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Diversity of True Bugs (Hemiptera: Heteroptera) on Common Ragweed (*Ambrosia artemisiifolia*) in Southern Slovakia

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Abstract: The common ragweed (*Ambrosia artemisiifolia* Linnaeus 1800) is an exceptionally invasive species. The information on true bugs occurring on ragweed plants is limited in the invasion region. The objective of this study was to determine the species composition of Heteroptera associated with *A. artemisiifolia*, to assess their vectoring potential based on a literature review, and to compare species similarity in the surveyed fields. Field surveys were conducted in 2020–2021 at 10 sites in southern Slovakia. Sweeping and visual observations were conducted in field margins, weedy agricultural fields, and mowed meadows infested with *A. artemisiifolia*. In the study, food specialization, the abundance of individual species, and their assignment to families were precisely determined. The Jaccard similarity index was used to evaluate similarities in species composition among the sites studied. A total of 2496 true bugs were recorded, representing 47 species of Heteroptera from 12 families. The most common phytophagous species were *Nysius ericae ericae* (Schilling, 1829) (Pentatomomorpha, Lygaeidae), *Adelphocoris lineolatus* (Goeze, 1778), *Lygus rugulipennis* (Poppius, 1911), *Lygus pratensis* (Linnaeus, 1758) (Cimicomorpha, Miridae), and a zoophagous species *Nabis* (*Dolichonabis*) *limbatus* (Dahlbom, 1851) (Cimicomorpha, Nabidae). The species similarities in pair-wise combined localities were low, with a dominance of highly migratory and polyphagous species able to traverse the field from the adjacent landscape. *A. artemisiifolia* is a known host for plant viruses and phytoplasmas, and several Heteroptera species are carriers of these plant pathogens. *Halyomorpha halys* was the only detected vector of phytoplasmas, and its abundance on *A. artemisiifolia* was extremely low.

Keywords: insect guild; habitat; invasive weed; vectors; carriers; Cimicomorpha; Pentatomomorpha; plant pathogens

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1. Introduction

The common ragweed (*Ambrosia artemisiifolia*/Linnaeus 1800/Asteraceae) is an invasive North American plant found in Europe and elsewhere [1–5]. The species has serious negative impacts on agriculture [6] and human health [7,8] and threatens biodiversity [9]. It produces allergenic pollen that is hazardous to the human respiratory system [10,11], and is a major cause of allergic rhinitis [12]. The native insect guild that is associated with common ragweed in Europe is mostly polyphagous and causes little damage. Only 18 insect species have been proposed as candidates for the biological control of *A. artemisiifolia* in Europe [13]. True bugs/Heteroptera (Insecta: Hemiptera: Heteroptera) are a large, cosmopolitan suborder of Hemiptera that includes over 45,000 described species. This is a diverse, abundant, and globally successful group. Their trophic behavior is also diverse, ranging from herbivores to predators [14]. Most true bugs are phytophagous [15], and the habitat characteristics are important for the structure of their guilds [16]. Their herbivorous species include some destructive pests, while their predatory species can be useful in agriculture, horticulture, and forestry [15]. Numerous sap-sucking bugs are involved in plant disease transmission [17,18]. Accurate data on the occurrences of true bugs are scarce, e.g., on sandy grasslands [19], in agricultural landscapes [20,21], or on litter and soil [22], but the occurrence of heteropterans on common ragweed in its introduced range in Eurasia is an area that remains poorly studied [23–26]. Since the occurrence of heteropterans on ragweed is common, we hypothesized that they might serve as carriers or vectors of ragweed diseases. Therefore, we decided to conduct a survey in southern Slovakia to determine the species composition of Heteroptera on *A. artemisiifolia*, their trophic preferences, and their ability to transmit and/or carry diseases. We also investigated the effects of geographic regions and local habitats on true bugs' guild.

2. Materials and Methods

Heteropterans were collected with an insect net (30 cm diameter) by sweeping the canopy of *A. artemisiifolia* or by beating the plants (3 × 30 plants per locality). The species caught in situ were euthanized in the field with ethyl acetate ($C_4H_8O_2$). The insects were monitored at 10 localities in southern Slovakia in 2020 and 2021 (Table 1, Figure 1). Screening was conducted from mid-July (beginning of flowering) to mid-late August (end of flowering) in three habitat types—field margins, weedy agricultural fields, and mowed meadows. The localities had low elevation, sandy-loam, or loamy soils, warm to very warm climates, moderately moist to very dry areas, and mild to cool winters [27]. The aerial distance between the westernmost (Balvany) and easternmost locality (Malé Trakany) was 310 km. The Jaccard similarity index was used to assess the true bugs species' composition similarities between the two localities [28,29]. The trophic preferences and vectoring ability were determined using information published in the literature. Relevant entomological identification keys were used to identify the true bugs, and the identification was confirmed by Heteroptera expert Jozef Cunev, Nitra, Slovakia.

Table 1. Geographical coordinates and habitat characteristics of the studied localities in southern Slovakia in 2020–2021.

Locations	Latitude, Longitude	Altitude (m/a.s.l.)	Habitats, Geo Relief	Climate Region
Western Slovakia				
Balvany (Figure 2)	47°50′24′′ N, 17°59′57′′ E	110	Field margins, plane	Warm, very dry, mild winter
Malá nad Hronom (Figure 3)	47°51′25′′ N, 18°40′40′′ E	140	Weedy agricultural field, hilly country	Warm, very dry, mild winter
Sikenička (Figure 4)	47°55′42′′ N, 18°41′34′′ E	140	Field margins, hilly country	Warm, very dry, mild winter
Central Slovakia				
Gemerský Jablonec (Figure 5)	48°11′57′′ N, 19°59′22′′ E	239	Mowed meadow, hilly country	Warm, moderate humid, cool winter
Tachty (Figure 6)	48°09′23′′ N, 19°56′59′′ E	262	Field margins, hilly country	Warm, moderate humid, cool winter
Eastern Slovakia				
Brehov (Figure 7)	48°29′59′′ N, 21°48′29′′ E	112	Field margins, hilly country	Warm, dry, cool winter
Malé Trakany (Figure 8)	48°23′58′′ N, 22°07′54′′ E	110	Field margins, plane	Warm, dry, cool winter
Strážne (Figure 9)	48°22′23′′ N, 21°50′47′′ E	100	Weedy agricultural field, plane	Warm, dry, cool winter

Table 1. *Cont.*

Locations	Latitude, Longitude	Altitude (m/a.s.l.)	Habitats, Geo Relief	Climate Region
Svätuše	48°25′16″ N, 21°55′10″ E	110	Field margins, plane	Warm, dry, cool winter
Veľký Horeš (Figure 10)	48°22′22″ N, 21°54′10″ E	100	Weedy agricultural field, plane	Warm, dry, cool winter

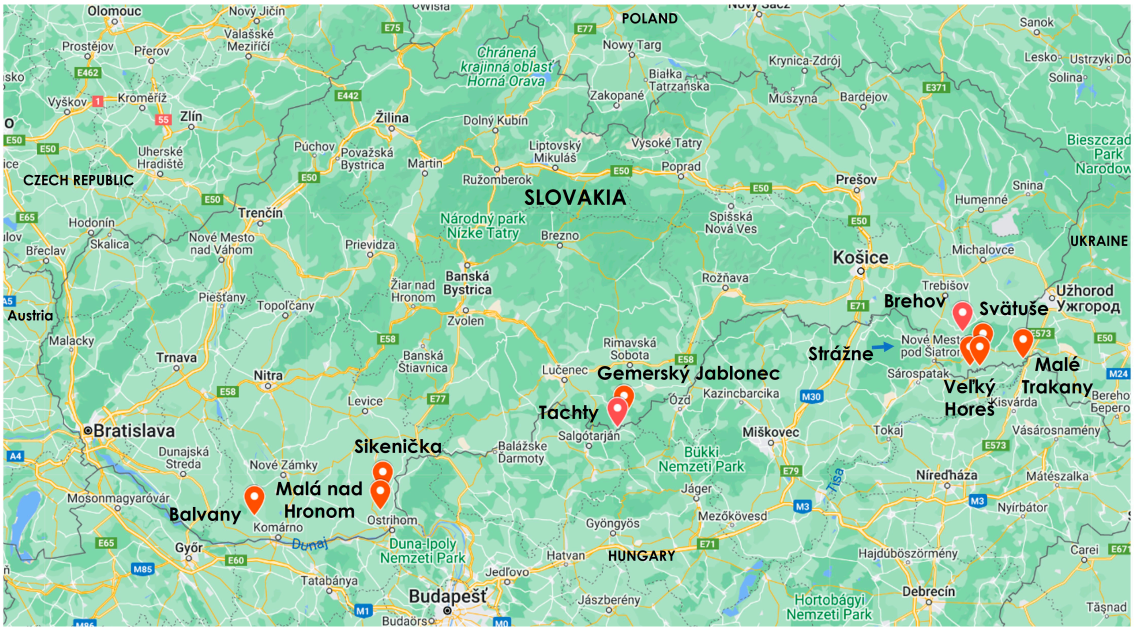

Figure 1. Sunflower field margin along the field path in Balvany (photo P. Tóth).

Figure 2. Weedy agricultural field near Malá and Hronom (photo P. Tóth).

Figure 3. Weedy corn field margin in Sikenička (photo P. Tóth).

Figure 4. Mowed semi-natural meadow in Gemerský Jablonec (photo P. Tóth).

Figure 5. Weedy field margin along the field road at Tachty (photo P. Tóth).

Figure 6. Heavily infested sunflower field, Brehov (photo P. Tóth).

Figure 7. Weed-infested field margin along the trees in the dike area near Malé Trakany (photo P. Tóth).

Figure 8. Heavily infested corn field in Strážne (photo P. Tóth).

Figure 9. Heavily infested corn field in Strážne (photo P. Tóth).

Figure 10. Weedy agricultural field in Veľký Horeš (photo P. Tóth).

3. Results and Discussion

During the field surveys in 2020–2021 at 10 localities throughout southern Slovakia, 2496 Heteroptera individuals were detected in sweep samples from stands of invasive *A. artemisiifolia*. A total of 47 species from the 12 families Nabidae, Miridae, Tingidae (Cimicomorpha), Coreidae, Rhopalidae, Stenocephalidae, Berytidae, Lygaeidae, Oxycarenidae, Rhyparochromidae, Pentatomidae, and Scutelleridae (Pentatomomorpha) were detected (Table 2).

Table 2. True bugs (Hemiptera: Heteroptera) fauna of flowering *Ambrosia artemisiifolia* during 2020–2021 in southern Slovakia.

Infraorder/Family/Species	Food Specialization	References	Balvany	Malá nad Hronom	Sikenička	Gemerský Jablonec	Tachty	Brehov	Malé Trakany	Strážne	Svatuše	Veľký Horeš	TOTAL	Relative Occurrence (%)
CIMICOMORPHA														
NABIDAE														
Nabis (Dolichonabis) limbatus Dahlbom, 1851	zoophagous	(Wachmann et al. 2006 [30])	53	185	4	7	14	2	25	12	2	32	336	13.46
Nabis rugosus (Linnaeus, 1758)	zoophagous	(Wachmann et al. 2006 [30])									1		1	0.04
MIRIDAE														
Adelphocoris lineolatus (Goeze, 1778)	phyto, poly (Fabaceae, eggs are laid to some Asteraceae)	(Puchkov 1972 [31])	70	149	5	32	20	6	53	35	11	100	481	19.27
Adelphocoris vandalicus (Rossi, 1790)	phyto, poly (incl. Asteraceae)	[32]		1									1	0.04
Adelphocoris seticornis (Fabricius, 1775)	phyto, oligo (Fabaceae)	(Wachmann et al. 2004: [30])				1			3				4	0.16
Deraeocoris (Deraeocoris) ruber (Linnaeus, 1758)	zoophagous	[33]							1				1	0.04
Deraeocoris (Camptobrochis) punctulatus (Fallén, 1807)	phytozoophagous (mostly Solanaceae)	[34,35]	1	2									3	0.12

Table 2. *Cont.*

Infraorder/Family/Species	Food Specialization	References	Balvany	Malá nad Hronom	Sikenička	Gemerský Jablonec	Tachty	Brehov	Malé Trakany	Strážne	Svatuše	Veľký Horeš	TOTAL	Relative Occurrence (%)
Lygocoris (Lygocoris) pabulinus (Linnaeus, 1761)	phyto, poly	(Southwood & Leston 1959 [36])					1		1		1		3	0.12
Lygus pratensis (Linnaeus, 1758)	phyto, poly (incl. Asteraceae)	(Lu & Wu 2008 [31])	47	37	18	6	5	4	23	12	6	13	171	6.85
Lygus rugulipennis Poppius, 1911	phyto, poly (Asteraceae among the most important)	[37]	54	92	2	3	6	1	2	3	1	25	189	7.57
Orthops (Orthops) campestris (Linnaeus, 1758)	phyto, oligo (Apiaceae)	(Wachmann et al. 2004 [30])		1			3	2	1				7	0.28
Orthotylus sp.	various, indefinite			50									50	2.00
Stenodema (Brachystira) calcarata (Fallén, 1807)	phyto, poly (Poaceae rarely Cyperaceae and Juncaceae)	[38]		2		1				2			5	0.20
Trigonotylus pulchellus (Hahn, 1834)	phyto, poly Amaranthaceae, Fabaceae, *Vitis vinifera*	(Lodos et al. 2003 [39])	3	11	1	1		3	6	2		4	31	1.24

Table 2. *Cont.*

Infraorder/Family/Species	Food Specialization	References	Balvany	Malá nad Hronom	Sikenička	Gemerský Jablonec	Tachty	Brehov	Malé Trakany	Strážne	Svatuše	Veľký Horeš	TOTAL	Relative Occurrence (%)
TINGIDAE														
Corythucha ciliata (Say, 1832)	phyto, oligo (*Platanus* spp.)	[40]							1				1	0.04
Dictyla echii (Schrank, 1782)	phyto, oligo (Boraginaceae)	[41]							1				1	0.04
PENTATOMOMORPHA														
COREIDAE														
Coreus marginatus marginatus (Linnaeus, 1758)	phyto, poly (Polygonaceae, Asteraceae)	(Putshkov 1962 [42])		5					1				6	0.24
Gonocerus juniperi (Herrich-Schaeffer, 1839)	phyto, oligo (Cupressaceae)	[40]		1									1	0.04
RHOPALIDAE														
Brachycarenus tigrinus Schilling, 1829	phyto, poly (mostly Brassicaceae, Chenopodioideae, Amaranthaceae, Ericaceae)	[43]		7									7	0.28

Table 2. *Cont.*

Infraorder/Family/Species	Food Specialization	References	Balvany	Malá nad Hronom	Sikenička	Gemerský Jablonec	Tachty	Brehov	Malé Trakany	Strážne	Svatuše	Veľký Horeš	TOTAL	Relative Occurrence (%)
Corizus hyoscyami hyoscyami (Linnaeus, 1758)	phyto, poly (incl. Asteraceae)	[44]		1									1	0.04
Chorosoma schillingii (Schilling, 1829)	phyto, oligo (Poaceae)	[45]		1									1	0.04
Myrmus miriformis miriformis (Fallén, 1807)	phyto, oligo (Poaceae)	[46]		2									2	0.08
Stictopleurus abutilon abutilon (Rossi, 1790)	phyto, oligo (Asteraceae)	[47]		3	1								4	0.16
Stictopleurus punctatonervosus (Goeze, 1778)	phyto, oligo (Asteraceae)	[46]	1						4		1		6	0.24
Rhopalus (Rhopalus) parumpunctatus Schilling, 1829	phyto, poly (incl. Asteraceae)	[46,48]		7					1	1			9	0.36
Rhopalus (Rhopalus) subrufus (Gmelin, 1790)	phyto, poly (incl. Asteraceae, some preference for Lamiaceae)	[46,48]		3								3	6	0.24
STENOCEPHALIDAE														
Dicranocephalus medius (Mulsant a Rey, 1870)	phyto, oligo (*Euphorbia*)	[48]		3									3	0.12

Table 2. *Cont.*

Infraorder/Family/Species	Food Specialization	References	Balvany	Malá nad Hronom	Sikenička	Gemerský Jablonec	Tachty	Brehov	Malé Trakany	Strážne	Svatuše	Veľký Horeš	TOTAL	Relative Occurrence (%)
BERYTIDAE														
Berytinus (Berytinus) minor minor (Herrich-Schaeffer, 1835)	phyto, poly (mainly Fabaceae)	[48,49]	1										1	0.04
LYGAEIDAE														
Lygaeus equestris (Linnaeus, 1758)	phyto, mono (*Vincetoxicum hirundinaria*)	[50]		1					1				2	0.08
Nysius ericae ericae (Schilling, 1829)	phyto, poly (incl. Asteraceae)	[48,51]	63	1004	1	2				11		19	1100	44.07
Nysius helveticus (Herrich-Schaeffer, 1850)	phyto, poly (incl. Asteraceae)	[48]									1		1	0.04
Nysius senecionis senecionis (Schilling, 1829)	phyto, oligo (Asteraceae, preference for *Senecio*)	[48,52]									2		2	0.08
OXYCARENIDAE														
Metopoplax origani (Kolenati, 1845)	phyto, oligo (Asteraceae)	[53]							4		5	3	12	0.48

Table 2. *Cont.*

Infraorder/Family/Species	Food Specialization	References	Balvany	Malá nad Hronom	Sikenička	Gemerský Jablonec	Tachty	Brehov	Malé Trakany	Strážne	Svatuše	Veľký Horeš	TOTAL	Relative Occurrence (%)
RHYPAROCHROMIDAE														
Rhyparochromus vulgaris (Schilling, 1829)	phyto, poly (seed feeder)	[48,54]		2									2	0.08
PENTATOMIDAE														
Aelia acuminata (Linnaeus, 1758)	phyto, oligo (Poaceae)	[55]		12					1		1		14	0.56
Aelia klugii Hahn, 1833	phyto, oligo (Poaceae)	[56]		1									1	0.04
Aelia rostrata (Boheman, 1852)	phyto, oligo (Poaceae)	[57]		2									2	0.08
Carpocoris (Carpocoris) purpureipennis (De Geer, 1773)	phyto, poly (incl. Asteraceae)	[58,59]	2						1				3	0.12
Dolycoris baccarum (Linnaeus, 1758)	phyto, poly (incl. Asteraceae)	[60]										4	4	0.16
Eurydema (Eurydema) oleracea (Linnaeus, 1758)	phyto, oligo (Brassicaceae)	[58]	1	4									5	0.20
Eysarcoris ventralis (Westwood, 1837)	phyto, poly (incl. Asteraceae)	[61]		1									1	0.04
Graphosoma italicum (Müller, 1766)	phyto, oligo (Apiaceae)	[62]					1		1			3	5	0.20

Table 2. *Cont.*

Infraorder/Family/Species	Food Specialization	References	Balvany	Malá nad Hronom	Sikenička	Gemerský Jablonec	Tachty	Brehov	Malé Trakany	Strážne	Svatuše	Veľký Horeš	TOTAL	Relative Occurrence (%)
Peribalus (Peribalus) strictus strictus (Fabricius, 1803)	phyto, poly (incl. Asteraceae)	[63]							2				2	0.08
Piezodorus lituratus (Fabricius, 1794)	phyto, poly (mainly Fabaceae)	[48]				1							1	0.04
Halyomorpha halys Stål, 1855	phyto, poly (incl. Asteraceae)	[64]		2									2	0.08
Zicrona caerulea (Linnaeus, 1758)	zoophagous	[65]		2					1				3	0.12
SCUTELLERIDAE														
Eurygaster testudinaria testudinaria (Geoffroy, 1785)	phyto, poly (mostly Poaceae, Cyperaceae, incl. Asteraceae)	[48,66]										2	2	0.08
			296	1594	32	54	50	18	134	78	32	208	2496	100.00

The phytophagous true bugs guild was the most abundant, with 41 species (2102 specimens). The polyphagous guild comprised 23 different species (2029 specimens). These species were generalists with a wide range of host plants; therefore, it was difficult to determine their trophic preferences in detail. However, a more detailed analysis of trophic relationships revealed the dominance of polyphagous species with a trophic affinity for Asteraceae (16 species, 1979 specimens). The most common polyphagous species without a trophic affinity to Asteraceae was *Trigonotylus pulchellus* (Hahn, 1834) which occurred at most of the localities examined in this study. The remaining polyphagous species occurred in low numbers and at random in the habitats studied. The abundance of specialized species (oligophagous and monophagous) was extremely low compared to generalists. A total of 17 oligophagous species (71 specimens) were identified, of which only 4 (24 specimens) were trophically linked to Asteraceae. The trophic preferences of monophagous species (2 specimens) were not associated with Asteraceae (Table 2).

The four most abundant herbivorous species were *Nysius ericae ericae* (Schilling, 1829) (Pentatomomorpha: Lygaeidae) 44.07%, *Adelphocoris lineolatus* (Goeze, 1778) 19.27%, *Lygus rugulipennis* (Poppius, 1911) 7.57%, and *Lygus pratensis* (Linnaeus, 1758) 6.85% (Cimicomorpha: Miridae). All of the species are polyphagous with trophic relationships to Asteraceae, and are widespread and native to Europe [31]. In Italy, *N. ericae ericae* was common in dry grasslands with shrubs and invasive plant invasion [26]. *N. ericae* has also been identified as a feeder on green mustard pods, and is a carrier of the plant pathogen *Nematospora coryli* [67]. According to Judd and Hodkinson [68], this species is associated with Asteraceae on early successional sites, sand dunes, marshes, heaths, and wastelands, and on abandoned or weedy agricultural fields. Despite their polyphagy, many species of mirid bugs (Miridae) show specific feeding preferences for host plants and plant parts [69]. *A. lineolatus* shows a strong preference for *Medicago sativa*—a host plant that is important for overwintering and early season development [70,71]. The preferred host plants of *L. rugulipennis* are nitrophilous wild plants (*Urtica dioica*, *Artemisia vulgaris*, *Tripleurospermum inodorum*, *Matricaria matricarioides*, and *Senecio vulgaris*), and the most reported cultivated host plants are Fabaceae (*Medicago sativa* and *Trifolium pratense*), which symbiotically fix nitrogen [37]. *L. pratensis* is biologically and ecologically close to *L. rugulipennis*, has a similar range of host plants, and often co-occurs with the latter, although usually in smaller numbers [72]. The four most common herbivore species are known to be vectors or carriers of plant pathogens (viruses, phytoplasmas, bacteria, and fungi) (Table 3).

Table 3. Vectoring potential and presence of viruses and Mollicutes in true bugs (Hemiptera: Heteroptera) associated with flowering *Ambrosia artemisiifolia* during 2020–2021 in Slovakia.

Infraorder/Family/Species	Food Specialization	Carrier/Vector	References	Abundance (pcs)	Abundance (%)
CIMICOMORPHA					
MIRIDAE					
Adelphocoris lineolatus (Goeze, 1778)	phyto, poly (Fabaceae, eggs are laid to some Asteraceae)	Ca. P. solani (16Sr XII) (carrier)	[73]	481	19.27
		Aster yellows phytoplasma (16SrI-C and 16SrI-F) (carrier)	[74]		
Lygocoris (Lygocoris) pabulinus (Linnaeus, 1761)	phyto, poly	*Erwinia amylovora* (pear shoots) (vector)	[75]	3	0.12
Lygus pratensis (Linnaeus, 1758)	phyto, poly (incl. Asteraceae)	Ca. P. solani (16Sr XII) (mixed sample of L. pratensis and L. rugulipennis) (carrier)	[76]	171	6.85
		Potato leaf roll virus (PLRV), Potato virus Y (PVY), Potato virus S (PVS), Potato virus M (PVM), Potato virus A (PVA) (carrier)	[77,78]		

Table 3. *Cont.*

Infraorder/Family/Species	Food Specialization	Carrier/Vector	References	Abundance (pcs)	Abundance (%)
Lygus rugulipennis (Poppius, 1911)	phyto, poly (Asteraceae among the most important)	Potato leaf roll virus (PLRV), Potato virus M (PVM) (vector) X-disease 16SrIII-B (in larva) (carrier) Ca. P. solani (16Sr XII) (carrier) Aster yellows phytoplasma (16SrI-C and 16SrI-F) (carrier) Pseudomonas syringae pv. aptata (sugar beet) (carrier)	(Turka 1978 [17]) [79] [73] [74] (Bilewicz-Pawińska 1967 [69])	189	7.57
Orthops (Orthops) campestris (Linnaeus, 1758)	phyto, oligo (Apiaceae)	*Stemphylium radicinum* (vector)	(Bech 1967 in [80])	7	0.28
PENTATOMOMORPHA					
LYGAEIDAE					
Nysius ericae ericae (Schilling, 1829)	phyto, poly (incl. Asteraceae)	*Nematospora coryli* (on Brassica juncea) (carrier)	[67]	1100	44.07
PENTATOMIDAE					
Halyomorpha halys (Stål, 1855)	phyto, poly (incl. Asteraceae)	Paulownia witches' broom phytoplasma (16SrI-D) (vector)	[81]	2	0.08

L. pratensis has been identified as a carrier of potato viruses—potato leaf roll virus (PLRV), potato virus Y (PVY), potato virus A (PVA), potato virus S (PVS), and potato virus M (PVM) [77,78]. The recognized vectors for these viruses are aphids. PVRL is transmitted in a persistent circulative manner; all the other viruses are non-persistently transmitted and spread through tubers as well as mechanically [82–85]. *A. artemisiifolia* serves as a reservoir for the PVY virus [77,78]. *L. rugulipennis* and *A. lineolatus* were recently identified as new carriers of Ca. Phytoplasma solani [73]. Although Ca. P. solani has a broad host plant range, including weeds [86], direct evidence of *A. artemisiifolia* as a host plant has only recently been confirmed [87]. Asteraceae (including *A. artemisiifolia*) are known to be hosts for the Aster yellows phytoplasma (AYp). This phytoplasma was detected in *A. lineolatus* and *L. rugulipennis* collected in southern Moravia (Czech Republic) [74]. In another study conducted in vineyards in the same region, AYp was not present in these two true bugs [73]. The X-disease phytoplasma found in *L. rugulipennis* infects most *Prunus* species and potentially a wide host range of herbaceous plants, including annual and perennial weeds [88]. Recently, a phytoplasma of the X-disease group, ribosomal subgroup 16SrIII-B, was detected in some perennial herbaceous plants of the Asteraceae family, *Echinacea purpurea* (L.) Moench, which is native to North America [89], *Cirsium arvense* (L.) Scop. [90], and *Arnica montana* L., native to Europe [91]. It is important to note that the isolation of phytoplasmas from *A. lineolatus*, *L. rugulipennis*, and *L. pratensis* does not guarantee their ability to transmit the disease [17]. The vectoring ability of *Stephanitis typica* (Tingidae), the only Cimicomorpha species previously classified as a phytoplasma vector, has not been confirmed [92]. True bug species belonging to the infraorder Cimicomorpha (Heteroptera) are characterized by a non-sheath-forming cell rupture feeding type [93]. Non-phloem feeding *Lygus* species preferentially feed on plant meristem tissue or developing reproductive organs [94]. The plant meristematic tissue is usually free of pathogens [95]. Meristematic tissues in terminal buds are the main source of auxin [96]. A loss of auxin-producing tissues due to feeding by *Lygus* bugs can lead to altered vegetative growth. Altered plant architecture is a result of suppressed apical dominance and an increased growth of lateral branches from the axillary buds [94]. These morphological changes can be referred to as corymb-like plant habits with a flat-topped appearance, as described for *Arabidopsis thaliana* (L.) Heynh. inflorescence [97].

Since phytoplasmas are phloem-limited, phloem-feeding insects can potentially acquire and transmit the pathogen [98]. Phloem feeding is usually associated with the formation of stylet salivary sheaths [99]. In Heteroptera, the formation of salivary sheaths is a common feature of the infraorder Pentatomomorpha, but their target sites include mesophyll or reproductive tissue (mature seeds, developing endosperm) in addition to vascular tissue. In the case of seed feeding, sheath formation is minimal [17]. Aster yellows phytoplasma (ribosomal subgroup SrI-A) has recently been detected in the seeds and seedlings of *Zea mays* L. [100], *Brassica napus* L., and *B. rapa* L. [101]. Many Lygaeidae species feed on nutrient-rich seeds, but also on plant sap [102,103]. The most numerous seed-feeding species in our collection was *N. ericae ericae*. Their ability to acquire phytoplasmas from seeds or other plant parts is not known, but phytoplasmic DNA was found in two Lygaeoidea species, *Nysius vinitor* Bergroth and *Oxycarenus maculatus* Stal [104,105]. However, there is evidence that phytoplasmas may be pathogens or beneficial symbionts of hemipteran insects [106]. In Slovakia, the highly polyphagous invasive *Halyomorpha halys* Stål, 1855 (Pentatomomorpha: Pentatomidae) was present in the guild of species associated with *A. artemisiifolia*. *H. halys* transmits the Paulownia witches' broom phytoplasma. Phytoplasma isolates found from China, Korea, and Japan belonged to ribosomal subgroup 16SrI (Aster yellows and related phytoplasmas) [81].

The fifth most abundant species was the predatory true bug *Nabis* (*Dolichonabis*) *limbatus* Dahlbom, 1851 (Nabidae), with a relative abundance of 13.46%. Nabids are predators of leafhoppers (Auchenorrhyncha), aphids (Sternorrhyncha), leaf beetles (Coleoptera: Chrysomelidae), and the eggs and larvae of Lepidoptera. Several species are also predators of Miridae, especially on the genus *Lygus* [107]. *N. limbatus* occurred at all of the observed localities, except Svätuše. In Svätuše, only one specimen of *N. rugosus* (Linnaeus, 1758) was found at the field margins. There is evidence that nabids respond to habitat manipulation. Higher populations are found in more diverse agroecosystems where insecticides are not used [108]. Since there is evidence that nabids feed on plants to obtain water [109], the use of systemic insecticides may negatively affect their populations [110].

A few specimens of *Zicrona caerulea* (Linnaeus, 1758) (Pentatomidae) found at two surveyed localities were predaceous. The species is usually associated with *Oenothera biennis* L. (Onagraceae), infested by herbivores outside of agricultural land. *O. biennis* may act as a companion plant that maintains this predatory true bug in the field margin and inside the crop field [65].

The predominantly phytophagous Miridae included a zoophagous species, *Deraeocoris* (*Deraeocoris*) *ruber* (Linnaeus, 1758), and a few specimens of the zoophytophagous *Deraeocoris* (*Camptobrochis*) *punctulatus* (Fallén, 1807). *D. punctulatus* was most abundant on solanaceous plants [35], and frequently fed on the whitefly *Bemisia tabaci* (Gennadius, 1889) (Hemiptera: Aleyrodidae) [111]—an important and versatile vector of plant viruses [112].

The highest similarity of true bug species was observed in pair combinations of distant localities with low species diversity—Sikenička, Gemerský Jablonec, and Strážne (60–70%) (Table 4). These localities were situated in different geographical areas of south Slovakia (the western, central, and eastern parts) with a warm humid climate that has been defined as very dry, dry and moderately humid, with mild to cool winters (Table 1). The lowest similarity of true bug species was found in the pair combination of locality Svätuše, with all others (8–27%) differing in habitat, georelief, and humidity (Tables 1 and 4). During the studied period (2020–2021), the localities in western Slovakia (Balvany, Malá nad Hronom, and Sikenička) had a mean annual temperature of 11.6 °C and a mean annual precipitation of 485 mm; the localities in central Slovakia (Gemerský Jablonec and Tachty) had a mean annual temperature of 10.8 °C with a mean annual precipitation of 636 mm; and the localities in eastern Slovakia (Strážne, Veľký Horeš, Svätuše, Brehov, and Malé Trakany) had a mean annual temperature of 10.6 °C with a mean annual precipitation of 620 mm [113,114]. Regardless of the mean annual temperature, precipitation, and winter season, most of the pair-wise combined localities had low species similarity with a median of Jaccard index as 28% (ranging from 8 to 70%) (Table 4). This suggests differences in the Heteroptera species composition at the localities studied, and a weak relationship with selected habitats and *A. artemisiifolia*.

Table 4. Jaccard similarity index (%) of true bug species on *Ambrosia artemisiifolia* by pairwise compared sites and quantitative characteristics of the heteropteran guild. Heteroptera were collected throughout southern Slovakia in 2020–2021.

Sites	**Balvany**	**Malá n/Hronomm**	**Sikenička**	**Gemerský Jablonec**	**Tachty**	**Brehov**	**Malé Trakany**	**Strážne**	**Svätuše**	**Veľký Horeš**
Balvany	•	24	50	43	28	33	28	46	17	37
Malá n/Hronom	9/28 *	•	23	22	15	17	27	27	8	21
Sikenička	6/12	7/30	•	60	40	50	22	67	27	50
GemerskýJablonec	6/14	7/22	6/10	•	33	40	17	70	12	42
Tachty	4/14	4/33	4/11	4/12	•	50	33	36	23	38
Brehov	5/12	6/30	5/8	5/10	5/8	•	23	44	18	33
MaléTrakany	7/25	11/37	5/23	5/24	7/21	6/20	•	26	25	28
Strážne	6/13	8/30	6/9	7/10	4/11	5/9	6/23	•	13	46
Svätuše	5/16	5/36	4/14	4/16	5/13	4/13	8/24	4/15	•	17
VeľkýHoreš	6/16	7/34	6/12	6/14	5/12	5/12	7/24	6/13	5/17	•

* The number of same species on both sites/amount of all species in both sites. • not applicable—data for the same location.

We studied three habitats; the most predominant ones were field margins, ragweed/weed-infested agricultural fields, and a mowed meadow, in three geographical areas of southern Slovakia (Table 1). No relationship between habitats or climate region and Heteropterans species similarity using the Jaccard index were found. Therefore, we are of the opinion that the composition of the landscape surrounding each field studied had a stronger influence on the composition and abundance of insect species than the field vegetation itself. The main reason for this could be the prevalence of polyphagous species and the presence of oligophagous species without a trophic affinity to Asteraceae (Table 2). Like other pest species, heteropterans are good flyers and colonizers that use and traverse different habitat types during their life cycle [115]. In the summer, *A. artemisiifolia* provided a suitable food source (maturing seeds on the main inflorescence and terminal buds on lateral shoots) for both infraorder representatives. Weeds are an important alternative food source, and play a significant role in promoting biodiversity in agroecosystems [116,117].

4. Conclusions

The studied localities in southern Slovakia showed low species similarity of true bugs with a Jaccard index median of 28%, and a weak relationship with habitats and *A. artemisiifolia*. The community of true bugs was composed of 16 species of the infraorder Cimicomorpha (51.48%) and 31 species of infraorder Pentatomomorpha (48.52%). The Cimicomorpha species, *Adelphocoris lineolatus* and *Lygus pratensis*, were recorded at all 10 localities, with *Nabis limbatus* at 9, and *Lygus rugulipennis* and *Trigonotylus pulchellus* at 8 localities. *Nysius ericae ericae* occurred at 6 localities and accounted for 90.83% of all Pentatomomorpha species. The remaining species occurred irregularly. Therefore, we assume that the landscape surrounding each studied field had a stronger influence on the species composition and abundance of the true bugs than the vegetation of the field. We found that 69.6% of the polyphagous species had trophic relationships with Asteraceae. The most numerous herbivorous Cimicomorpha species (*A. lineolaris*, *L. rugulipennis*, and *L. pratensis*) are known to be carriers of plant viruses or phytoplasmas. The only documented vector of phytoplasmas is *Halyomorpha halys* (Pentatomomorpha), which transmits Aster yellows and related phytoplasmas to Paulownia trees. *A. artemisiifolia* is a known reservoir for several plant viruses and phytoplasmas, including Aster yellows disease. From our results and the literature review, we can conclude that Heteroptera remains a less important vector of phytoplasmas. *A. artemisiifolia* serves as an important reservoir for plant pests and provides an alternative food source for true bugs in the summer, after crop harvest. Therefore, it plays an important role in maintaining populations of polyphagous true bugs in the studied agricultural habitats in southern Slovakia.

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