) was used. In this method the dorsal plate and alimentary canal are removed to permit observation of the reproductive organs. When the abdominal cuticle was sufficiently sclerotized, the terminal abdominal segments were grasped and separated from the insect to expose the reproductive organs. Mating status of females was recorded in addition to ovary condition. Females were classed as mated if evidence of a spermatophore was observed within the seminal depository; otherwise they were classed as unmated.

Concurrent with sweepnet sampling, the 1-m retention rows were visually searched for marked adults. On most sample dates, searches for marked insects were not discontinued until the plants had been dissected and the surrounding soil surface was examined. Marked insects were recorded as dead or alive at the time of recovery.

Immediately after sweepnet sampling, data were collected to characterize plant phenology. At 5 locations evenly spaced within each sampled row a measure of plant height (mainstem length from the soil surface to the terminal), mainstem node number (considering the hypocotyl as node 0 and counting to the uppermost expanded leaf), canopy width, and fruiting stage (pinhead, matchhead, or 1/3-grown square, white bloom, boll) was recorded. A square in which the bud, excluding the bracteoles, was ≥6 mm in diameter was recorded as a 1/3-grown square. A matchhead square was smaller than a 1/3-grown square, but the bud diameter was ≥3 mm. Squares smaller than matchhead were recorded as pinhead.

Statistical analyses. Data from the 3 experiments were analyzed separately using SAS (SAS Institute 2008). Counts of marked adult *L. hesperus* from the sweepnet samples were analyzed by mixed model ANOVA (PROC GLIMMIX) using experimental treatment (combinations of insect gender and age class), sample date, and their interaction as fixed effects, and sample area (block) as a random effect. Means corresponding to levels of main effects were separated using the ADJUST=SIMULATE option of the LSMEANS statement, and numerator degrees of freedom were corrected using the Kenward-Roger adjustment. The mean counts of marked adults recaptured on each sample date were then used to calculate sweepnet collection efficiency (the number of marked adults recaptured divided by the expected number in 3.8 m of row). In addition, recovery of living marked adults from the 1-m retention rows, expressed as a proportion of the number of insects that were released, was calculated for each sample date.

In each experiment, associations between age class of marked adults determined by dissection, and assigned age class, were compared separately for *L. hesperus* genders using the Cochran-Mantel-Haenszel general association statistic (*Q*, PROC FREQ). Unmarked (native) insects in the 2011 studies were included as a separate age class in these analyses for comparison with the marked insects. For female *L. hesperus*, similar tests examined the association between assigned age class and mating status.

Finally, patterns of cotton plant growth and development were characterized by calculating means of plant height, canopy width, and numbers of mainstem nodes for each sample date. Corresponding phenological stages (pinhead, matchhead, or 1/3-grown square, white bloom, boll) were calculated based on medians.

Results and Discussion

Retention and reproductive condition of released insects. Recovery of marked adult *L. hesperus* from 1-m retention rows was generally high in the 3 studies. Recovery was as low as 60% for any combination of adult gender, age class, and sample date in only 4% (Pima in 2011) to 10% (Acala in 2011) of the samples. Recovery was ≥80% for combinations of gender, age class, and sample date in 67% of samples from the Pima field in 2010, 87.5% of samples from Pima cotton in 2011, and 75% of samples from Acala cotton in 2011. Overall recovery ranged from 83% (Acala in 2011) to 87.5% (Pima in 2011) for prereproductive marked adults and from 78.3% (Pima in 2010) to 88.3% (Pima in 2011) for reproductive adults. No patterns were observed to suggest a systematic loss of marked insects of either gender or age class. Recovery of marked adult *L. hesperus* in this study was similar to that reported by Cooper and Spurgeon (2010) and Spurgeon and Cooper (2011). Because retention of marked insects was generally high, there was no basis for adjusting numbers of insects captured by the sweepnet, or for excluding any sample dates before analysis of insect captures.

Dissections of recaptured marked adult *L. hesperus* from the 2010 study in Pima cotton indicated clear distinctions in the extent of reproductive development exhibited by the respective age classes (female, $Q = 72.0$, df = 1, $P < 0.01$, $n = 82$; male, $Q = 63.4$, df = 1, $P < 0.01$, $n = 106$; Table 1). Likewise, >80% of female adults assigned to the reproductive age class were mated whereas none of the females designated as prereproductive were mated ($Q = 63.4$, df = 1, $P < 0.01$, $n = 82$).

In the 2011 study in Pima cotton, dissections again indicated clear distinctions in reproductive development between adults designated as prereproductive and adults

Table 1. Percentages of marked and native *L. hesperus* adults characterized as reproductive (both genders) or mated (females) according to designated physiological age classes, from sweepnet collections in Pima and Acala cotton, Shafter, CA, 2010 and 2011.

		Pima 2010		Pima 2011		Acala 2011	
Gender	Age class*	% reproductive	% mated	% reproductive	% mated	% reproductive	% mated
Female	PR	4.0	0	0	0	8.2	3.1
	R	98.2	80.4	95.0	73.1	92.9	79.8
	N	–	–	95.6	87.0	90.2	88.2
Male	PR	6.7	–	0	–	27.0	–
	R	85.2	–	99.1	–	98.8	–
	N	–	–	96.6	–	96.6	–

*Assigned physiological age classes were PR, prereproductive; R, reproductive; and N, native insects.

assigned to the reproductive class, or native (unmarked) adults (female, $Q = 203.8$, df = 2, $P < 0.01$, $n = 232$; male, $Q = 228.6$, df = 2, $P < 0.01$, $n = 243$; Table 1). A similar association with age class was observed for mating in females ($Q = 126.8$, df = 2, $P < 0.01$, $n = 232$), where none of the females designated as prereproductive were mated but ≈73 and 87% of reproductive and native adults, respectively, were mated.

In the 2011 study in Acala cotton, the frequency with which marked adults designated as prereproductive exhibited reproductive development appeared higher than in the studies in Pima cotton, especially for males (Table 1). Also, reproductive development was observed slightly less often in marked adults designated as reproductive, and in native adults, compared with the other studies. However, substantial differences in the extent of reproductive development between the assigned age classes remained (female, $Q = 170.6$, df = 2, $P < 0.01$, $n = 247$; male, $Q = 151.0$, df = 2, $P < 0.01$, $n = 262$). Associations of mating with female adult age class were similar to those observed in the other studies ($Q = 148.9$, df = 2, $P < 0.01$, $n = 243$; Table 1). Therefore, distinct differences in the occurrence of reproductive development and mating observed between age classes, combined with the generally high retention of marked adults, indicated the objective of establishing equivalent populations representing combinations of adult gender and age class was achieved.

Sweepnet captures of marked adult *L. hesperus*. Analyses of numbers of marked adult *L. hesperus* captured per 10-sweep sample indicated a general decline in collection efficiency with increasing plant development in all 3 studies (Table 2). In the 2010 study in Pima cotton, this decline was significant ($F = 8.70$; df = 2, 24; $P < 0.01$) despite delayed development of fruiting forms caused by poor square retention early in the fruiting cycle (Table 2). Similar declines in captures of marked insects with increasing sample date were observed in 2011 studies in Pima ($F = 3.58$; df = 5, 36.1; $P < 0.01$) and Acala cotton ($F = 7.31$; df = 5, 39.8; $P < 0.01$). Fruiting phenology in the 2011 studies was more typical of production fields than in 2010, and the Acala plants tended to be larger than the Pima plants throughout the experiment (Table 2).

It is intuitive that collection efficiency of a sampling tool of fixed size (38-cm diam sweepnet) should decline as the sampled substrate becomes more voluminous and complex. In the present study, Pima plants tended to be shorter, but with wider canopies relative to plant height, than were Acala plants. Furthermore, the 2 Pima fields differed substantially in plant height at equivalent stages of fruiting phenology (Table 2). Despite these differences, roughly similar trends representing a seasonal decrease in sampling efficiency were observed in the 3 study fields. Spurgeon and Cooper (2011) used plant height, canopy width, and the plant height to canopy width ratio, as proxies for sample date in an attempt to identify the plant parameters most responsible for seasonal declines in sweepnet collection efficiency. They concluded that none of the plant parameters examined was as effective as sample date for partitioning this important source of experimental variation. Although the specific factors controlling seasonal changes in sweepnet collection efficiency remain unknown, the seasonal declines in sweepnet collection efficiency observed in the present studies were consistent with those reported by Spurgeon and Cooper (2011).

In addition to a seasonal change in sweepnet sampling efficiency, captures of marked adults also varied among treatment groups, defined by combinations of adult gender and age class, in the 2010 study in Pima cotton ($F = 5.37$; df = 3, 24; $P < 0.01$). The absence of a significant interaction between sample date and treatment group ($F = 1.91$; df = 6, 24; $P = 0.12$) suggested the differences attributed to treatment group were relatively consistent among sample dates. Multiple comparisons among treatment

Table 2. Mean numbers* of marked *L. hesperus* adults captured, corresponding estimated sweepnet collection efficiency (%), and measures of plant growth and development by sampling date in Pima and Acala cotton, Shafter, CA, 2010 and 2011.

Study	Date	No. marked** *L. hesperus*	Collection efficiency (%)	Plant height (cm)	Canopy width (cm)	No. nodes	Growth stage†
2010	24 Jun	6.8 (0.64) a	36	24.9 (0.46)	28.0 (0.86)	8.5 (0.17)	PH
Pima	2 Jul	6.3 (0.64) a	33	31.8 (0.68)	41.0 (1.01)	10.5 (0.20)	PH
	21 Jul	3.3 (0.64) b	17	59.1 (1.28)	75.1 (2.21)	15.0 (0.25)	TG
2011	16 Jun	7.3 (0.66) a	38	18.6 (0.44)	19.2 (0.72)	7.4 (0.11)	PH
Pima	23 Jun	5.5 (0.66) ab	29	24.0 (0.50)	23.7 (1.11)	9.0 (0.22)	MH
	30 Jun	7.7 (0.66) a	41	27.7 (0.78)	27.9 (0.95)	10.3 (0.16)	MH
	8 Jul	5.6 (0.66) ab	29	35.7 (1.38)	41.6 (1.80)	12.3 (0.23)	TG
	15 Jul	6.3 (0.66) ab	33	44.8 (1.54)	53.0 (3.10)	13.8 (0.20)	BL
	27 Jul	4.4 (0.66) b	23	48.2 (1.53)	57.0 (2.69)	14.8 (0.25)	BO
2011	14 Jun	8.3 (0.66) a	44	21.8 (0.68)	18.6 (0.52)	8.1 (0.13)	PH
Acala	22 Jun	7.5 (0.66) ab	39	36.4 (0.96)	33.7 (0.99)	10.5 (0.12)	MH
	29 Jun	5.2 (0.66) bc	27	49.6 (1.07)	46.6 (1.79)	12.5 (0.12)	MH
	7 Jul	5.4 (0.66) bc	28	64.6 (1.43)	62.2 (1.59)	14.0 (0.16)	TG
	14 Jul	5.7 (0.66) abc	30	74.6 (2.31)	72.5 (2.67)	15.2 (0.23)	BL
	21 Jul	3.3 (0.66) c	17	82.8 (1.80)	79.7 (2.38)	17.3 (0.20)	BO

*Means of numbers of marked *L. hesperus*, plant height, canopy width, and numbers of mainstem nodes are followed by (SE).

**Means followed by the same letter within a study are not statistically different ($\alpha = 0.05$, SIMULATE option of the SAS LSMEANS statement).

†Cotton growth stages were PH, pinhead square; MH, matchhead square; TG, third-grown square; BL, white bloom; and BO, boll.

groups, adjusted for multiplicity, indicated that prereproductive females were captured less frequently than were reproductive adults of either gender (Table 3). Although the mean number of captured prereproductive males was not statistically different from means for any other gender by age class group, it was intermediate to the means for prereproductive females and reproductive adults of either gender (Table 3).

The 2011 study in Pima cotton also indicated a significant influence of *L. hesperus* gender by age class group on capture by the sweepnet ($F = 6.28$; df = 3, 45.1; $P < 0.01$; Table 3). Examination of treatment group means indicated the numbers of captured prereproductive females or males were less than for reproductive males. Captures of reproductive females were not significantly different from captures of other groups, but were intermediate to those of prereproductive adults and reproductive males (Table 3). Although the interaction between sample date and the combination of gender and age class was not significant ($F = 1.73$; df = 15, 45.1; $P = 0.08$), it suggested the influence of gender and age class group varied among dates. Examination of slices of this interaction implied the differences among sample dates in captures of marked adults were greater for reproductive females ($F = 3.83$; df = 5, 46.1; $P < 0.01$) and males ($F = 2.64$; df = 5, 46.1; $P = 0.04$) than for prereproductive adults of either gender (female, $F = 1.88$; df = 5, 46.1; $P = 0.12$; male, $F = 0.75$; df = 5, 46.1; $P = 0.59$).

In contrast to the studies in Pima cotton, counts of marked adult *L. hesperus* from Acala cotton in 2011 did not indicate a significant influence of gender by age class group ($F = 0.86$; df = 3, 45.7; $P = 0.47$; Table 3). An influence of treatment group that varied among sample dates could go undetected by the main effect test. However, this possibility was not supported by the data because the interaction between sample date and treatment group was not significant ($F = 1.60$; df = 15, 45.7; $P = 0.11$).

Based on these results, *L. hesperus* adult gender and age class influenced captures by the sweepnet in Pima, but not in Acala cotton. Results of mean separations corresponding to combinations of adult gender and age class were not exactly the same between the two studies in Pima cotton (Table 3). However, the rankings of means corresponding to treatment groups were identical in both studies, as was the tendency for higher captures of reproductive male *L. hesperus* compared with prereproductive females.

Table 3. Mean numbers* of marked *L. hesperus* adults representing combinations of gender and age class captured by sweepnet from Pima and Acala cotton, Shafter, CA, 2010 and 2011.**

		No. marked *L. hesperus*		
Gender	Age class*	Pima 2010	Pima 2011	Acala 2011
Female	PR	3.1 (0.74) b	5.1 (0.54) b	5.5 (0.54)
	R	6.4 (0.74) a	6.6 (0.54) ab	5.5 (0.54)
Male	PR	5.4 (0.74) ab	5.2 (0.54) b	6.2 (0.54)
	R	7.0 (0.74) a	7.7 (0.54) a	6.4 (0.54)

*Mean numbers of marked *L. hesperus* are followed by (SE). Means followed by the same letter within a column are not statistically different ($\alpha = 0.05$, SIMULATE option of the SAS LSMEANS statement).

**Assigned physiological age classes were PR, prereproductive; R, reproductive; and N, native insects.

Cooper and Spurgeon (2011) demonstrated in laboratory feeding assays that prereproductive *L. hesperus* adults of both genders fed more and exhibited less trivial movement compared with reproductive adults. Subsequent greenhouse studies on intact plants indicated prereproductive adults were nearly 3 times as likely as reproductive adults to reside on axillary buds, squares, or plant terminals (as opposed to stems, petioles, or leaves) (Cooper and Spurgeon 2012). In addition, adult females were twice as likely to be on buds or terminals compared with males (Cooper and Spurgeon 2012). These observations motivated the present study, as we suspected sweepnet collection efficiency would be lower for adults spending more time feeding on buds and less time other plant parts, and higher for adults frequenting more exposed plant structures (leaves, petioles, and stems). These presumptions appear reasonable given our results for Pima cotton, but not for Acala cotton.

Failure to observe a significant influence of the combination of *L. hesperus* adult gender and age class on captures by the sweepnet in Acala cotton may be explained by the plant architecture of the variety that we used. Compared with the Pima plants, the Acala plants tended to be taller and with narrower canopies. These observations were consistent with those of Spurgeon and Cooper (2011). Additional differences in plant structure between the Acala and Pima plants were not measured, but were apparent to casual observation. Compared with Acala plants, the upper leaves of Pima plants tended to be larger, and had petioles that were longer and more erect. Leaf size and petiole length of Acala plants increased more gradually with increasing distance from the terminal. These respective arrangements of foliage caused the terminals of Pima plants to be more sheltered by foliage compared with terminals of the Acala plants. Therefore, we hypothesize that differences in architecture between Pima and Acala plants were likely responsible for the observed differential influences of *L. hesperus* adult gender and age class on sweepnet collection efficiency.

In summary, we conclude that seasonal declines in sweepnet collection efficiency for adult *L. hesperus* in cotton should generally be expected, although the exact mechanisms for this decline are not known. In addition, gender- and age class-specific differences in adult *L. hesperus* behavior influence collection efficiency by the sweepnet in Pima cotton, but not necessarily in Acala cotton. These findings suggest basic differences in the dynamics of sweepnet sampling in Pima and Upland cottons that may ultimately justify cotton species-specific sampling procedures. Finally, dissection of native *L. hesperus* indicated the age structure of the natural adult population in cotton not disrupted by pesticides is dominated by reproductively mature individuals. Therefore, future mark-release-recapture studies of biotic and abiotic factors influencing sweepnet sampling for *L. hesperus* adults may minimize experimental error and maximize relevance by focusing on reproductively mature adults.

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