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Spider fauna associated with wheat crops and adjacent habitats in Buenos Aires, Argentina

Araneofauna asociada a cultivos de trigo y hábitats adyacentes en Buenos Aires, Argentina

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Abstract. A census of spiders was undertaken in winter wheat fields of Buenos Aires province, Argentina, as well as from their margins and from wheat stubble. Spiders were collected weekly over 3 consecutive years using entomological sweeping and pitfall traps. Field margins were the richest and densest habitats (H'= 3.27, J'= 0.82) and registered 52 species from 14 families, while 31 species from 13 families were found in wheat. Thomisidae and Araneidae were the most abundant families in the herbaceous layer of both the margins and the crop, and Lycosidae in the soil litter. In contrast, 17 species from 8 families were recorded from wheat stubble, making it the least diverse habitat surveyed (H'= 1.67, J'= 0.72). These results could be related to repeated disturbance of wheat fields by harvest, tillage and other field work. Furthermore, the similarity observed in the families of both margin and crop communities indicates that colonization of wheat fields is from the adjacent areas.

Key words: Araneae, diversity, agroecosystems, natural enemies.

Resumen. Se realizó un censo de arañas en cultivos de trigo de invierno de la provincia de Buenos Aires, Argentina, así como en sus márgenes y en el rastrojo. Las arañas fueron recolectadas semanalmente con redes entomológicas y trampas de caída durante 3 años consecutivos. El margen del cultivo fue el hábitat más rico y más denso (H'= 3.27, J'= 0,82) y registró un total de 52 especies pertenecientes a 14 familias, mientras que en el cultivo de trigo se encontraron 31 especies pertenecientes a 13 familias. Thomisidae y Araneidae fueron las familias más abundantes en el estrato herbáceo (tanto en los márgenes como en el cultivo) y Lycosidae en el suelo; mientras que en el rastrojo del trigo se registraron 17 especies representantes de 8 familias y fue el hábitat menos diverso (H'= 1.67, J'= 0,72). Estos resultados podrían estar relacionados con el disturbio repetido, debidos a la cosecha, la labranza y otros trabajos de campo. Por otra parte, la similitud observada entre las familias de ambas comunidades del margen y del cultivo indicaría que el proceso de colonización se iniciaría en las áreas adyacentes.

Palabras clave: Araneae, diversidad, agroecosistemas, enemigos naturales.

Introduction

Spiders (Araneae) represent a significant component of the terrestrial arthropod diversity, with approximately 40 000 species described to date (Platnick, 2010). They have been found to represent abundant, species-rich predators in European crop fields (Sunderland et al., 1997; Marc et al., 1999; Töth and Kiss, 1999; Nyffeler and Sunderland, 2003) and contribute to the control of agricultural pests (Symondson et al., 2002; Lang, 2003; Schmidt et al., 2003). Protection and promotion of natural enemies in agroecosystems depend on the information about their phenology, habitat preferences, and behavior. The first step is to gather knowledge about the spider fauna that inhabits the commercial fields and forests (Rinaldi, 2005)

Winter wheat and corn are the 2 most important cereal crops in Argentina. Only few data sets concerning the spider assemblages of arable lands are available. Minervino (1996), Liljesthröm et al. (2002), and Beltramo et al. (2006) have examined the spider community in soybeans fields, and Armendano and González (2010) in alfalfa crops. According to a recent bibliography of arachnological studies, the present research is the first to study the spider fauna of winter wheat in Argentina. Thus our study aimed to analyze the spider assemblages of winter wheat fields, adjacent margins, and wheat stubble with respect to biotic diversity and the development of integrated pest management (IPM).

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Materials and methods

Study sites and spider sampling. Spiders were studied in three 1 ha lots of winter wheat (*Triticum aestivum* L.) in the Experimental Station of Gorina (34º 53' S y 58º 05' W), Buenos Aires province, Argentina. Winter wheat fields were drilled every year in autumn, received only herbicides prior to implantation, and no insecticides were applied. Crops were surrounded by adjacent margins of spontaneous vegetation of Compositae, Graminae, and Cruciferae, represented by the dominant species *Carduus acanthoides* L., *Bromus unioloides* Kunth, and *Raphanus sativus* (L.). The collections were carried out weekly over 3 consecutive years (2004 -2006) on wheat crops (WC), adjacent margins (AM), and wheat stubble (WS). The spider community was sampled at the plant layers in WC and AM, with a 38 cm diameter sweep net and with pitfall traps in soil stratum of WC, AM, and WS. These traps consisted of 6.5cm x 12cm plastic containers, filled with 30% ethylene glycol as a preserver. Each sampling consisted in 40 sampling units in the wheat crop, arranged in 4 linear transects. Traps were buried and distributed every 20 m, and in each point at the plant layer, 20 sweeps were performed, at a rate of 6 movements each one. All captured material was preserved in 70% ethyl alcohol and identified at the laboratory. Individuals were identified to family and adults to species or morphospecies. The classification used follows Platnick (2010). Voucher specimens were deposited in the Arachnological Laboratory of the Center of Parasitological Studies (University of La Plata).

Data analyses. The data were analysed with EstimateS Version 8.0 (Colwell, 2006). The species richness (S) and the Shannon- Wienner (H'), Margalef (DMg), Simpson (D), and Pielou (J) diversity indexes were calculated (Colwell and Coddington, 1994; Moreno, 2001). To analyse guild structure of spiders in wheat the classification of Uetz et al. (1999) was used.

Results

Taxonomic structure. In total, 1 701 specimens representating 13 families and 31 species were collected on wheat crops (WC). Eight families were captured from the plant layer (N= 939, 55.20%) and 13 families from the ground (N= 762, 44.79%). The most abundant families were Thomisidae (21.46%), Araneidae (15.70%), and Anyphenidae (9.81%) in the foliage, and Lycosidae (18.52%) and Linyphiidae (9.05%) in the soil litter (Table 1). The other families represented less than 7% of the total abundance. In wheat stubble (WS), 89 spiders were collected with pitfall traps, representing 8 families. The most abundant families were Tetragnathidae (46.06%) and Linyphiidae (21.35%). The other families represented less than 7% of the total abundance (Table 1). In adjacent margins (AM), 14 families were recorded. The most abundant were Araneidae (21.32%), Thomisidae (12.99%). and Oxyopidae (8.59%) in the foliage, and Lycosidae (18.33%), Tetragnathidae (10.26%), and Hahniidae (8.86%) in the soil litter (Table 1).

According to the guild structure classification proposed by Uetz et al. (1999), in WC we registered 7 spider guilds (Table 1). The dominant group was hunting spiders, represented by ambushers (21.58%) and ground runners (19.70%). The other dominant guild comprised orb weavers (18.58%), with the largest number of recognized species (7) (Table 2). The rest of the guilds represented less than 11% of all captures. In WS we recorded 6 guilds; orb weavers (46.06%) and wandering sheet/tangle weavers (21.35%) were the dominant guilds. In AM we registered 8 guilds; orb weavers (31.58%), ground runners (19.51%), and ambushers (14.09%) were dominant.

Species diversity. In WC, 31 species were determined, of which 20 were captured in the foliage (Table 2). The most abundant species was *Misumenops pallidus* (Keyserling, 1880) (Thomisidae) (20.11%), followed by *Araneus* sp.1 (Araneidae) (8.29%), *Gayenna* sp. (Anyphaenidae) (8.23%), and *Oxyopes salticus* Hentz, 1845 (Oxyopidae) (6.82%). In the soil litter the most abundant species were *Lycosa poliostoma* (Koch, 1847) (11.17%), *Lycosa erythrognatha* (Lucas, 1836) (7.35%) (Lycosidae), *Meioneta* sp. (Linyphiidae) (7.17%), and *Hahnia* sp. (Hahniidae) (6.58%). In WS, 17 species were determined and the most abundant species was *Glenognatha lacteovittata* (Mello-Leitão, 1944) (Tetragnathidae) (46.07%). All the families were represented by a single species, with the exception of Theridiidae (S= 3). In AM, 51 species were captured, 36 in the foliage. The most abundant species was *O. salticus* (Oxyopidae) (8.71), followed by *Araneus* sp.1 (Araneidae) (5.87%), *M. pallidus* (Thomisidae) (3.57%), and *Metepeira* sp. (Araneidae) (3.45%). In the soil stratum the most abundant species were *L. poliostoma* (Lycosidae) (10.67%), *G. lacteovittata* (Tetragnathidae) (10.40%), and *Hahnia* sp. (Hahniidae) (8.98%). Only Oxyopidae was represented by 1 species. The richest families were Araneidae (S= 15), Lyniphiidae (S= 9), and Thomisidae (S= 6). The values of the Shannon- Wienner (H'), Margalef (DMg), Simpson (D), and Pielou (J) indices characterizing species diversity are shown in Table 3. The level of species diversity for adjacent margins (AM) is higher than in wheat crops (WC) and wheat stubble (WS).

Temporal diversity of spiders. Spiders were recorded throughout the phenological development of the wheat crop. In the herbaceous layer the greatest abundance peak occurred in spring (October and November). The greatest number of spiders was recorded in November (N= 220)

Table 1. Guild structure, abundance, and species richness of spider families in wheat crops, stubble, and adjacent margins

	Wheat crop			*Stubble*			*Adjacent Habitats*		
	S	*% Families*	*% Guilds*	*S*	*% Families*	*% Guilds*	*S*	*% Families*	*% Guilds*
Sheet web builders			*10.64*			*5.62*			*11.62*
Amaurobiidae	2	4.06		0	0		2	2.76	
Hahniidae	1	6.58		1	5.62		1	8.86	
Orb weavers			*18.58*			*46.06*			*31.58*
Araneidae	7	15.70		0	0		15	21.32	
Tetragnathidae	1	2.88		1	46.06		1	10.26	
Wandering sheet/tangle weavers			*9.05*			*21.35*			*8.18*
Linyphiidae	4	9.05		1	21.35		9	8.18	
Ambushers			*21.58*			*0*			*14.09*
Philodromidae	1	0.12		0	0		2	1.10	
Thomisidae	4	21.46		0	0		6	12.99	
Space web builders			*0*			*5.62*			*0.34*
Theridiidae	0	0		3	5.62		3	0.34	
Ground runners			*19.70*			*14.61*			*19.51*
Coriniidae	1	0.53		1	5.62		2	0.57	
Gnaphosidae	1	0.65		1	2.25		1	0.61	
Lycosidae	2	18.52		1	6.74		2	18.33	
Foliage runners			*9.81*			*0*			*5.26*
Anyphaenidae	2	9.81		0	0		3	5.26	
Stalkers			*10.64*			*6.74*			*9.42*
Oxyopidae	1	6.82		0	0		1	8.59	
Salticidae	4	3.82		1	6.74		3	0.83	
Total	31	100	100	10	100	100	51	100	100

(Fig. 1A) and the predominant families were Thomisidae (*M. pallidus*), Araneidae (*Araneus* sp.), and Oxyopidae (*O. salticus*), representing 43.98% of the total number of spiders caught in vegetation. The lowest number of spiders was recorded in June (N= 39) (Fig. 1B). On the ground, Lycosidae (*L. poliostoma*, *L. erythrognatha*), Hahniidae (*Hahnia* sp.), and Linyphiidae (*Meioneta* sp.) represented 34.15%, and were the most abundant especially during summer (December) (N= 249). The lowest number of spiders was recorded in June (N= 35).

Discussion

The spider species found in wheat represent less than one fourth of those cited for Argentina (Pikelin and Schiapelli, 1963; Platnick, 2010), which is compatible with results obtained by Young and Edwards (1990) in cereal crops. The spider community registered in this study is similar to the arachnofauna in US field crops, which is more evenly dispersed over families, and hunting spiders from several families make up a large percentage (Young and Edwards, 1990; Greenstone, 2001; Nyffeler and Sunderland, 2003). Web-building spiders in US crops are represented mainly by the families Tetragnathidae, Araneidae, Linyphiidae, Theridiidae, and Dictynidae; the hunters by Oxyopidae, Salticidae, Clubionidae, Thomisidae, and Lycosidae (Nyffeler, 1999). In contrast, the spider fauna of European field crops is very uniform, inhabited by different spider species, mainly from the families Linyphiidae, Lycosidae, Araneidae, Tetragnathidae, and Theridiidae (Luczak, 1979; Sunderland, 1987), but it is largely dominated by Linyphiidae (Nyffeler and Sunderland, 2003; Clough et al., 2005; Schmidt and Tscharntke, 2005), while in this study Linyphiidae represented less than 10% of the total abundance in the soil litter.

In studies conducted near Lima, Peru, it was found that 80-90% of the spiders collected from cotton were hunting spiders (predominantly Anyphaenidae,

Table 2. Families and species/morphospecies of spiders associated with wheat crops, stubble, and adjacent margins (TC:techniques collection; S: sweep net; P: pitfall trap)

		Wheat crops (WC)		*Wheat stubble (WS)*		*Adjacent margins (AM)*	
Family	*Species/morphospecies*	*TC*	*%*	*TC*	*%*	*TC*	*%*
Araneomorphae							
Amaurobiidae	Morpho sp. 1	P	0.35			P	0.61
"	" sp. 2	P	3.7			P	2.19
Anyphaenidae	*Gayenna sp.*	S/P	8.23			S/P	2.88
"	Morpho sp. 2	S	1.59			S/P	1.27
Araneidae	*Araneus* sp. 1	S/P	8.29			S/P	5.87
"	*Araneus* sp. 2	S/P	1.41			S/P	1.27
"	*Argiope* sp.					S	0.58
"	*Cyclosa* sp.					S/P	1.07
"	*Gea heptagon* (Hentz, 1850)					S/P	1.50
"	*Larinia* sp.					S/P	1.77
"	*Metepeira* sp.	S	3.23			S/P	3.45
"	*Metazygia* sp.	S/P	1			S/P	2.07
"	*Wixia* sp.					S	0.31
"	Morpho sp. 1	S	0.41				
"	" sp. 2					S	0.12
"	" sp. 3	S/P	0.65				
"	" sp. 4	S	0.71				
"	" sp. 5					P	1.04
"	" sp. 6					P	1.00
"	" sp. 7					S	0.23
"	" sp. 8					S	0.12
"	" sp. 9					S/P	1.15
Coriniidae	*Trachelas* sp.	P	0.53			P	0.35
"	Morpho sp. 1			P	5.62	P	0.12
Gnaphosidae	Morpho sp. 1	P	0.65	P	2.25	P	0.61
Hahniidae	*Hahnia* sp.	S/P	6.58	P	5.62	P	8.98
Lycosidae	*Lycosa poliostoma* (Koch, 1847)	P	11.17	P	6.74	S/P	10.67
"	*Lycosa erythrognatha* (Lucas, 1836)	P	7.35			P	7.91
Linyphiidae	*Meioneta* sp.	S/P	7.17			S/P	2.76
"	Erigoninae					S/P	0.81
"	*Erigone* sp. 1					P	0.96
"	*Erigone* sp. 2					S	0.35
"	Morpho sp. 1	P	0.18				
"	" sp. 3	P	0.41				
"	" sp. 4	S/P	1.29	P	21.35	S/P	1.04
"	" sp. 5					S/P	0.31
"	" sp. 6					P	1.04
"	" sp. 7					S/P	0.58
"	" sp. 8					S/P	0.46
Oxyopidae	*Oxyopes salticus* (Hentz, 1845)	S/P	6.82			S/P	8.71
Philodromidae	Morpho sp. 1	S/P	0.12			S	0.81
"	" sp. 2					S	0.31

Table 2. Continues

Family	Species/morphospecies	Wheat crops (WC) TC	%	Wheat stubble (WS) TC	%	Adjacent margins (AM) TC	%
Salticidae	Dendryphantinae					S	0.35
"	*Dendryphantes* sp.					S	0.15
"	*Tullgrenella* sp.					S	0.23
"	Morpho sp.1	S/P	2.59	P	6.74	S	0.12
"	" sp. 2	P	0.35				
"	" sp. 4	S	.53				
Tetragnathidae	*Glenognatha lacteovittata* (Mello-Leitao, 1944)	P	2.88	P	46.07	P	10.40
Theridiidae	*Achaearanea* sp.			P	3.37	P	0.12
"	*Argyrodes* sp.			P	1.12	P	0.12
"	*Tidarren* sp.			P	1.12	P	0.12
Thomisidae	*Misumenops pallidus* (Keyserling, 1880)	S	20.11			S	3.57
"	*Misumenops* sp.	S	0.24			S/P	2.88
"	*Misumena* sp.	S/P	0.76			S	2.01
"	*Misumena vatia*					P	0.63
"	Morpho sp. 3	S/P	0.35			S/P	2.42
"	" sp. 4					S	1.62
T			100		100		100

Table 3. Species richness and diversity indices of spiders in wheat crops, stubble, and adjacent margins

	Wheat crops (WC)	Wheat Stubble (WS)	Adjacent margins (AM)
S	31	17	51
H'	1.95	1.67	3.27
DMg	4.03	2.04	7.67
D	0.09	0.28	0.05
J	0.69	0.72	0.82

S: species richness, diversity indexes: Shannon-Wienner (H'), Margalef (DMg), Simpson (D) and Pielou (J).

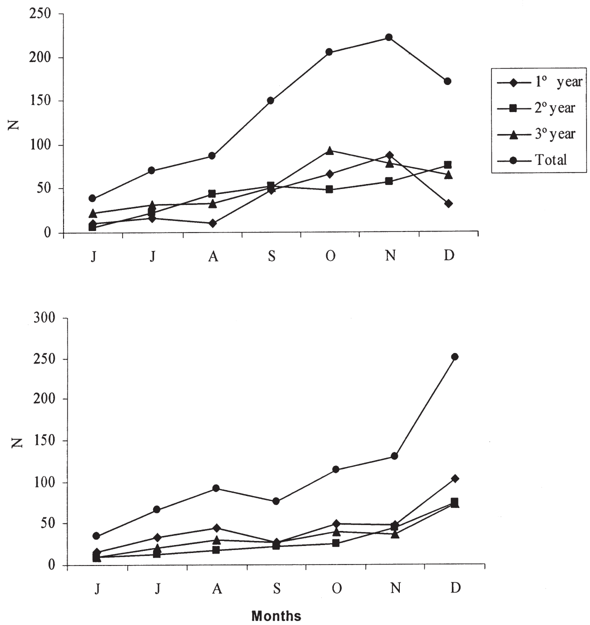

Figure 1. Total spider abundance during the phenological development in wheat crops. (A), foliage; (B), soil litter.

Clubionidae, Salticidae, and Thomisidae), whereas Linyphiidae constituted only 1% (Aguilar, 1977, 1979). This is consistent with studies carried out in Argentinean crops. Also a similar taxonomic composition and species diversity (37 species representative of 13 families) was observed in soybean and alfalfa field crops (Minervino, 1996; Liljesthröm et al., 2002; Beltramo et al., 2006; Armendano and González, 2010), whereas Thomisidae (*M. pallidus*) and Lycosidae were the most abundant families in the herbaceous and soil stratum, respectively.

The dominant group of spiders recorded in wheat fields and adjacent margins were hunting spiders, coinciding with the information reported by Nyffeler and Sunderland (2003). This guild made up 50% of the spider individuals collected in US fields, where *O. salticus* was a particularly prominent agroecosystem colonizer (Dean and Sterling, 1987; Young and Edwards, 1990). In areas with drier climate, Oxyopidae are replaced by Thomisidae as a dominant family (e.g. west Texas and Arizona are dominated by *Misumenops* spp.) (Plagens, 1983; Dean and

Sterling, 1987). In contrast, in this study, wheat stubble was dominated by Linyphiids and Tetragnathids, small web-building species found near the ground together with Theridiids, which were not registered in the field crop. These differences can be explained because spider assemblages are highly influenced by variations in plant community structure, ecosystem dynamics such as disturbance, and abiotic factors such as soil texture, environmental humidity, and temperature (Bonte et al., 2002).

While spiders were recorded throughout the phenological development of the wheat crop, a greater abundance peak occurred in spring and summer coinciding with reproductive periods and the emergence of juveniles, when the vegetation reached its highest development, resulting in stable microhabitats, where the permanent ground vegetation provides shelter and a wide availability of prey for spiders. Adjacent margins seem to be a more dense and rich habitat than wheat fields. This is explained because the fields are strongly and repeatedly disturbed by harvest, tillage, and other agricultural activity, while disturbance in the adjacent margins does not destroy the habitat. Furthermore, the similarity observed in the families of both margin and crop communities could indicate that the fields are colonized from the adjacent margins. These results could be related to the composition of the spontaneous vegetation in the margins, which provides a complex structure to meet life requisites such as web construction, brood care, mating, shelter, active hunting, ambush hunting, and dispersal (McDonald, 2007).

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