Autumnal Populations of Arthropods on Aster and Goldenrod in the Delta of Mississippi[1]

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ABSTRACT During the period 30 September to 22 October 1986, 8054 arthropods were captured by sweepnet on flowering *Aster pilosus* (aster) and *Solidaqo altissima* (goldenrod). The principal species captured were two Miridae (Heteroptera): the tarnished plant bug (TPB), *Lygus lineolaris* (22%), and *Taylorilygus pallidulus* (TPAL) (22 %). Phytophages, most of which were mirids, represented 77 % of the assemblage. TPB was twice as abundant as TPAL on aster; the opposite was true on goldenrod. These two mirid species represented 74 % of the phytophages on goldenrod, but only 44 % on aster. Spiders represented 71 % of the predator/parasite component. Significantly more predators occurred on aster than on goldenrod. The most abundant predator was a spider, *Misumenops* sp. (Thomisidae). Differences between the compostion of the arthropod communities on aster and goldenrod may be due to differences in plant architecture and its effect on predator success. Very high densities of TPB on autumnal aster and goldenrod may lead to high TPB densities the following spring prior to dispersal onto cotton.

KEY WORDS Insecta, Araneae, phytophage, predator, cotton, *Solidago, Aster.*

In Washington County, Mississippi, hairy aster (*Aster pilosus*) Willdenow) and tall goldenrod (*Solidago altissima* L.) are two of the most abundant flowering Compositae(= Asteraceae) in September and October (Gunn et al. 1980). These plants are primary late-season breeding and feeding sites for the tarnished plant bug (TPB), *Lygus lineolaris* (Palisot) (Heteroptera: Miridae), an important pest of cotton in the Delta of Mississippi (Cleveland 1982, Snodgrass et al. 1984a). Other crop pests such as the three-cornered alfalfa hopper, *Spissistilus festinus* (Say) (Homoptera: Membracidae) and the spotted cucumber beetle, *Diabrotica undecimpunctata howardi* Barber (Coleoptera: Chrysomelidae) may also be abundant on these two composites (Young, personal observation). The purpose of this preliminary report is to compare and contrast the composition and density of the arthropod communities on flowering populations of hairy aster and tall goldenrod, to indicate the position of the TPB in these communities, and to consider strategies for TPB control involving the manipulation of these communities and their host plants.

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Materials and Methods

Beginning in 1984, an extensive arthropod sampling program was conducted on non-crop plants in Washington County, Mississippi. Though most of the sampling effort was directed towards species of *Erigeron* (Compositae), scattered collections in 1984 and 1985 indicated considerable densities of arthropods on aster and goldenrod. Thus in 1986 a special effort was made to obtain samples from these two plant species during their period of peak flowering. Arthropods were collected on six days during the period of 30 September to 22 October 1986. This interval was typical climatologically as compared to 1984-85 and 1987. Collection sites were primarily the margins of roads, drainage ditches, and cultivated fields that had not received recent herbicide treatment and/or mowing. Sampling was restricted to homogeneous clusters of hairy aster (N=30) and tall goldenrod (N=23) in which most plants were in flower. Plants were sampled in mid-morning by sweepnet (diameter 39 cm), with 10 sweeps constituting a sample.

Collected material was brought into the lab and frozen at -20° C for an indefinite period, then thawed, sorted, identified at least to family, and tabulated. Each specimen was classified as either a phytophage or a predator/parasite (Borror et al. 1976). Unidentified material was stored in alcohol for future processing. Voucher specimens were deposited either in the Florida State Collection of Arthropods, Division of Plant Industry, Gainesville, FL or in the Mississippi Entomological Museum, Mississippi State University, Starkville, MS. Data analysis included Chi-square tests of the differences between sample and expected means, and comparisons of abundances of species pairs or groups among samples by Pearson product-moment correlations (Sokal and Rohlf 1969).

Results

During the period 30 September - 22 October 1986, 8054 arthropods were obtained in 53 sweepnet samples from flowering hairy aster and tall goldenrod (Table 1). Over 50 % of the specimens were hemipterans, primarily TPB (21.6% and *Taylorilygus pallidulus* (Blanchard) (TPAL) (22.0 %). The third most abundant species was a homopteran, the three-cornered alfalfa hopper (TAH) (6.4%). Tabulation of the total assemblage on both plant species indicated that 76.6 % of the 8054 specimens were phytophagous.

Considerable differences were detected between the composition of the arthropod communities on the two plant species, but not in the total size of each community. The mean number of arthropods per sample for both plant species combined was 152. This value was not significantly different (x^2, $P > 0.1$) than the values for aster (162.2) and goldenrod (138.7) (Table 2). Seventy-three-percent of the aster assemblage was composed of phytophages, as opposed to 82 % of the goldenrod arthropods. These differences were not significant when analyzed using mean no. per sample and compared to the composite percentage for both plant species of 77 % (x^2, $P > 0.1$). Twenty-seven percent of the aster assemblage was composed of predators and parasites, compared to 18 % of the goldenrod community. These differences were significant when analyzed using mean no. per sample and when compared to the composite percentage of 23 % (x^2, $P < 0.05$).

Table 1. Arthropods collected from two species of Compositae in Washington Co., MS, during Sept-Oct 1986.

	Aster pilosus		*Solidago altissima*		
	mean no. /sample	std. dev.	mean no. /sample	std. dev.	total no. individuals
Phytophage					
Lygus lineolaris - adult	21.3	17.7	12.2	18.1	920
Lygus lineolaris - nymph	14.5	26.9	16.5	35.5	816
Taylorilygus pallidulus - ad	14.0	17.4	20.9	25.6	901
Taylorilygus pallidulus - ny	2.5	6.7	34.7	42.6	872
other hemipterans*	15.7	28.9	9.1	16.9	680
Spissistilus festinus	11.7	10.6	7.3	6.3	517
other homopterans †	1.1	1.5	2.6	3.7	92
Coleoptera ‡	28.1	74.8	6.6	7.8	996
other arthropods §	9.0	7.3	4.5	3.8	374
Predator/Parasite					
Thomisidae/ Philodromidae	24.5	26.9	6.0	6.6	875
Salticidae	6.8	4.8	4.9	4.1	316
other wandering spiders	3.0	2.7	0.8	1.2	110
web-spinning spiders	0.8	1.2	0.3	0.5	31
Orius insidiosus	2.3	4.5	8.7	20.5	271
Geocoris spp.	1.2	3.6	0	0	36
other hemipterans¶	1.7	2.8	0.8	1.3	68
Chrysopidae/Syrphidae	0.3	0.5	0.4	0.9	17
Hymenoptera**	2.0	2.9	1.8	4.3	103
other insects † †	1.5	1.7	0.6	0.9	59
Total --------	162.2 (n=30)		138.7 (n=23)		8054

* Coreidae (*Leptoglossus*), Lygaeidae (*Blissus*), Pentatomidae (*Acrosternum, Euchistus,* Thyanta), Rhopalidae, Tingidae, Thyreocoridae.

† Cicadellidae (*Empoasca, Graphocephala*), Flatidae, Fulgoridae, Membracidae.

‡ Chrysomelidae (*Altica, Ceratoma, Diabrotica, Metriona*), Curculionidae, Elateridae, Lathridiidae, Phalacridae.

§ Diptera: Culicidae, Dolichopodidae.
Hymenoptera: Anthophoridae, Apidae, Halictidae, Megachilidae.
Lepidoptera: Geometridae, Noctuidae, (*Heliothis, Spodoptera).*
Acari: Tetranychidae.

¶ Berytidae (*Jalysus*), Miridae (*Hyaloides*), Nabidae *(Reduviolus, Tropiconabis*), Pentatomidae (*Podisus, Stiretrus*), Phymatidae (*Phymata),* Reuviidae (*Sinea, Zelus*).

** Braconidae, Chalcididae, Formicidae (*Solenopsis*), Ichneumonidae, Pompilidae, Sphecidae, Vespidae.

† † Coleoptera: Coccinellidae (*Coleomegilla, Hippodamia, Olla, Scymnus*), Carabidae (*Lebia*). Diptera: Tachinidae. Odonata: Coenagrionidae. Orthoptera: Mantidae (*Stagmomantis*).

Within the phytophage guild, the TPB was twice as abundant on hairy aster as TPAL; the opposite was true on tall goldenrod (Fig. 1). Both mirid species together represented 73.7 % of the phytophages on goldenrod, but only 44.3 % of the phytophages on aster. Abundance of the TPB was significantly correlated with TPAL abundance on hairy aster ($r = 0.5119$, $P = 0.003$), but not on tall goldenrod ($r = 0.2045$, $P = 0.349$). Other comparisons involving TPB and TPAL indicated that TPB was not significantly correlated with any other grouping of phytophages.

Table 2. Phytophages and predators/parasites collected from two species of Compositae in Washington Co., MS, during Sept-Oct 1986.

	A. pilosus (n = 30)			*S. altissima* (n = 23)		
	sum		mean/sample	sum		mean/sample
All arthropods	4864		162.2	3190		138.7
Phytophages	3539		118.0	2629		114.3
as % of all arthropds		72.8			82.4	
Hemiptera	2042		68.1	2147		93.4
as % of phytophages		57.8			81.7	
Homoptera	383		12.8	226		9.8
as % of phyto.		10.8			8.6	
Coleoptera	844		28.1	152		6.6
as % of phyto.		23.8			5.8	
Other arthropods	270		9.0	104		4.5
as % of phyto.		7.6			3.9	
Predators/parasites	1324		44.2	561		24.4
as % of all arthropods		27.2			17.6	
Spiders	1054		35.1	278		12.1
as % of pred.		79.4			49.6	
Non-spiders	270		9.1	283		12.3
as % of pred		20.6			50.4	

TPAL, however, demonstrated a significant negative correlation with the TAH and "other homopterans" on hairy aster (r = -0.3680, P = 0.045), but only a positive trend on tall goldenrod (r = 0.3325, P = 0.121). Adult TPB populations were significantly correlated with immature TPB populations on hairy aster (r = 0.5985, P = <0.001) and tall goldenrod (r = 0.5523, P = 0.006). Adult TPAL populations were not significantly correlated with immature TPAL populations on hairy aster (r = 0.2438, P = 0.194) or tall goldenrod (r = 0.2835, P = 0.190).

The use of a large correlation coefficient matrix in the analysis of the arthropod assemblages on each plant species requires a consideration of the probability of random occurrence of significant correlations. The application of a Bonferroni-adjusted probability would normally be recommended if the number of correlation pairs was relatively small, perhaps less than ten. The Bonferroni Method is also an overadjustment to the probability of error and increases in magnitude as the number of paired comparisons increase (Millikan and Johnson 1984). In the present study, the arthropod assemblage on each plant species was divided into 19 exclusive, non-overlapping taxonomic categories resulting in 181 pair-wise comparisons. A Bonferroni-adjusted probability for this large matrix would be less than 0.0003, suggesting the inappropriateness of the adjustment. Considered in a different manner, each 181-pair matrix has a 95 % probability of containing nine significant correlations due to chance. The hairy aster matrix contained 22 significant (P < 0.05) correlations and the tall goldenrod matrix contained 13 significant correlations, suggesting that the occurrence of significant correlations was not due to chance.

The predator/parasite guild, when divided into six subgroups, was not equally represented on both plant species (Fig. 2). Members of the spider families Thomisidae and Philodromidae together constituted 55.4% of the guild on hairy aster, but only 24.6 % on tall goldenrod. *Orius insidiosus* (Say) (Hemiptera: Anthocoridae) constituted 5.3% of the guild on hairy aster, 35.8 % on tall goldenrod. The other four subgroups were approximately equally represented on

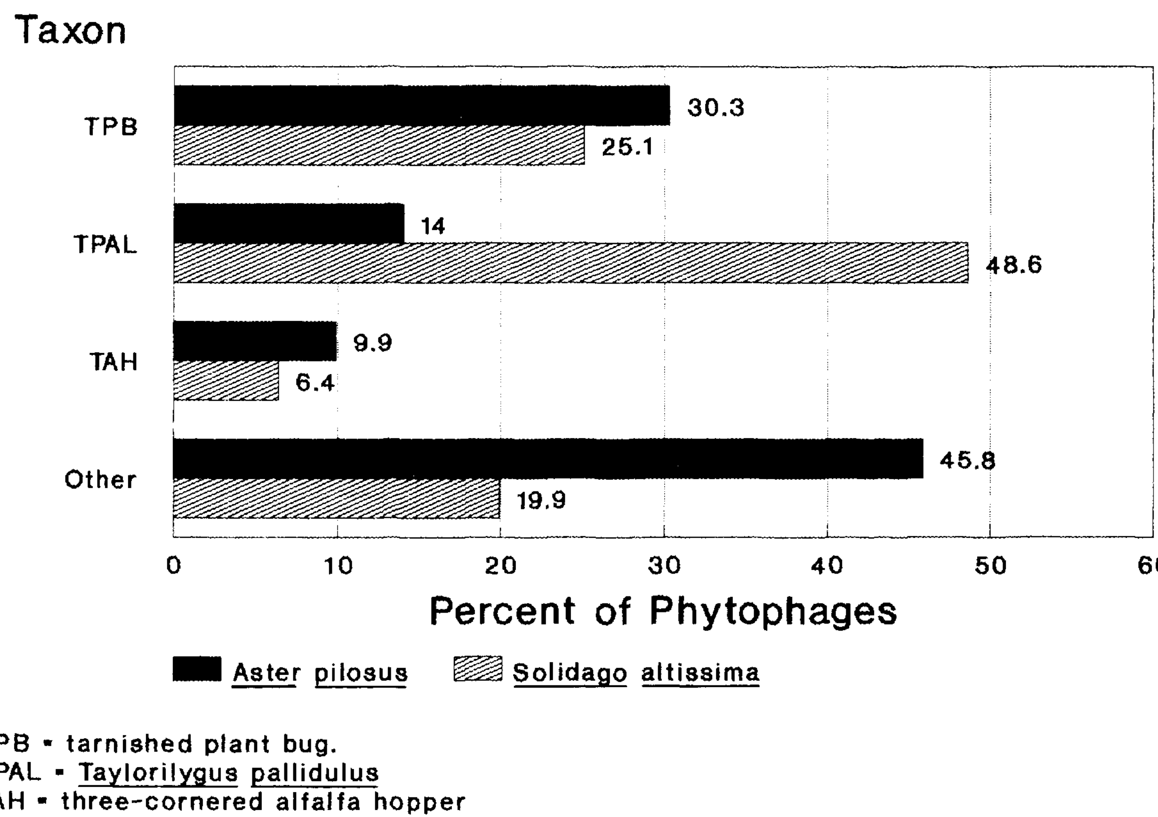

Fig. 1. The percentage of total phytophages represented by *Lygus lineolaris* (TPB), *Taylorilygus pallidulus* (TPAL), *Spissistilus festinus* (TAH), and "other," captured on the composite species *Solidago altissima* and *Aster pilosus.*

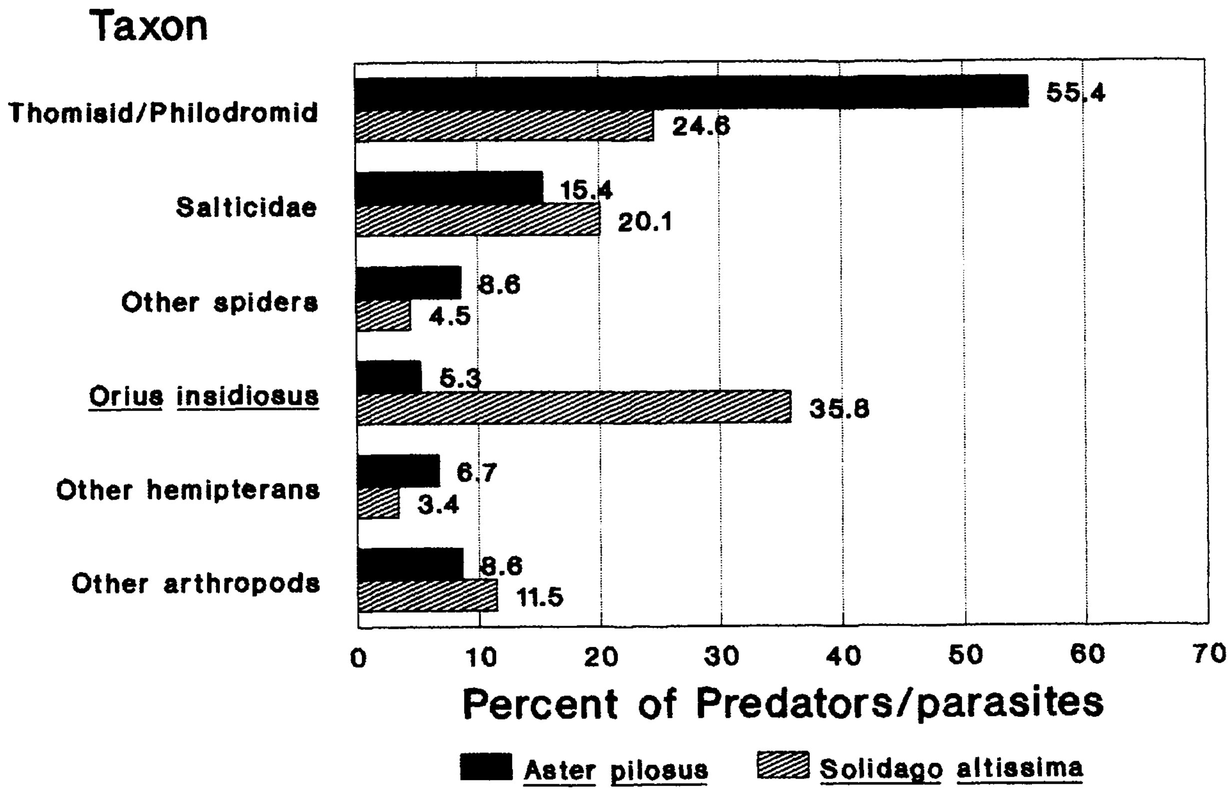

Fig. 2. The percentage of total predators/parasites represented by Thomisidae/Philodromidae, Salticidae, other spiders, *Orius insidiosus*, other hemipterans, and other arthropods, captured on the composite species *Solidago altissima* and *Aster pilosus*.

both plant species. The most abundant predator species, however, was the crab spider, *Misumenops* sp. (Thomisidae), representing 32.3 % of the predator/parasite guild on both plants combined and 43.8 % of the guild on hairy aster.

The predator/parasite guild and its component subgroups was related in various ways to the two major prey species. Adult, but not immature, TPB populations were significantly ($P < 0.05$) correlated with populations of wandering spiders (excluding Thomisidae and Philodromidae) (Ad: $r = 0.3880$, $P = 0.034$; Imm: $r = 0.3171$, $P = 0.087$) and with predaceious hemipterans (excluding *Orius* spp. and *Geocoris* spp.) (Ad: $r = 0.4933$, $P = 0.006$; Imm: $r = 0.3072$, $P = 0.098$) on hairy aster but not on tall goldenrod. Adult TPAL populations on hairy aster demonstrated a significant negative correlation with populations of the spider grouping composed of Thomisidae and Philodromidae ($r = 0.3880$, $P = 0.034$). On tall goldenrod, TPAL adult populations were significantly correlated with populations of wandering spiders (excluding Thomisidae and Philodromidae) ($r = 0.7046$, $P < 0.001$). Immature TPAL populations were only correlated significantly with wandering spiders (excluding Thomisidae and Philodromidae) on hairy aster ($r = 0.4277$, $P = 0.018$).

The predator/parasite guild was divided into three spider and three non-spider groups (Fig. 2). Spiders, however, represented almost 80% of the guild population on hairy aster and 50 % on tall goldenrod (Table 2). Spider populations were not significantly correlated with overall non-spider populations on either plant species. Examination of the spider assemblage on hairy aster indicated that more than 70 % of the individuals captured were in the crab spider family Thomisidae, almost all in the genus *Misumenops* (Table 3). On tall goldenrod, *Metaphidippus galathea* (Walck.) (Salticidae) and *Misumenoides formocipes* (Walck.) (Thomisidae) accounted for 58 % of the spider assemblage.

Discussion

Considerable differences exist between the two plant species in the composition of their respective autumnal arthropod communities. These differences may be due in part to differences in plant architecture. Hairy aster is typically 0.2-1.5 m high with straight spreading branches containing small and sparse leaves and with scattered but numerous flower heads (Fernald 1950). Some individual plants may have more than 850 flowers (diameter ca. 15 mm) scattered throughout a spherical space 2 m high and 2 m wide (Young 1989c). Tall goldenrod is typically 1-2.5 m high with an erect stem or stem cluster containing numerous and crowded leaves and recurved-spreading terminal inflorescences containing crowded and densely floriferous secund divergent racemes (Fernald 1950). Arthropods are probably much more apparent to other arthropods on hairy aster than on tall goldenrod due to the sparse arrangement of leaves and flowers and the exposed position and flat shape of the flower. This situation probably increases the likelihood of predation upon the arthropods of hairy aster and could be responsible for its significantly larger density of predators/parasites (Table 2) and a larger number of predator (spider) species (Table 3). On tall goldenrod, arthropods such as the TPB and other mirids are able to fit between the tightly-packed flower heads on a raceme and become difficult to see and to contact (Sholes 1984). This degree of physical protection from predators provided by the plant may explain the high proportion of the phytophage guild (81.7 %) represented by mirids.

Table 3. Spiders collected from two species of Compositae in Washington Co., MS, during Sept-Oct 1986.

taxon	*Aster pilosus* no. indiv.	*Aster pilosus* mean no. /sample	*Solidago altissima* no. indiv.	*Solidago altissima* mean no. /sample	total no. individuals
Anyphaenidae					
Anyphaena celer (Hentz)	1	*	1	*	2
Aysha gracilis (Hentz)	1	*			1
Araneidae					
Araneus miniatus (Walck.)			1	*	1
Eustala cepina (Walck.)	1	*	1	*	2
Neoscona arabesca (Walck.)	3	*			3
Neoscona nautica (L. Koch)	1	*			1
Tetragnatha laboriosa Hentz			1	*	1
Clubionidae					
Chiracanthium inclusum (Hentz)	5	*			5
Clubiona abbotii L. Koch	13	*	7	*	20
Clubionoides sp.	1	*			1
Linyphiidae					
Frontinella pyramitela (Walck.)	4	*			4
Linyphia sp.	7	*	2	*	9
Lycosidae					
Lycosa punctulata Hentz	1	*	1	*	2
Pardosa milvina (Hentz)	3	*	2	*	5
Oxyopidae					
Oxyopes salticus Hentz	26	0.9	6	*	32
Philodromidae					
Ebo latithorax Keyserling			1	*	1
Philodromus marxi Keys.	16	0.5	2	*	18
Tibellus duttoni (Hentz)			1	*	1
Pisauridae					
Dolomedes triton (Walck.)	4	*	1	*	5
Pisaurina mira (Walck.)	43	1.4	3	*	46
Pisaurina undulata (Keys.)			1	*	1
Salticidae					
Agassa cyanea (Hentz)	3	*			3
Eris militaris (Hentz)	2	*	3	*	5
Habronattus coecatus (Hentz)	1	*			1
Hentzia palmarum (Hentz)	1	*			1
Maevia inclemens (Walck.)	1	*			1
Marpissa sp.	1	*			1
Metaphidippus galathea (Walck.)	108	3.6	92	4.0	200
Phidippus audax (Hentz)	11	*	3	*	14
Phidippus insignarius C. L. Koch	2	*			2
Phidippus otiosus (Hentz)	1	*			1
Phidippus sp.	36	1.2	4	*	40
Thiodina puerpera (Hentz)	5	*	1	*	6
Thiodina sylvana (Hentz)			1	*	1
Zygoballus rufipes Peckhams	27	0.9	9	*	36
Theridiidae					
Theridion frondeum Hentz	3	*			3
Thomisidae					
Misumena vatia (Clerck)	1	*	37	1.6	38
Misumenoides formocipes (Walck.)	126	4.2	69	3.0	195
Misumenops sp.	581	19.4	27	1.2	608
Synaema parvula (Hentz)	11	*	2	*	13
Xysticus ferox (Hentz)			1	*	1
Uloboridae					
Uloborus sp.	1	*			1
Totals	1054	35.1 SD = 28.1 n = 30	278	12.1 SD = 8.4 n = 23	1332
number of species		35		27	

* = less than 0.5.

Although we did not attempt to identify all arthropods to species and produce a listing of all inhabitants, we strongly suspect that the autumnal community on goldenrod in Washington County contains fewer species than in communities further north. Very few aphids were obtained in our study, which probably reduced the resource base for the many potential aphidophagous and honeydew-associated insects such as ants and coccinellids typically found at more northerly sites in late summer and autumn (Sholes 1984). Tall goldenrod in Canada and northern sections of the United States is known to support a large and diverse community of arthropods. In Michigan, 241 species of insects were collected from this species in one year (Farr 1948). In New York, five feeding guilds were recognized on tall goldenrod, with sucking herbivores the numerically dominant guild and aphids the most common taxon (Sholes 1984). Several investigations have examined the diverse plant bug (Heteroptera: Miridae) assemblage on goldenrods. In Ontario, 46 species of mirids were obtained, with the TPB the most common species in August and September (Reid et al. 1976). In New York, the TPB was also the most common species (Messina 1978). In some situations, mirids may in fact be the most important herbivores in resource utilization. A study of trophic relationships in an old-field ecosystem by means of radionuclide tracers demonstrated that just three species of mirids (including TPB) accounted for 75 % of all herbivore transfer (Shure 1973). Similar comparative information from sites outside Mississippi is not available for hairy aster (Young 1989c), though the species ranges from Canada to Mexico and from the East Coast to the Rockies (Fernald 1950).

Arthropod populations on autumnal flowering hairy aster and tall goldenrod in Washington County are dominated by phytophagous heteropterans, particularly the mirids *Lygus lineolaris* (TPB) and *Taylorilygus pallidulus* (TPAL). The TPB occurs on more than 350 plant species and is distributed in many habitats throughout North America (Young 1986). The TPAL has been reported previously from both composite species in Washington County (Snodgrass et al. 1984a), is very common throughout the southeastern United States, and may be the most abundant plant bug in south Florida (Slater and Baranowski 1978). Both mirid species probably complete their last generation of the year on these plants before entering an overwintering diapause and appear to have little effect on each other's populations. Low nymphal populations of TPAL on hairy aster suggest that this plant species is only important as a source of food for adults, whereas substantial TPB nymphal and adult populations on both plant species suggests equal importance (Table 1). The dominance of the phytophagous guild by these two mirid species may be responsible for the dominance by spiders of the predator guild. Phytophagous mirids such as the TPB are relatively easy prey for most spiders of Washington County to capture (Young 1989a, Young and Lockley 1986), and may be the principal food item for species such as *Oxyopes salticus* Hentz (Lockley and Young 1987) and *Pisaurina mira* (Walck.) (Young 1989b). The most abundant spider on hairy aster, *Misumenops* sp. (Table 3), has been frequently observed on this plant capturing TPB adults and nymphs (Young 1989c). The most abundant spider on tall goldenrod *Metaphidippus galathea* (Walck.) (Table 3), is also the most abundant predator on goldenrod at other locations (Sholes 1984) and is a voracious predator on TPB nymphs in the laboratory (Young 1989a) and on goldenrod (pers. observ., O.P.Y.). Late-season (August-September) predator populations in cotton fields in the Delta typically are composed primarily of spiders (Smith and Stadelbacher 1978), most of which are non-web-builders (Lockley et al.

1979) that can easily disperse at harvest into adjacent plots of aster and goldenrod (Young et al. 1989). That movement has been preceded by dispersal of TPB out of cotton in July-August (Cleveland 1982). The resultant accumulation of TPB and spiders in non-crop habitats no doubt has a strong impact on the resident population, but may do little to reduce the combined TPB population.

Recent personal observations (O.P.Y.) of tall goldenrod in late October have revealed densities of adult TPB as high as 20 on one raceme and more than 150 on the 10 or so racemes of a single plant. Sweeping of several one-acre plots of densely-spaced goldenrod in Washington County during 1988 has also indicated densities of adult TPB exceeding 130,000 per acre (Young, unpublished data). Assuming that only 10% of this population survives the overwintering period, the remaining early spring cohort should be of ample size to initiate population growth and dispersal of subsequent generations into cotton. Given the widespread distribution of small plots of goldenrod throughout Washington County and its relatively high abundance compared to other host plants of the TPB (Gunn et al. 1980, Snodgrass et al. 1984b), reduction of the autumnal goldenrod population could have a significant impact on the size of the TPB population surviving the autumn-winter period and could lead to a reduction in the size of the subsequent TPB population dispersing to cotton. Autumnal mowing or herbicide treatment of margins, fallow fields, and waste ground on an area-wide basis may thus be an effective and relatively inexpensive means of reducing TPB damage to cotton.

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