

Plant Bugs (Heteroptera: Miridae) Associated with Roadside Habitats in Argentina and Paraguay: Host Plant, Temporal, and Geographic Range Effects

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ABSTRACT Between November 1999 and September 2001, mirid nymphs (Hemiptera: Miridae) were collected on wild and cultivated plants in central and northern Argentina and southeastern Paraguay. In the laboratory, nymphs were reared until adult emergence. Four (Bryocorinae, Deraeocorinae, Mirinae, and Orthotylinae) of the eight mirid subfamilies were collected during the study. Twenty-two mirid species on 43 putative host plant species were collected in Argentina, and five species of mirids on eight plant species were collected in Paraguay. Eighty-five new mirid–plant associations were recorded (only 112 mirid–plant associations had been reported previously for Argentina). Most of the mirids were in the subfamily Mirinae, tribe Mirini, and most of the host plants belonged to Asteraceae. Almost all mirids were collected on plants with flower buds present. In addition to host plant records, the phenology and pattern of plant use for the most abundant mirids are reported. Mirid richness and abundance varied according to the host plant species; the highest diversity and richness of mirids occurred in the western region of Argentina (Salta, Jujuy, and Tucumán provinces). The most frequently collected mirid, *Taylorilygus apicalis* (Fieber) ($\approx 87\%$ of the 35,970 collected mirids), was usually collected on Asteraceae. This exotic species could have affected the native mirid fauna in the study area. More research on the possible interactions between *T. apicalis* and the native mirids of Argentina and Paraguay is needed. Our results suggest that *T. apicalis* exhibits regional polyphagy, i.e., uses numerous hosts throughout its geographic range.

RESUMEN Entre Noviembre de 1999 y Septiembre de 2001, ninfas de míridos (Hemiptera: Miridae) fueron colectadas sobre plantas silvestres y cultivadas en centro y norte de Argentina y el sudeste de Paraguay. Las ninfas colectadas se criaron hasta el estado adulto en el laboratorio. De las eight subfamilias de míridos conocidas, se colectaron four en este estudio: (Bryocorinae, Deraeocorinae, Mirinae, y Orthotylinae). En Argentina, 22 especies de míridos fueron colectadas sobre 43 especies de plantas, y 5 míridos sobre ocho plantas en Paraguay. Un total de 85 asociaciones planta-insecto nuevas fueron registradas (112 eran conocidas previamente en Argentina). La mayoría de los míridos colectados pertenecían a la subfamilia Mirinae, tribu Mirini, mientras que las plantas hospedadoras pertenecieron a la familia Asteraceae. La casi totalidad de los míridos fueron colectados sobre plantas con flores presente. Además de los datos sobre las plantas hospedadoras de los míridos, se presentan datos sobre fenología y patrones de utilización de las plantas de los míridos más abundantes. En general la riqueza y la abundancia de los míridos varió de acuerdo a las especies de las plantas hospedadoras; la mayor diversidad y riqueza de míridos se observó en el oeste de Argentina (en las provincias de Salta, Jujuy, Tucumán). *Taylorilygus apicalis* (Fieber) fue el mírido más abundante (87% de los 35.970 míridos colectados) y en la mayoría de los casos sobre Asteraceae. Esta especie exótica podría estar afectando la fauna nativa de míridos en el área estudiada. Sin embargo, se necesita de más investigación para establecer las posibles interacciones entre la fauna de míridos de Argentina y Paraguay y *T. apicalis*. Nuestros resultados sugieren que *T. apicalis* muestra una polifagia regional, por ejemplo, utiliza numerosas plantas hospedadoras a lo largo de su distribución geográfica.

KEY WORDS Miridae, plant bugs host plants, geographic distribution, species richness

THE MIRIDAE (HEMIPTERA: HETEROPTERA) commonly known as plant bugs, is the largest and most diverse

family of true bugs. Our knowledge of mirid biology is based mainly on the study of relatively few economically important species. Some plant bugs are important pests of cultivated plants (e.g., species of *Creontiades*, *Helopeltus*, *Lygus*, *Pseudatomoscelis*, and *Taedia*), whereas others are predacious (e.g., species of *Cyrtorhinus*, *Deraeocoris*, *Orthotylus*, and *Phytocoris*) (Wheeler 2001). Although the trophic habits of

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most of the $\approx 10,000$ described species are unknown, the available data suggest that many species operate along a continuum between phytophagy and zoophagy. Thus, their omnivorous habits preclude easy definition as "predator" or "plant pest." In fact, this diversity of trophic habits is a striking characteristic of the Miridae; few other families of insects exhibit such a range and plasticity of diet (Wheeler 2001).

Mirid–host plant records are valuable scientific resources that provide relevant information for systematics, ecology, agriculture, evolution, forestry, and conservation. Wheeler (2001) reviewed many mirid–host plant associations, but others remain scattered in difficult-to-retrieve publications of restricted circulation. Moreover, host records sometimes are never published and thus are inaccessible to researchers. Mirid–host plant associations for Argentine species (Bosq 1937, 1940; Quintanilla et al. 1967, 1976, 1981; Rizzo 1976, 1977; Carpintero and Carvalho 1993) were summarized by Carpintero and Carvalho (1993). These records, without doubt, are incomplete. Carpintero and Carvalho (1993) also cautioned that some published host records may not be accurate because they rely on sweep net or light trap collections of highly mobile adults from plants that may not serve as hosts. Thus, there is a need for additional studies of mirid–host plant associations in Argentina that provide accurate, reliable information.

During field exploration for nymphal parasitoids of plant bugs in Argentina and Paraguay (Williams et al. 2003), we collected mirid nymphs from known plants and reared them to adulthood for subsequent identification. This article reports the host plant records, the phenology for all the mirids collected, and the pattern of plant use for the most abundant species.

Materials and Methods

Twenty-one trips were made from November 1999 to September 2001 to collect mirid nymphs on wild and cultivated plants in northern Argentina and southeastern Paraguay. Most collections were made from plants growing along roadways and from cultivated crops. Collection methods differed according to the kinds of plants sampled. Herbs and small shrubs were sampled by sweeping with a standard sweep net, by hand beating over a white plastic tray (30 by 27 by 17 cm), or by classical beating over a sheet (100 by 100 cm). Medium and large shrubs were sampled by hand beating over a tray and by classical beating.

Two trained people collected nymphs at each site for 5–30 min. Collection times varied in proportion to availability of nymphs. We abandoned a site if 1) five nymphs or fewer were collected within the first 5 min, or 2) the rate of nymph collection decreased before 30 min. A total of 59 plant species (35 Asteraceae and 24 in 14 other families) were sampled for mirid nymphs (Table 1). When choosing a sampling site, we emphasized: 1) plant stands large enough to sample for 30 min without resampling plants, and 2) plant species known as mirid hosts.

Table 1. Plant species sampled during the study in Argentina and Paraguay, 1999–2001

Plant family	Species
Apiaceae	<i>Ammi visnaga</i> (L.) Lam.
Amaranthaceae	<i>Gomphrena perennis</i> L., <i>G. haenkeana</i> Mart., <i>G. pulchella</i> Mart.
Asteraceae	<i>Ambrosia tenuifolia</i> Sprengel, <i>Baccharis dracunculifolia</i> DC., <i>B. medulosa</i> DC., <i>B. coridifolia</i> DC., <i>Baccharis</i> sp., <i>B. salicifolia</i> (Ruiz et Pav.) Persoon, <i>B. spicata</i> (Lam.) Baill., <i>B. trimera</i> (Less.) DC., <i>Bidens</i> spp., <i>Centratherum camporum</i> (Hassl.), <i>Conyza</i> spp., <i>Coreopsis lanceolata</i> L., <i>Eupatorium candolleianum</i> Hook. et Arn., <i>E. christeanum</i> Baker, <i>E. hecatanthum</i> (DC.), <i>E. inulaefolium</i> H.B.K., <i>E. laevigatum</i> Lam., <i>E. macrocephala</i> Less., <i>E. oblongifolium</i> (Spreng.), <i>E. odoratum</i> L., <i>Flaveria bidentis</i> (L.) Kuntze, <i>Gaillardia megapotamica</i> (Spreng.) Baker, <i>Gamochaeta falcata</i> (Lam.). <i>G. pennsylvanicum</i> (Willd.), <i>Hymenoxis robusta</i> (Rusby) Parker, <i>Mikania cordifolia</i> (L.f.) Willd., <i>Parthenium hysterophorus</i> L., <i>Pterocaulon alopecuroides</i> (Lam.), <i>Senecio argentinus</i> Baker, <i>Senecio grisebachii</i> Baker., <i>Solidago chilensis</i> L., <i>Sonchus oleracea</i> L., <i>Stevia multiristata</i> Spreng., <i>Tessaria absinthioides</i> (Hook et Arn.) De Candolle, <i>Wedelia</i> sp.
Brassicaceae	<i>Brassica</i> sp.
Calyceraceae	<i>Acicarpa tribuloides</i> Juss
Chenopodiaceae	<i>Chenopodium album</i> L.
Clusiaceae	<i>Hypericum</i> sp.
Commelinaceae	<i>Physalis pubescens</i> L.
Cyperaceae	<i>Carex albidula</i> Bailey
Fabaceae	<i>Medicago sativa</i> L., <i>Melilotus albus</i> Medik
Lamiaceae	<i>Hyptis fasciculata</i> Benth., <i>H. lappacea</i> Benth.
Malvaceae	<i>Abutilon grandiflorum</i> (Willd.) Sweet, <i>A. pauciflorum</i> St. Hill, <i>Gossypium hirsutum</i> L., <i>Sphaeralcea</i> spp., <i>Sida rhombifolia</i> L., <i>S. spinosa</i> L.
Rubiaceae	<i>Borreria verticillata</i> (L.) G. Mey.
Scrophulariaceae	<i>Stemodia verticillata</i> (Mill.) Hassl.
Solanaceae	<i>Solanum</i> spp.
Verbenaceae	<i>Glandularia</i> sp., <i>G. peruviana</i> (L.) Small

No mirids were collected on the underlined plant species.

In the field, mirid nymphs were removed from the sweep net, tray, or beat sheet by an aspirator and were sorted to morphospecies and placed in rearing chambers similar to those described by Debolt (1981) and modified by Williams et al. (2003). The rearing chambers consisted of 0.5-liter cylindrical cardboard cartons (9 by 9 cm) with the top and bottom removed. The top of the chamber consisted of mosquito netting held in place by the ring of the lid. A piece of 1.5-mm mesh fiberglass window screen was glued to the hole in the bottom of the chamber to facilitate collection of parasitoids (Williams et al. 2003). Nymphs (<75 per rearing chamber) were fed green beans (*Phaseolus* sp.) which were replaced every 2 to 3 d. Rearing chambers were checked every other day for emergence of adult mirids. In the laboratory, rearing chambers were held at $\approx 25^{\circ}\text{C}$ with ambient light and humidity.

Putative host plants from which mirid nymphs were collected were pressed and identified by consultation

with specialists. Voucher specimens of plants are deposited in the USDA-ARS South American Biological Control Laboratory. Voucher specimens of mirids are deposited in the National Entomological Collection, National Museum of Natural History, Smithsonian Institution, Washington, DC, and in the División Entomología, Museo de La Plata, La Plata, Buenos Aires, Argentina.

The collection sites in northern Argentina and southeastern Paraguay were grouped into three regions according to geography, altitude, and annual precipitation. In the western region (Salta, Jujuy, and Tucumán provinces) rainfall varies from 250 to 450 mm and altitude varies from 400 to 1500 m. In the central region (Santiago del Estero, Chaco, and Córdoba provinces) precipitation ranges from 450 to 1100 mm and altitude from 50 to 500 m. In the eastern region (Misiones, Corrientes, Entre Ríos, and Buenos Aires provinces, and southeastern Paraguay) precipitation ranges from 900 to 2000 mm and altitude from 0 to 500 m. In total, 219 sites (77 in the western region, 34 in the central region, and 108 in the eastern region) were sampled in the study. Sixteen of the sites in the eastern region were in Paraguay.

The mirid fauna and host plant composition in the three regions were analyzed by Sorensen Index of Similarity (Sorensen 1948).

$$\text{Index of similarity} = \frac{2C}{A + B}$$

where A is the number of species in one community, B is the number of species in the second community, and C is the number of species occurring in both communities being compared. The index ranges from 0.0 (no similarity) to 1.0 (complete similarity).

To establish whether there were preferences for any of the main host plants of *T. apicalis*, we performed a regression between the number of sampled stands for each host plant and the number of nymphs of *T. apicalis* collected. We expected no preference for any host plants, i.e., that all host plants were attacked in the same proportion regardless of the number of sites sampled.

Results and Discussion

Approximately, 36,000 nymphs of 22 mirid species were collected in Argentina and Paraguay, representing four of the eight mirid subfamilies. Most of the mirids (19 species) belonged to the subfamily Mirinae. The three remaining mirids were *Tupiocoris cucurbitaceus* (Spinola) (Bryocorinae), *Hyaliodorocoris insignis* (Stål) (Deraeocorinae), and *Orthotylus* sp. (Orthotylinae) (Table 2). Most of the plant species (81.1%, $n = 56$) harbored mirids (Table 2). Approximately 87% of the 35,970 mirid nymphs from Argentina were identified as *T. apicalis*, a cosmopolitan species native to Africa and introduced unintentionally into other regions (Carvalho 1959, Linnavuori 1974, Wheeler and Henry 1992). *T. apicalis* is the only member of the genus that occurs outside Africa (Carvalho 1959). The introduction of *T. apicalis* into the Neotropics might

be related to commerce (Lindberg 1958). Most of our collections were made from annual plants growing along roadsides or adjacent to crop fields, and from cultivated plants. Future studies emphasizing collections from other habitats, such as perennial plants, will surely result in additional mirid-plant associations for the study area.

We recorded 85 mirid-host plant associations, most of them (90%) not previously reported, which is an increase of $\approx 57\%$ from the 112 known mirid-host associations in Argentina (Carpintero and Carvalho 1993). Here, host plants for eight mirids with no previous host information in Argentina and or Paraguay are reported: *Garganus saltensis* (Berg), *Horcias* sp., *Polymerus testaceipes* (Stål), *Polymerus* sp., *Taedia guttulosa* (Reuter), *Taedia incaica* (Carvalho & Gomez), and *Taedia signata* (Carvalho & Gomez) (Table 2).

In Paraguay, four species of mirids were collected on eight plant species, resulting in 12 mirid-host plant associations (Table 3). All mirids collected in Paraguay also were collected in Argentina, except for *Pycnoderes sixeonotooides* Carvalho & Hussey. However, this species has been collected previously in Argentina (Carpintero and Carvalho 1993).

Pattern of Plant Utilization. Mirids were encountered on all plant families sampled, except Malvaceae and Fabaceae (Table 1). Interestingly, we did not collect mirids in alfalfa, even though this plant supports a relatively diverse and abundant mirid fauna in the Northern hemisphere (Day 1999). This observation warrants further study. More than 75% of the plants harboring mirids were Asteraceae. Nearly 63% of the 56 plant species sampled were Asteraceae. Significantly more mirids were collected on Asteraceae than on other plant families ($\chi^2 = 5.52$, $df = 1$, $P < 0.05$). With the exception of *Phytocoris aspersus* (Carvalho & Gomez), a late-season species (D.L.C., unpublished data), all mirids were collected on hosts with flower buds present. This finding is consistent with the plant-feeding habits of many other mirids (Wheeler 2001).

T. apicalis was collected on plants in seven families (Table 2); most of the collections (201 sites of 219) (Table 4) were made from Asteraceae. The main host plants of *T. apicalis* were *P. hysterophorus* (10,600 nymphs in 54 sites), *Conyza* spp. (6,400 nymphs in 39 sites), *S. chilensis* (5,750 nymphs in 28 sites), and *Baccharis dracunculifolia* (3,200 nymphs in 10 sites). These hosts accounted for 73% of the nymphs collected (Tables 2 and 4). We found a significant regression ($F = 29.15$, $df = 3$, $P = 0.032$) between number of sites sampled and the number of *T. apicalis* nymphs collected among the four main hosts (Fig. 1). These results indicate that *T. apicalis* did not show preference for these hosts, suggesting that host availability is the main factor that mediated plant utilization by *T. apicalis* in this study. We suggest that *T. apicalis* exhibits regional polyphagy, i.e., monophagy or oligophagy at certain locations, leading to use of numerous hosts throughout the bug's geographic range, as has been demonstrated in some other mirids (Scudder 1997, Wheeler 2001).

Table 2. Continued

Mirid subfamily	Mirid species	Host plant	Family	Western	Central	Eastern
	<i>E. oblongifolium</i> (Spreng.)		Asteraceae			1
	<i>Eupatorium</i> sp.		Asteraceae			
	<i>Flaveria bidentis</i> (L.) Kuntze		Asteraceae		2	
	<i>Gamochaeta falcata</i>		Asteraceae	2		
	<i>Gamochaeta pensylvanicum</i>		Asteraceae	1	2	1
	<i>Gomphrena perennis</i>		Amaranthaceae	1		
	<i>Hyptis fasciculata</i>		Lamiaceae	2		
	<i>Hyptis lappacea</i> Benth.		Lamiaceae	1		
	<i>Mikania cordifolia</i>		Asteraceae	5	1	2
	<i>Parthenium hysterophorus</i>		Asteraceae	36	18	
	<i>Pterocaulon alopecuroides</i> (Lam.)		Asteraceae	1		
	<i>Senecio argentinus</i> Baker		Asteraceae		1	
	<i>Solidago chilensis</i>		Asteraceae		2	26
	<i>Sonchus oleracea</i> L.		Asteraceae			1
	<i>Stevia multiristata</i> Spreng.		Asteraceae			1
	<i>Glandularia</i> sp.		Verbenaceae	1		
	<i>Wedelia</i> sp.		Asteraceae		1	
Orthotylinae	<i>Orthotylus</i> sp. ^b	<i>Physalis pubescens</i> L.	Commelinaceae	1		

^a Considered chiefly predacious.

^b Thought to have mixed trophic habits (i.e., phytophagous and predacious).

Only three hosts were reported previously for *T. apicalis* in Argentina: *Flaveria bidentis* (Morán Lemir 1985), *Galinsoga parviflora*, and Poaceae (Carpintero and Carvalho 1993). In Paraguay it is known from *Bidens gardneri* Baker (Asteraceae) (Carvalho and Hussey 1954). In the United States, *T. apicalis* often is associated with Asteraceae (Knight 1918; Henry and Wheeler 1982; Snodgrass et al. 1984a, b; Wheeler and Henry 1992), mainly on the genera *Conyza* and *Parthenium*. In Texas, *T. apicalis* apparently disperses to flowers of *Baccharis halimifolia* L. but does not develop on this plant (Palmer 1987). In Africa, *T. vosseleri* (McKinlay and Geering 1957, Stride 1968, MacFarlane 1989), *T. ricini* (Taylor 1947, Boyes 1964), and *T. virens* (Taylor 1947) have been collected from sorghum panicles. *T. vosseleri* also has been listed as a cotton pest in Africa (Stride 1968, Cadou 1993). *T. apicalis* was not collected on cotton in the current study.

The number of mirid species collected on the main host plants of *T. apicalis* was variable. *Solidago chilensis* L. and *Conyza* spp. harbored only one other mirid, whereas *P. hysterophorus* and *B. dracunculifolia* each harbored six additional species. Seven mirid species were collected on *Mikania cordifolia* (Lf.) Willd., and five species were collected on *Hyptis fasciculata* Benth. (Table 2). *Polymerus testaceipes* and *Proba vitiscuttis* have been collected on *P. hysterophorus* in Puerto Rico (Wheeler 2001) and Florida (Henry and Wheeler 1982, Wheeler 2001), respectively. Competitive interactions may occur between *T. apicalis* (as *T. pallidulus*), *Polymerus basalis* (Reuter), and *Lygus lineolaris* (Palisot de Beauvois) when these bugs occur on the same host plant (Snodgrass et al. 1984b).

Several plant associations also were made for mirids with mixed feeding habits (predacious and/or phytophagous) for which plant associations were not previously known: *Hyaliodorcoris insignis* (Stål), *P. asper-*

Table 3. Mirid–host plant associations in Paraguay, 1999–2001

Mirid subfamily	Mirid species	Host plant	Family	No. sites
Bryocorinae	<i>Pycnoderes sixeonotoides</i> (Carvalho and Hussey)	<i>Commelina virginica</i> L.	Commelinaceae	2
Mirinae	<i>Horcias nobilellus</i> (Berg)	<i>Solidago chilensis</i> L.	Asteraceae	1
		<i>Baccharis dracunculifolia</i> DC.	Asteraceae	1
		<i>Baccharis punctulata</i> DC.	Asteraceae	1
	<i>Phytocoris aspersus</i> (Carvalho & Gomes) ^a	<i>Baccharis dracunculifolia</i>	Asteraceae	1
	<i>Proba vitiscuttis</i> (Stål)	<i>Baccharis punctulata</i>	Asteraceae	2
	<i>Taylorilygus apicalis</i> (Fieber)	<i>Ambrosia tenuifolia</i> Spreng.	Asteraceae	
		<i>Baccharis punctulata</i>	Asteraceae	2
		<i>Conyza</i> sp.	Asteraceae	1
		<i>Eupatorium candolleianum</i> Hook. et Arn.	Asteraceae	1
		<i>Gamochaeta pensylvanicum</i> (Willd.)	Asteraceae	1
		<i>Baccharis dracunculifolia</i>	Asteraceae	
		<i>Solidago chilensis</i>	Asteraceae	9

These mirid–host plant records are included in Table 2, northeastern region.

^a Thought to be chiefly predacious.

Table 4. Number of nymphs collected and sites for the mirids surveyed in Argentina and Paraguay, 1999–2001

Mirid subfamily	Mirid species	No. nymphs	No. sites
Bryocorinae	<i>Tupiocoris cucurbitaceus</i> (Spinola)	31	1
	<i>Pycnoderes sixeonotoides</i> (Carvalho & Hussey) ^a	30	2
Deraeocorinae	<i>Hyaliodocoris insignis</i> (Stål)	24	2
Mirinae	<i>Dagbertus phaleratus</i> (Berg)	58	2
	<i>Garganus saltensis</i> (Berg)	11	7
	<i>Henicocnemis tucumanus</i> (Berg)	1	1
	<i>Horcias nobilellus</i> (Berg)	387	6
	<i>Horcias nobilellus</i> (Berg) ^a	273	3
	<i>Orthotylus</i> sp.	130	1
	<i>Phytocoris aspersus</i> (Carvalho & Gomes)	1,186	16
	<i>Phytocoris aspersus</i> (Carvalho & Gomes) ^a	10	1
	<i>Phytocoris bonaerensis</i> (Berg)	2	1
	<i>Phytocoris effictus</i> (Stål)	72	4
	<i>Phytocoris subvitattus</i> (Stål)	114	4
	<i>Phytocoris</i> sp.	230	9
	<i>Polymerus</i> sp.	97	3
	<i>Polymerus testaceipes</i> (Stål)	200	1
	<i>Proba vitiscuttis</i> (Stål)	49	5
	<i>Proba vitiscuttis</i> (Stål) ^a	35	2
	<i>Taedia incaica</i> (Carvalho & Gomes)	10	1
	<i>Taedia guttulosa</i> (Reuter)	3	1
	<i>Taedia lineolatus</i> (Berg)	495	9
	<i>Taedia signata</i> (Carvalho and Gomes)	8	3
	<i>Taedia stigmosa</i> (Berg)	200	2
	<i>Taylorilygus apicalis</i> (Fieber)	31,294	201
	<i>Taylorilygus apicalis</i> (Fieber) ^a	1,239	8

^a Collections from Paraguay; all others were made in Argentina.

sus, *Phytocoris subvitattus* (Stål), *Phytocoris* sp., *Orthotylus* sp., and *T. cucurbitaceus* (Wheeler 2001). Trophic habits of these groups are poorly understood, but what little is known suggests that they are com-

pllicated. For example, *Phytocoris* species to a great degree live exclusively on one or a few closely related plant species, but little is known about their actual food sources (Wheeler 2001). Several species of *Phy-*

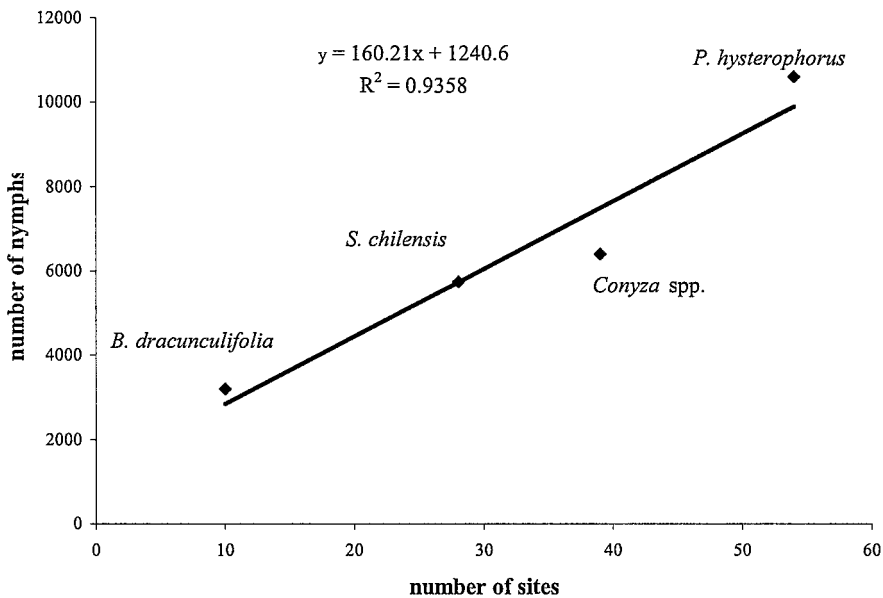


Fig. 1. Relationship between the number of sites sampled and the number of nymphs collected for the main host plants of *T. apicalis* in Argentina and Paraguay. There is no preference of *T. apicalis* for *B. dracunculifolia*, *S. chilensis*, *Conyza* sp., or *P. hysteriphorus*. The utilization of these host plant is densodependent, the same proportion of nymphs per collecting sites was found regardless the host.

Table 5. Summary of mirid–host plant associations in Argentina and Paraguay, 1999–2001

Region	No. sites sampled	No. mirid species	No. host plants	No. mirid–host associations
Western	77	18	17	40
Central	34	4	13	17
Eastern	108	11	27	48

torcoris are at least partially phytophagous (Stonedahl 1988, Schowalter et al. 1999, Wheeler 2001). *Phytocoris varipes* Boheman use Poaceae (Kullenberg 1944, Southwood and Leston 1959, Stonedahl 1988) as well as other plants and possibly insects (Southwood and Leston 1959). *Phytocoris obscuratus* Carvalho has been implicated in injury to cotton in Turkey (Nizamlioglu 1962). *T. cucurbitaceus* is a facultative predator of leafhoppers (Carpintero and Carvalho 1993) and *Sibovia sagata* (Signoret, 1863) (Homoptera: Cicadellidae) (D.L.C., unpublished data) in Argentina. The dicyphine bryocorine often exhibit mixed feeding habits (Wheeler 2001). One of us (D.L.C.) has observed *Campyloneuropsis cincticornis* (Stål) nymphs and adults feeding on aphids, and the gravid females feeding on the nectaries of the host plant *Solanum sisymbriifolium* (Solanaceae). A deraeocorine, *Deraeocoris nigrifrons*, has been recorded feeding on Poaceae (Stephens 1982). *Orthotylus ericetorum* Fallén develops on inflorescences of *Erica* spp. and *Calluna vulgaris* (L.) Hull in Europe (Kullenberg 1944, Southwood and Leston 1959). Thus, definitive “host plant” associations for species with mixed feeding habits must be deferred until careful, rigorous studies of their trophic habits are conducted.

Host Plant–Mirid Associations by Region. Species richness of mirids differed among the three regions. The western region had the highest number of mirid species (18), the eastern region was intermediate (11), and the central region had fewest species (4) (Table 5). Based on the species–area curves, it is expected that mirid richness be proportional to the number of sites sampled. However, in the western region the ratio of number of mirid species to the number of sites sampled (0.21) was larger than in the central (0.15) and the eastern (0.10) regions.

The highest index of similarity values for mirid and host–plant composition were observed between western and central regions (0.36), and between western and eastern regions (0.27). The index of similarity for host plants between the western and central regions was 0.40, and between the western and eastern regions was 0.23. The similarity indices between eastern and central regions were lowest for mirids (0.14) and host plants (0.25). Our results indicated that the highest diversity and richness of mirids occurred in the western region.

The geographical pattern of plant use observed for *T. apicalis* supports the previous hypothesis that plant availability dictates plant use by this bug. In the western region, the main hosts were *P. hysterophorus* at 36 sites, and *Conyza* spp. (a complex of species that is under revision) at 24 sites. *T. apicalis* was collected on

these hosts throughout the year in 100% of the flowering stands. In the central region, the main host of was *P. hysterophorus*, with collections made at 18 sites only in the fall. In the eastern region, the main hosts were *S. chilensis* (26 sites) and *Conyza* spp. (18 sites) in the summer and fall. When the main hosts in the three regions were not flowering, *T. apicalis* used several host plants depending of the month and the geographic region. In Africa *T. vosseleri* seems to have an obligatory relationship with the flowering stage of its host (Stride 1968).

The geographical distributions of *Parthenium hysterophorus*, *Conyza* spp., and *S. chilensis* were described by Cabrera (1963, 1971, 1974, 1978). *Parthenium hysterophorus* occurs in central and northern Argentina, being frequent along roadways, but it is much more common in western Argentina. Species of the *Conyza* complex are widely distributed in Argentina and Paraguay and flower at different seasons. *S. chilensis*, which occurs throughout the study area was used by *T. apicalis* almost exclusively in the eastern region, where it is most abundant.

P. aspersus was the second most abundant species collected in the study (Table 4). This genus is considered to be mainly predacious (Wheeler 2001). *P. aspersus* was restricted to the eastern region where, with one exception, *Senecio grisebachii* Baker, it was collected on the genus *Baccharis* (19 of 20 collections) (Table 2). Sixteen of the 20 collections of *P. aspersus* (1,186 nymphs) were made from *Baccharis dracunculifolia*. Moreover, four of the five species (41 of 42 collections) of *Phytocoris* collected in this study were associated with *Baccharis* species, suggesting a strong association between *Phytocoris* and *Baccharis*. No previous plant associations have been recorded for this mirid. *B. dracunculifolia* is restricted to northern Argentina (Cabrera 1974, 1978) and is most abundant in the eastern region, although it also occurs in the western region (Salta Province) (Carpintero and Carvalho 1993). We found *P. aspersus* nymphs during fall and winter; they were almost absent in spring and summer. Additionally, adults and nymphs were present on plants without flower buds. Because nymphs from each collection site–host plant combination were caged together, it is impossible to determine their trophic habits with certainty. Nymphs reared in this manner might have preyed on other nymphs, fed on the green beans, or both. *Baccharis* might serve as a host for preferred prey of *P. aspersus* and/or *Phytocoris* is a facultative herbivore that prefers *Baccharis*. Thus, the presence of *P. aspersus* on plants may be more closely linked to prey densities than to plant phenology. Some mirids that have mixed feeding habits or are chiefly predacious prefer certain plant species (Slater and Baranowski 1978, Wheeler 2001). For example, some *Phytocoris* species develop only on *Quercus* or *Pinus* (Wheeler 2001). Partial phytophagy may help to synchronize predator and prey populations (Razafimahatratra 1980) and provide nutrients when prey are not present (Razafimahatratra 1980, Stonedahl 1988). Further studies are necessary to elu-

cidate possible *Phytocoris*-*Baccharis*-prey relationships.

At nine sites, 495 of 500 *T. lineolata* Berg nymphs were collected on *G. perennis* (Amaranthaceae) (Table 2). At six sites in the western region nymphs of this mirid were collected in the summer and fall. In the central region it was collected at three sites in the fall. Previous host records include *Atriplex lampa* Gill, and cotton, *Gossypium hirsutum* L., in Argentina (Carpintero and Carvalho 1993). We swept adults of *T. lineolata* from cotton but collected nymphs only on *G. perennis*.

Proba vitiscuttis (Stål) was collected in the eastern and western regions on Asteraceae. In the eastern region, it was collected on *B. dracunculifolia* at five sites (Table 2) at the end of the fall. In the western region it was collected on *E. odoratum* and *P. hysterophorus* at the beginning of the fall. Carpintero and Carvalho (1993) mentioned *P. vitiscuttis* on sunflower, *Helianthus annuus* L., throughout much of Argentina.

The remaining mirids were collected on Asteraceae and Lamiaceae. However, Carpintero and Carvalho (1993) recorded these species mostly on Malvaceae, Fabaceae, and Poaceae. Carpintero and Carvalho (1993) recorded *Dagbertus phaleratus*, *H. tucumanus*, and *P. effictus* on butter bean, *Phaseolus vulgaris* L. (Fabaceae). In particular, the host plants reported for *T. apicalis* and *T. lineolata* seem to be incomplete and/or inaccurate. Carpintero and Carvalho (1993) also listed Poaceae as hosts of *T. apicalis*, *P. effictus*, and *P. bonariensis*. Cotton was listed as a host of *Taedia stigmosa*, *T. lineolata*, and *H. nobilellus*. We did not collect nymphs of *T. lineolata* or *T. stigmosa* on cotton. However, Sosa et al. (1995) demonstrated that *H. nobilellus* can complete its development on cotton in Argentina, where it is considered a pest. This species also has been recorded as a pest of cotton in Brazil (Ramalho 1994).

Mirid-host plant associations described in this study differ from those reported previously in the literature, perhaps due in part to differences in collecting methods. We focused on collection of nymphs, most of which were collected from plants on which the bugs had developed, i.e., actual hosts used as sources of nutrition. After collection, nymphs were reared to adulthood en masse while being provided with plant tissue as a food source. Other studies (e.g., Carpintero and Carvalho (1993), relied on collections of adults from light traps or sweep nets and inferring host plant associations from plants near the collection site. Mirid-host associations derived from collection and subsequent rearing of nymphs are more reliable than those of adults. Future studies might focus on nymphs collected on host plants and reared individually to adulthood for identification.

In general, the trophic relations of most mirids have been little studied, the research having focused on crops and ornamentals, ignoring most associations with weeds and other noncultivated host plants that nevertheless play important roles in mirid life histories. In this study, we collected 22 mirid species on 43 plants, resulting in 85 mirid plant associations. Before

this study, Carpintero and Carvalho (1993) reported 68 mirid species on 57 plant species (112 mirid plant associations) for Argentina. Our results are consistent with the prevailing belief that the diet breadth of mirids ranges from monophagy to polyphagy (Wheeler 2001). Among the phytophagous mirids, most are considered oligophagous (Wheeler 2001). We collected numerous species on only one host plant, whereas other species were collected on several hosts (Table 2). In our study, the mirids did not seem to be highly host specific, although some seemed to show a preference for certain plants. Most species were collected from several hosts, whereas only one, *T. apicalis*, was broadly polyphagous (Table 2). This mirid, an introduced species, seemed to have the widest diet breadth (>36 species in eight families). Perhaps its ability to use numerous host plants over a broad geographic range facilitated its apparent success as an introduced species.

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References Cited

- Bosq, J. M. 1937. Lista preliminary de los Hemípteros (Heterópteros) especialmente relacionados con la agricultura nacional. Rev. Soc. Entomol. Arg. 9: 111-134.
- Bosq, J. M. 1940. Lista preliminary de los Hemípteros (Heterópteros) especialmente relacionados con la agricultura nacional (continuación). Rev. Soc. Entomol. Arg. 10: 399-417.
- Boyes, D. G. 1964. The bionomics and control of mirids attacking castor, pp. 12-15. In Symposium on entomological problems, Pretoria, 17-21 July 1961. Dep. Agric. Tech. Serv., Pretoria. Tech. Commun. No. 12.
- Cabrera, A. L. 1963. Flora de la Provincia de Buenos Aires (República Argentina). Compositae. Colección Científica del Instituto Nacional de Tecnología Agropecuaria 4: 1-443.
- Cabrera, A. L. 1971. Flora Patagónica (República Argentina). Compositae. Colección Científica del Instituto Nacional de Tecnología Agropecuaria 8: 1-451.
- Cabrera, A. L. 1974. Flora de la Provincia de Entre Ríos (República Argentina). Compositae. Colección Científica del Instituto Nacional de Tecnología Agropecuaria 6: 106-554.
- Cabrera, A. L. 1978. Flora de la Provincia de Jujuy (República Argentina). Compositae. Colección Científica del Instituto Nacional de Tecnología Agropecuaria 13: 1-726.
- Cadou, J. 1993. Les Miridae du cotonnier en Afrique et à Madagascar. CIRAD-CA, Paris, French.
- Carpintero, D. L., and J.C.M. Carvalho. 1993. An annotated list of the Miridae of the Argentine Republic (Hemiptera). Rev. Brasil Biol. 53: 397-420.
- Carvalho, J.C.M., and R. Hussey. 1954. On a collection of Miridae (Hemiptera) from Paraguay, with descriptions of three new species. Occas. Papers Mus. Zool. Mich. 552: 1-11.
- Carvalho, J.C.M. 1959. A catalogue of the Miridae of the world. Part IV. Subfamily Mirinae. Arp. Mus. Nac. Rio J. 48: 1-384.

- Day, W. H. 1999. Host preferences of introduced and native parasites (Hymenoptera: Braconidae) of phytophagous plant bugs (Hemiptera: Miridae) in alfalfa-grass fields in the northeastern USA. *Biocontrol* 44: 249–261.
- Debolt, J. W. 1981. Laboratory biology and rearing of *Leiophron uniformis* (Gahan) (Hymenoptera: Braconidae), a parasite of *Lygus* spp. (Hemiptera: Miridae). *Ann. Entomol. Soc. Am.* 74: 334–337.
- Henry, T. J., and A. G. Wheeler Jr. 1982. New United States records for six Neotropical Miridae (Hemiptera) in southern Florida. *Fla. Entomol.* 65: 257–268.
- Knight, H. H. 1918. Interesting new species of Miridae from the United States, with a note on *Orthocephalus mutabilis* (Fallen) (Hemiptera: Miridae). *Bull. Brook. Entomol. Soc.* 13: 111–116.
- Kullenberg, B. 1944. Studien über die Biologie der Capsiden. *Zool. Bidr. Upps.* 23: 1–522.
- Lindberg, H. 1958. Hemiptera Insularum Caboverdensium: Systematik, Ökologie und Verbreitung der Heteropteran und Cicadinen der Kapverdischen Inseln. *Comment. Biol. Soc. Sci. Fenn.* 19: 1–246.
- Linnavuori, R. 1974. Studies on African Miridae (Heteroptera). *Occas. Publ. Entomol. Soc. Niger.* 12: 1–67.
- MacFarlane, J. 1989. The hemipterous insects and spiders of sorghum panicles in northern Nigeria. *Insect Sci. Appl.* 10: 277–284.
- McKinlay, K. S., and Q. A. Geering. 1957. Studies of crop loss following insect attack on cotton in East Africa. I. Experiments in Uganda and Tanganyika. *Bull. Entomol. Res.* 48: 833–849.
- Morán Lemir, A. H. 1985. Entomofauna relacionada con *Flaveria bidentis* (L.) O. K. (Compositae), en las Provincias de Tucumán y Santiago del Estero (República Argentina). *CIRPON. Rev. de Investig.* 3: 39–51.
- Nizamlioglu, K. 1962. Türkiye pamuklarında yeni bir hasere *Phytocoris obscurus* Reut. *Koruma (Istanbul)* 3: 6–7.
- Palmer, W. A. 1987. The phytophagous insect fauna associated with *Baccharis halimifolia* L. and *B. neglecta* Britton in Texas, Louisiana, and northern Mexico. *Proc. Entomol. Soc. Wash.* 89: 185–199.
- Quintanilla, R. H., A. E. Margheritis, and H. F. Rizzo. 1967. Catálogo de los Hemípteros hallados en la Provincia de Entre Ríos. *Rev. Fac. Agr. Vet. Univ. Buenos Aires* 17: 29–38.
- Quintanilla, R. H., A. E. Margheritis, and H. F. Rizzo. 1976. Catálogo de los Hemípteros hallados en la Provincia de Corrientes (Arg.). *Rev. Soc. Entomol. Arg.* 35: 115–133.
- Quintanilla, R. H., H. F. Rizzo, and A. S. de Núñez. 1981. Catálogo preliminar de los Hemípteros hallados en la Provincia de Misiones. *Rev. Fac. Agr. Univ. Buenos Aires* 2: 145–161.
- Ramallo, F. S. 1994. Cotton pest management: Part 4. Brazilian perspective. *Annu. Rev. Entomol.* 39: 563–578.
- Razafimahatratra, V. P. 1980. A revision of the genus *Deiraocoris* Kirschbaum (Heteroptera: Miridae) from western America north of Mexico. Ph.D. dissertation, Oregon State University, Corvallis, OR.
- Rizzo, H. F. 1976. Hemípteros de interés agrícola. Chinchas perjudiciales y chinchas benéficas para los cultivos. Edit. Hemisferio Sur, Buenos Aires, Argentina.
- Rizzo, H. F. 1977. Catálogo de los insectos perjudiciales en cultivos de la República Argentina. Edit. Hemisferio Sur, Buenos Aires, Argentina.
- Schowalter, T. D., D. C. Lightfoot, and W. G. Whitford. 1999. Diversity of arthropod responses to host-plant water stress in a desert ecosystem in southern New Mexico. *Am. Midl. Nat.* 142: 281–290.
- Scudder, G.G.E. 1997. True bugs (Heteroptera) of the Yukon, pp. 241–336. In H. V. Danks and J. A. Downes [eds.], *Insects of the Yukon. Monogr. Ser. 2. Biological Survey of Canada (Terrestrial Arthropods)*, Ottawa, Canada.
- Slater, J. A., and R. M. Baranowski. 1978. How to know the true bugs (Hemiptera: Heteroptera). Brown, Dubuque, IA.
- Snodgrass, G. L., T. J. Henry, and W. P. Scott. 1984a. An annotated list of the Miridae (Heteroptera) found in the Yazoo-Mississippi delta and associated areas in Arkansas and Louisiana. *Proc. Entomol. Soc. Wash.* 86: 845–860.
- Snodgrass, G. L., W. P. Scott, and J. W. Smith. 1984b. Host plants of *Taylorilygus pallidulus* and *Polymerus basalis* (Hemiptera: Miridae) in the delta of Arkansas, Louisiana, and Mississippi. *Fla. Entomol.* 67: 402–408.
- Sorensen, T. 1948. A method for establishing groups of equal magnitude in plant sociology based in similarity of species content. *R. Danish Acad. Sci. Lett. Biol. Skrift.* 5: 1–34.
- Sosa, M. A., J. Fariña Núñez, R. O. Lorenzini, and G. Lazarczuk. 1995. Evaluación de métodos de muestreo de chinche horcias en el cultivo de algodón. Informe Técnico N° 5. Centro Regional Santa Fé. Estación Experimental Agropecuaria Reconquista, INTA, Santa Fé, Argentina.
- Southwood, T.R.E., and D. Leston. 1959. Land and water bugs of the British Isles. Warne, London, United Kingdom.
- Stephens, III, G. M. 1982. The plant bug fauna (Heteroptera: Miridae) of grasses (Poaceae) of Medicine Bow Mountain Ranger District, Wyoming. *Wyo. Agric. Exp. Stn. Sci. Monogr.* 43: 1–175.
- Stonedahl, G. M. 1988. Revision of the mirine genus *Phytocoris* Fallén (Heteroptera: Miridae) for western North America. *Bull. Am. Mus. Nat. Hist.* 188: 1–257.
- Stride, G. O. 1968. On the biology and ecology of *Lygus vosseleri* (Heteroptera: Miridae) with special reference to its hostplant relationships. *J. Entomol. Soc. S. Afr.* 31: 17–55.
- Taylor, T.H.C. 1947. Some East African species of *Lygus*, with notes on their host plants. *Bull. Entomol. Res.* 38: 233–258.
- Wheeler, Jr., A. G. 2001. Biology of the plant bugs: pests, predators, opportunists. Cornell University Press, Ithaca, NY.
- Wheeler, Jr., A. G., and T. J. Henry. 1992. A synthesis of the Holarctic Miridae (Heteroptera): distribution, biology, and origin, with emphasis on North America. Thomas Say Found. Monogr. vol. 15. Entomological Society of America, Lanham, MD.
- Williams, L., III, G. A. Logarzo, S. R. Shaw, L. D. Price, and V. Manrique. 2003. *Leiophron argentinensis* Shaw (Hymenoptera: Braconidae) - a new species of parasitoid from Argentina and Paraguay, with information on life history and potential for controlling *Lygus* bugs (Hemiptera: Miridae). *Ann. Entomol. Soc. Am.* 96: 834–846.

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