



## RECORDS OF EPIGEAL SPIDERS IN BAHÍA BLANCA IN THE TEMPERATE REGION OF ARGENTINA

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**ABSTRACT.** Ecological surveys of diversity and seasonal patterns of spiders in relation with cadavers have rarely been conducted, despite the high potential species diversity and abundance of spiders. The composition, abundance, guilds and seasonality of the spiders of Bahía Blanca, in the temperate region of Argentina were analysed. The study was performed in a semi-rural area between 2010 and 2011, using pitfall traps that were checked daily during  $168 \pm 7$  days in winter, 38 days in spring, 30 days in summer, and 71 days in autumn. A total of 972 spiders were recorded belonging to 22 families and 65 species/morphospecies. The most abundant families were: Lycosidae, Zodariidae, Thomisidae, Theridiidae and Salticidae. The guild with more specimens was represented by ground hunters followed by specialists and ambush hunters, and the guild with the greatest number of species corresponded also to the ground hunters. Considering all specimens, adults prevailed with respect to juveniles, and males were more abundant than females. The more abundant species were *Leprolochus birabeni*, *Steatoda* sp. 1, Thomisidae sp. 33, Thomisidae sp. 32, *Ostearius melanopygius* and *Metaltella simoni*.

**Key words:** Araneae, diversity, guilds, pitfall traps, taxocenosis.

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**RESUMEN.** A pesar del alto potencial de la diversidad de especies y abundancia de arañas, raramente han sido conducidos censos ecológicos de la diversidad y de los patrones estacionales de arañas en relación con cadáveres. Se analizó la composición, abundancia, gremios y estacionalidad de las arañas de Bahía Blanca, en la región templada de Argentina. El estudio se realizó en un área semi-rural entre 2010 y 2011, usando trampas de caída que se revisaron diariamente durante  $168 \pm 7$  días en invierno, 38 días en primavera, 30 días en verano, y 71 días en otoño. Se registraron un total de 972 arañas pertenecientes a 22 familias y 65 especies/morfo-especies. Las familias más abundantes fueron: Lycosidae, Zodariidae, Thomisidae, Theridiidae y Salticidae. El gremio con más especímenes estuvo representado por las cazadoras del suelo seguidas por las especialistas y por las cazadoras por emboscada, y el gremio con el mayor número de especies corresponde también al de las cazadoras del suelo. Considerando todos los especímenes, los adultos prevalecieron respecto a los juveniles, y los machos fueron más abundantes que las hembras. Las especies más abundantes fueron *Leprolochus birabeni*, *Steatoda* sp. 1, Thomisidae sp. 33, Thomisidae sp. 32, *Ostearius melanopygius* y *Metaltella simoni*.

**Palabras clave:** Araneae, diversidad, gremios, trampas pitfall, taxocenosis.

### INTRODUCTION

Spiders are a diverse, widely distributed group in all terrestrial ecosystems and even freshwater (Turnbull 1973; Foelix 2011). At the trophic level, the spiders are important generalist predators due to their abundance, biomass, species diversity and life strategies. Their feeding habits influence the density and activity of detritivores and fungivores, affecting the litter decomposition process (Wise *et al.* 1999; McNabb *et al.* 2001), and they are a key factor to the mortality of crop pest insects (Liljesthrom *et al.* 2002).

A cadaver can represent a trophic and/or reproductive resource, among others, to the associated fauna. Most scavenger species are insects, belong to the orders Coleoptera, Diptera and Hymenoptera, but also arthropods such as spiders (Araneae), millipedes (Diplopoda), centipedes (Chilopoda) and isopods (Isopoda), are commonly associated with that resource and/or ephemeral habitats, due to their predatory or saprophagous habits (Norris 1965; Seastedt *et al.* 1981; Keh 1985; Smith 1986; Lord 1990; Catts & Goff 1992). Considering the ecological role of the cadaveric entomofauna, such arthropods are regarded as adventitious or accidentals species, that is, those which



use the cadaver as an extension of their own normal habitat (Catts & Goff 1992; Goff 2009). In forensic cases, the presence of spiders can confirm the compatibility of the specimens with the environment (García Rojo *et al.* 2009) and, together with other opportunistic insects, could provide clues about the type and location of the crime scene (Chin *et al.* 2011).

Several factors can influence the abundance, distribution and composition of spiders, such as: the type and structure of the vegetation (Scheidler 1990; Rubio *et al.* 2008); the type of habitat (Hatley & MacMahon 1980; Uetz 1991); the pattern of land use (Weeks & Holtzer 2000); seasonality (Lubin 1978; Sudhikumar *et al.* 2005; Mineo *et al.* 2010); climatic conditions (Crouch & Lubin 2000; Kwon *et al.* 2014); amongst others. The latter are considered environment indicators (Clausen 1986; Mael-fait *et al.* 1990; Willett 2001; Pinkus-Rendón *et al.* 2006; Tsai *et al.* 2006). Certain species are associated to environments with a certain degree of disturbance. Some of them are related to urban environments and can be found inside homes or in the peridomicile, and are indicators of anthropic impact (Durán-Barrón *et al.* 2009; Greene *et al.* 2009; Lima Silveira 2009; Silva de Miranda & Ponce Leão Giupponi 2011; Desales-Lara *et al.* 2013; Cramer 2015). Other species can disperse and/or broaden their geographic location, adapting to new environments and becoming introduced or invasive species that usually displace native ones, eventually resulting in a loss of biodiversity, due to human activity (Taylor & Doran 2001). Therefore, because of farming and cattle breeding activity, the anthropic action has caused changes in the ecosystems (Barnes *et al.* 1998), modifying populations, species distribution, structure and functioning of communities, and even more leading to eventual extinctions (Meffe & Carroll 1994).

In Argentina, census or studies of the community or different patterns of spiders were performed with different crops and in different places (Liljeström *et al.* 2002; González *et al.* 2009; Armendrano & González, 2010, 2011a, b; Almada *et al.* 2012; Avalos *et al.* 2013). Also, spiders associated with other ecosystems of Argentina were studied under different conditions (Avalos *et al.* 2007; Rubio & Moreno 2010; Pompozzi *et al.* 2011).

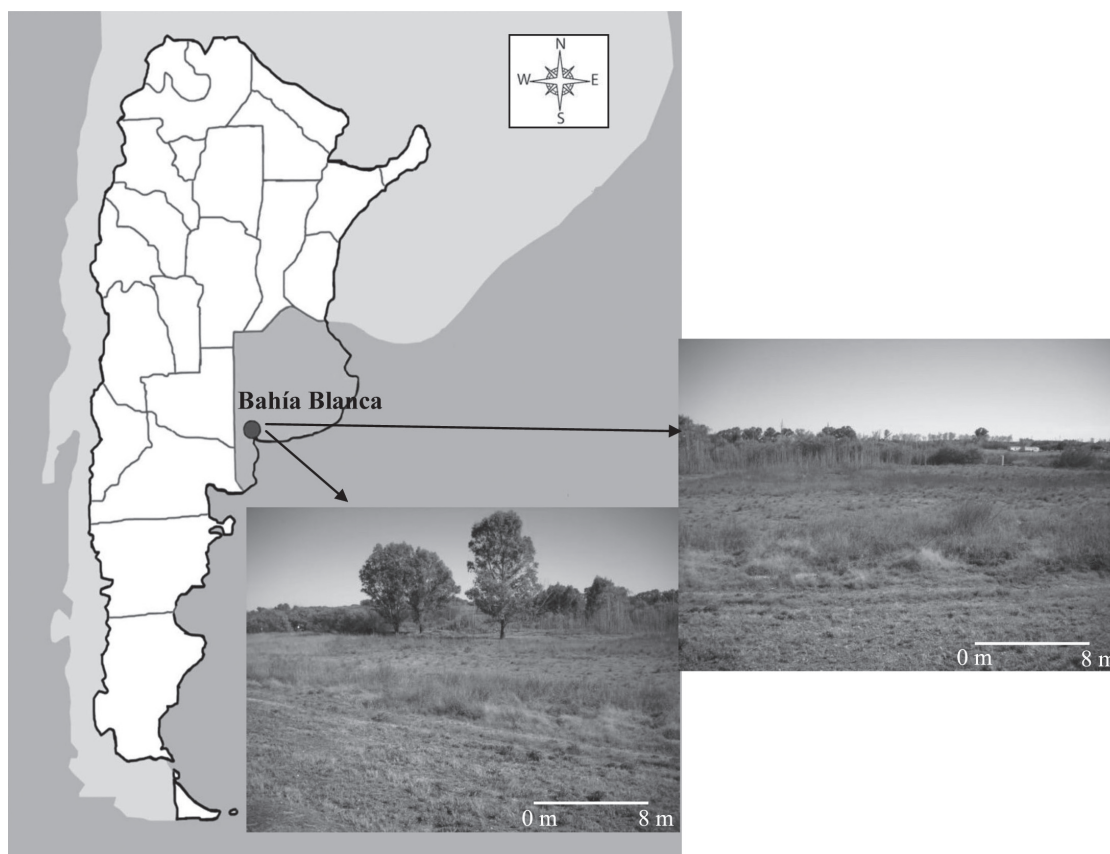
The purpose of this study was to know and characterize the composition, diversity, abundance and seasonality of the epigeal spiders of a semi-rural area of Bahía Blanca, in the temperate region of Argentina, using the data obtained from a cadaveric decomposition and succession

study, which contributed to the analysis of the coleoptero-fauna of forensic interest of the area.

## MATERIALS AND METHODS

The study was conducted in natural fields (38°41'52" S, 62°14'47" W, 51 m.a.s.l.), in 4 randomly selected plots, of approximately 20 × 30 m, located at 300-500 m from buildings and at 100 m from a branch of the Napostá stream, enclosed by *Populus alba* L. 1753 and *Tamarix* sp. plantations (Fig. 1). The rest of the vegetation was dominated by *Eucalyptus globulus* Labill. 1800, *Prosopis alpacato* Phil. 1862, *Chenopodium quinoa* Willd. 1797 subsp. *melanospermum* Hunz. 1943, and pastures (Fig. 1). The study area is located within the Pampa biogeographic province (Morrone 2002). The climate is continental warm and sub-humid (Campo de Ferreras *et al.* 2004; Campo & Zapperi 2010) with high thermal and rainfall variability through the year. According to Köppen, it can be classified as "pampeano", because in the warmer season the average temperature exceeds 22 °C, and there is no dry season. The annual average rainfall is 600 mm, but there are variations in the area (Gil *et al.* 2008; Campo *et al.* 2009; Gabella *et al.* 2010). The maximum and minimum average temperature, and accumulated rainfalls recorded during the study periods were: 20.2 °C, 7 °C and 19.1 mm, respectively (winter); 23.3 °C, 11.6 °C and 40.3 mm, respectively (spring); 27.4 °C, 15.8 °C and 35.1 mm, respectively (summer); and 18.2 °C, 6.8 °C and 18.3 mm, respectively (autumn). These values were calculated from data provided by the CERZOS-CONICET weather station.

The methodology used was part of a cadaveric decomposition and succession study which contributed to the analysis of the coleoptero-fauna of forensic interest (Zanetti *et al.* 2014). Samplings were carried out every season in selected plots, starting in winter 2010 and finishing in spring 2011. The average length (Mean ± SE) of each experiment (total time to cadaver decomposition) was: 168 ± 7 days (winter), 39 days (spring), 31 days (summer), and 72 days (autumn). In the selected plots, vegetation was cut at 4-5 cm of soil brim. Then, in three of the four plots we placed a cage of wire mesh containing a pig cadaver. Six pitfall traps were installed surrounding each cage. In the remainder plot six traps with the same disposition were used as control. The pitfall traps were made from plastic containers of 500 mL volume and 8.5 cm diameter, each buried to the rim of the soil. Each trap



**Figure 1.** Map of Argentina with the location of Bahía Blanca (point), study area (arrows) and vegetation (*Chenopodium quinoa* subsp. *melanospermum*, pastures, and plantations of *Populus alba*, *Tamarix* sp. and *Eucalyptus globulus*, can be seen).

had two containers, one inside the other: the inner container had a solution of 90% distilled water and 10% coolant. The outer container remained buried in the ground while the solution with the arthropods was filtered with a plastic funnel and a piece of fine mesh cloth, according to Zanetti (2013). The pitfall traps and cadavers were examined daily between 9:00 and 12:00 AM, during experiment time. I followed the criterion established by Centeno *et al.* (2002) to define the stages of decomposition. The biological material collected was transferred to a plastic container with 70% ethanol for later determination in the laboratory and storage.

The adult specimens were determined to family and species level according to Schiapelli & Gerschman de Pikelin (1963), Goloboff (1995), Ramirez (1999), Ferretti *et al.* (2010), and validated with World spider Catalog (2015), and when it was not possible, they were separated into morphospecies; juveniles were only identified to family level due to the absence of genitalia and the identification at level species the adults specimens are necessary.

Relative abundance of each family, species, state of development of specimens and seasonal abundance was estimated as:  $RA = (ni (100)/N)$ , where  $ni$  is the number of specimens collected at each site and  $N$  is the total of specimens collected at the site (Flórez-D. 1998). Species richness ( $S$ ) was considered as the number of species per family and per season. Density of each family and species was calculated per week. Diversity per season was assessed and compared with the Shannon Index ( $H'$ ), in a binary logarithm scale, and the species evenness using the  $J$  (Pielou) index ( $J = H'/H'max$ ). To determine if the environment has been enough sampled was used the estimator CHAO 1 (Colwell & Coddington 1994):  $S1 = Sobs + (a^2/2b)$ , where  $Sobs$  is the number of species/morphospecies observed in the study area,  $a$  is the number of species/morphospecies with one individual in the study area and  $b$  is the number of species/morphospecies with two individuals in the study area. For this analysis was used the EstimateS 9.1.0 version (Colwell 2013).



Spiders were grouped into eight guilds after Cardoso *et al.* (2011) to see if families may have similar ecological roles and for future studies of ecological change in the area. The specimens collected were deposited in the collection of Laboratorio de Zoología de Invertebrados II, Universidad Nacional del Sur, Bahía Blanca, Argentina.

## RESULTS

A total of 972 spiders were collected, belonging to 22 families and 65 species/morphospecies (20 of them were identified to species level) and, 189 individuals (19.44%) were identified at family level because they were juve-

niles. The most abundant families were: Lycosidae ( $n = 254$ , 26.13%), Zodariidae ( $n = 162$ , 16.67%), Thomisidae ( $n = 149$ , 15.33%), Theridiidae ( $n = 74$ , 7.61%) and Salticidae ( $n = 59$ , 6.07%), amounting to 71.81% of the total of the collected individuals (Table 1). Lycosidae, Thomisidae and Theridiidae were more abundant in spring; Zodariidae and Salticidae were more abundant in summer followed by spring. Some families were only found in one season (Table 1).

All the families with exception of Theraphosidae ( $n = 5$ , 0.51%), Actinopodidae ( $n = 7$ , 0.72%) and Nemesiidae ( $n = 11$ , 1.13%), because they live in burrows, were grouped into eight guilds (Table 2). The greatest number of individuals was represented by ground hunters ( $n =$

**Table 1.** Density of spiders of each family and species/morphospecies per week during each season, and absolute and relative abundance of them. Juveniles were not included in the species/morphospecies analysis.

Families and species/morphospecies	Winter	Spring	Summer	Autumn	Absolute abundance	Relative abundance (%)
Amaurobiidae	0.58	0	0	0.35	18	1.85
sp. 1	0.42	0	0	0.35	14	1.90
sp. 2	0.17	0	0	0	4	0.54
Amphinectidae	1.04	0	0	1.75	45	4.63
<i>Metaltella simoni</i> Keyserling, 1878	0.88	0	0	1.75	41	5.56
Anyphaenidae	0.21	2.33	0	0.70	26	2.67
<i>Sanogasta</i> sp. 1	0	0.36	0	0.18	4	0.54
<i>Sanogasta</i> sp. 2	0	0	0	0.09	1	0.14
<i>Sanogasta bonaeriensis</i> Mello-Leitão, 1940	0.04	0.90	0	0	6	0.81
sp. 3	0	0.18	0	0.09	2	0.27
sp. 4	0.04	0	0	0.18	3	0.41
sp. 5	0.04	0	0	0	1	0.14
Araneidae	0.21	1.26	0	0	12	1.23
<i>Alpaida holmbergi</i> Levi, 1988	0.08	0	0	0	2	0.27
<i>Alpaida veniliae</i> Keyserling, 1865	0	0.72	0	0	4	0.54
<i>Zygiella x-notata</i> Clerck, 1757	0	0.18	0	0	1	0.14
sp. 6	0.08	0	0	0	2	0.27
Corinnidae	0.38	1.08	0	0.61	22	2.26
<i>Meriola arcifera</i> Simon, 1886	0.29	1.08	0	0.53	19	2.57
<i>Meriola cetiformis</i> Strand, 1908	0.08	0	0	0.09	3	0.41
Ctenidae	0	0	0.45	0	2	0.21
sp. 7	0	0	0.45	0	2	0.27
Dyctinidae	0.17	0.18	0	0.26	8	0.82
sp. 8	0.13	0.18	0	0.18	6	0.81
sp. 9	0.04	0	0	0.09	2	0.27
Gnaphosidae	0.58	2.87	0.68	0.26	36	3.70
<i>Apopyllus silvestrii</i> Simon, 1905	0.17	0.36	0	0	6	0.81

Table 1. Continue.

Families and species/morphospecies	Winter	Spring	Summer	Autumn	Absolute abundance	Relative abundance (%)
<i>Camillina chilensis</i> Simon, 1902	0.33	1.95	0	0.09	20	2.71
<i>Echemoides argentinus</i> Mello- Leitão, 1940	0	0	0.68	0	3	0.41
Gnaphosidae sp. 10	0	0.36	0	0	2	0.27
Gnaphosidae sp. 11	0	0.18	0	0	1	0.14
Gnaphosidae sp. 12	0.04	0	0	0	1	0.14
Linyphiidae	1.13	1.97	0.68	1.23	55	5.66
<i>Ostearius melanopygius</i> O. P.-Cambridge, 1879	0.92	1.62	0.68	0.96	45	6.10
<i>Moyosi rugosa</i> Millidge, 1991	0.13	0	0	0.09	4	0.54
Linyphiidae sp. 13	0	0	0	0.09	2	0.27
Linyphiidae sp. 14	0.04	0	0	0.09	1	0.14
Lycosidae	5.95	12.18	6.58	1.26	254	26.13
sp. 15	0.17	1.44	0	0	12	1.63
sp. 16	0.04	1.44	0	0	9	1.22
sp. 17	0.17	0.54	0	0	7	0.95
sp. 18	0.29	0.72	2.26	0.09	22	2.98
sp. 19	0	0	0.23	0	1	0.14
sp. 20	0	0.18	0.23	0	2	0.27
sp. 21	0	0	0.23	0	1	0.14
sp. 22	0.17	0	0	0	4	0.54
<i>Lycosa thorelli</i> Keyserling, 1877	0.92	0.72	0	0	26	3.52
<i>Hogna bivittata</i> Mello-Leitão, 1939	0.90	1.08	0.45	0.09	30	4.07
Miturgidae	0	0.18	0	0	1	0.10
<i>Macerio</i> sp.	0	0.18	0	0	1	0.14
Philodromidae	0.08	0.36	0	0	4	0.41
<i>Paracleocnemis</i> sp.	0.08	0	0	0	2	0.27
Salticidae	1.13	2.51	2.03	0.79	59	6.07
sp. 23	0.75	1.44	0.45	0.35	32	4.34
sp. 24	0.04	0.36	0	0	3	0.41
sp. 25	0.04	0.36	0	0	3	0.41
sp. 26	0	0	0	0.09	1	0.14
sp. 27	0.13	0	0	0	3	0.41
Segestriidae	0.04	0	0	0	1	0.001
Titanoecidae	0	2.33	0.68	0	16	1.65
<i>Goeldia</i> sp.	0	1.95	0.68	0	14	1.90
Theridiidae	0.54	3.77	1.58	2.89	74	7.61
<i>Steatoda</i> sp. 1	0.33	3.41	1.13	2.63	62	8.40
<i>Steadota</i> sp. 2	0	0	0.45	0	2	0.27
<i>Guaraniella</i> sp.	0.08	0	0	0	2	0.27
sp. 28	0	0.18	0	0	1	0.14
sp. 29	0	0	0	0.18	2	0.27
sp. 30	0.08	0	0	0	2	0.27
sp. 31	0.04	0	0	0	1	0.14



Table 1. Continue.

Families and species/morphospecies	Winter	Spring	Summer	Autumn	Absolute abundance	Relative abundance (%)
Thomisidae	3.70	5.92	0.68	2.1	149	15.33
sp. 32	0.46	2.70	0.20	1.75	47	6.37
sp. 33	2.08	1.10	0	0	56	7.59
sp. 34	0.08	0.40	0	0	4	0.54
sp. 35	0.67	0.70	0.45	0	22	2.98
<i>Misumenops pallidus</i> Keyserling, 1880	0	0	0	0.18	2	0.27
Zodariidae	3.33	4.13	4.52	3.41	162	16.67
sp. 36	0	0	0.23	0	1	0.14
<i>Cybaeodamus ornatus</i> Mello-Leitão, 1938	0.08	0.45	0.90	0.53	14	1.90
<i>Leprolochus birabeni</i> Mello-Leitao, 1942	2.67	3.61	2.03	2.71	120	16.26
Zoridae	0.17	0.18	0	0	5	0.51
<i>Odo bruchi</i> Mello-Leitão, 1938	0.17	0.18	0	0	5	0.68
Actinopodidae	0	0	1.58	0	7	0.72
<i>Actinopus</i> sp.	0	0	1.35	0	6	0.81
Nemesiidae	0.33	0	0.23	0.18	11	1.13
<i>Acanthogonatus centralis</i> Goloboff, 1995	0.29	0	0.21	0.21	10	1.36
Theraphosidae*	0.04	0	0.23	0.26	5	0.51
<i>Catumiri argentinensis</i> Mello-Leitão, 1941	0.04	0	0	0.26	4	0.54

\**Grammostola doeringi* Holmberg, 1881 was not included because was found only as juvenile (1 individual in summer).

Table 2. Guilds, specific richness (S) of each family and relative abundance (%) of each guild.

Guild	Family/Subfamily	Specific richness (S)	Relative abundance (%)
Ambush hunters	Thomisidae	5	15.33
Ground hunters	Amphinectinae	1	37.24
	Corinnidae	2	
	Gnaphosidae	6	
	Lycosidae	10	
	Zoridae	1	
	Orb weavers	Araneidae	
Other hunters	Anyphaenidae	6	9.47
	Ctenidae	1	
	Philodromidae	1	
	Miturgidae	1	
	Salticidae	5	
Sensing web	Segestriidae	1	0.10
Specialists	Zodariidae	3	16.67
Sheet web	Amaurobiidae	2	7.51
	Linyphiidae	4	
Space web	Dictynidae	2	10.08
	Titanoecidae	1	
	Theridiidae	7	

362; 37.24%), followed by specialists ( $n = 162$ ; 16.67%) and ambush hunters ( $n = 149$ ; 15.33%). The rest of the guilds had percentages lower than 10.08% (Table 2). The guild of ground hunters also exhibited the greatest species richness ( $S = 20$ ).

Adults ( $n = 738$ , 75.93%) predominated over juveniles ( $n = 234$ , 24.07%), and males were more abundant ( $n = 523$ , 70.87%) than females. When seasonality was evaluated, males were the most abundant in all seasons. Figure 2 shows the relative abundance of adults and juveniles of each family. Lycosidae was the family most strongly represented by juveniles ( $n = 140$ ; 55.12%).

The specific richness ( $S$ ) registered was of 65 species. The total specific diversity and the evenness were high in all seasons (Fig. 3). The families with the greatest number of species were Lycosidae ( $S = 10$ ) and Theridiidae ( $S = 7$ ) (Table 2). The former had the greatest number of species in winter ( $S = 7$ ) and spring ( $S = 8$ ), and the latter in winter ( $S = 4$ ) (Table 1). The most abundant species (Table 1) were *Leprolochus birabeni* Mello-Leitao, 1942 (Zodariidae) ( $n = 120$ ), *Steatoda* sp. 1 (Theridiidae) ( $n = 62$ ), Thomisidae sp. 33 ( $n = 56$ ), Thomisidae sp. 32 ( $n = 47$ ), *Ostearius melanopygius* O. P.-Cambridge, 1879 (Linyphiidae) ( $n = 45$ ) and *Metaltella simoni* Keyserling, 1878 (Amphinectidae) ( $n = 41$ ). *Leprolochus birabeni* (Zodariidae) was almost constant in number of individuals between seasons; *Steatoda* sp. 1 was more abundant

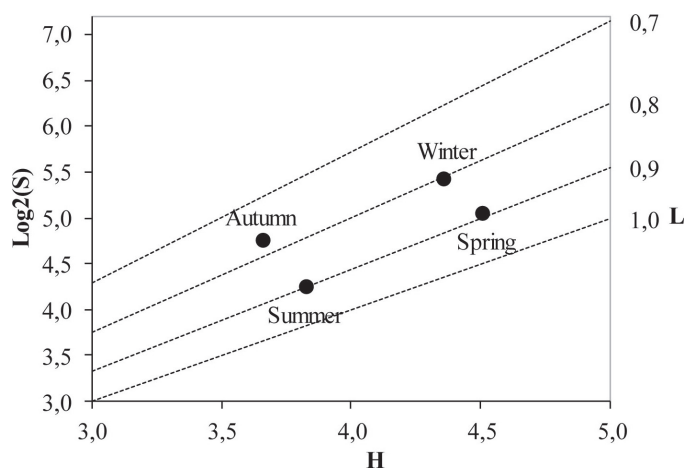


Figure 3. Specific diversity ( $H$ ) and evenness ( $L$ ) per season.

in spring followed by autumn; Thomisidae sp. 33 had the greatest number of individuals in winter; Thomisidae sp. 32 and *O. melanopygius* were more abundant in spring; and *Metaltella simoni* was more abundant in autumn (Table 1). For the more abundant families the relative abundance of Lycosidae was due to *Lycosa thorelli* Keyserling, 1877 and *Hogna bivittata* Mello-Leitão, 1939; for Thomisidae it was due to Thomisidae sp. 1, and for Theridiidae, it was due to *Steatoda* sp. 1. During summer and spring the relative abundance of Zodariidae was due

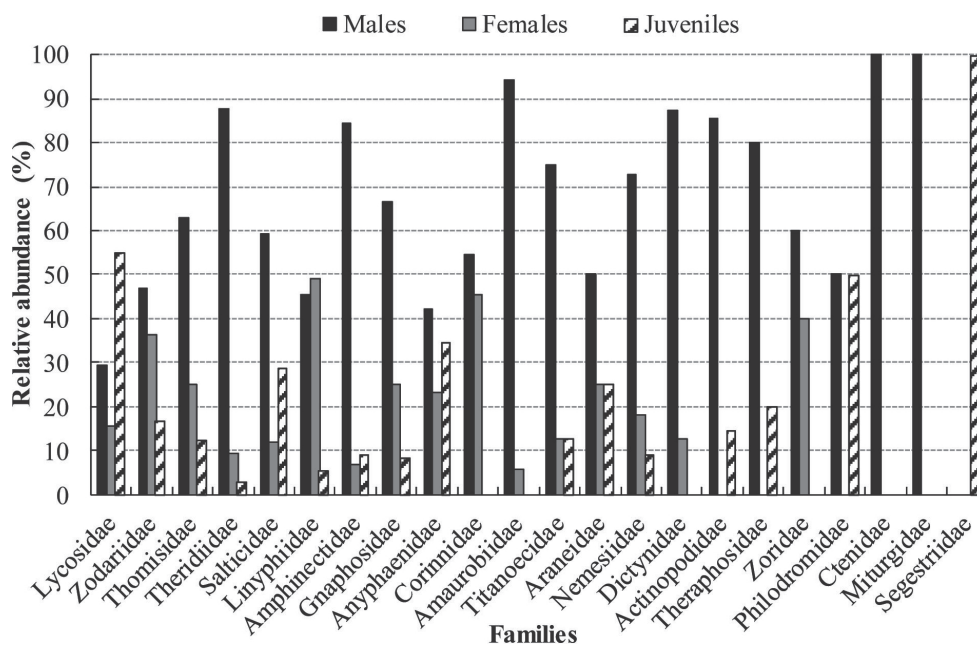


Figure 2. Relative abundance of the juveniles and adults of each family.



to *L. birabeni*, and of Salticidae it was due to Salticidae sp. 1. The total number of species was highest in winter and lowest in summer. Some species were only found in one season (Table 1). When the abundance of the six most abundant species was analysed per sex (Fig. 4), it was registered that contrary to the general finding, *L. birabeni* females were more abundant than males particularly in summer and autumn; Thomisidae sp. 32 females were more abundant than males in spring; *Steatoda* sp.1 males were very abundant in spring as well as autumn; and *O. melanopygius* both sexes were almost in equal amounts during seasons.

From the total of the species registered, 13 were “singletons” (species represented by one individual in the sample) (20% of all the species) and other 12, “doubletons” (species represented by two individuals in the sample) (18.46%). The observed species and the expected number of species curves reached an asymptote (Fig. 5A). Chao 1 mean was 70.99. The accumulative curve of singletons tends to decrease and of doubletons tends to stability (Fig. 5B).

## DISCUSSION

The geography, vegetation, and climatic variables, amongst other factors may result in differences in the distribution of members of some groups of spiders and on habitat selection (Gerschman de Pikelin & Schiapelli

1963; Comstock 1965; Uetz 1992). Several authors have described a greater diversity and biomass of spiders in undisturbed natural areas than in agro-ecosystems (Nyefeler & Benz 1987; Alderweireldt 1989; Desender *et al.* 1989; Heideger & Nentwig 1989; Liljesthröm *et al.* 2002; Avalos *et al.* 2007, 2009; Beltramo *et al.* 2006; Almada 2010; Almada *et al.* 2012), such as is the semi-rural area used in this work.

The spider families found in this study represented 34% of the total of the families described in Argentina and the species, to 5.5% (World spider Catalog 2015). The families Amphinectidae, Nemesiidae, Theraphosidae, Zoridae, Ctenidae and Segestriidae were not registered in agro-ecosystems of Santa Fe (Beltramo *et al.* 2006; Almada *et al.* 2012), and neither Amphinectidae nor Nemesiidae were recorded in the ecological Reserve “El Pozo” (Almada 2010), before this survey. Moreover, these two families were not found in degraded woods of the humid Chaco in Corrientes province (Avalos *et al.* 2007). These differences might be due to the geography, type of environment, climate or the sampling technique. In relation to the sampling technique, may be differences could also be attributed to the fact that some spiders are commonly associated with ephemeral habitats such as cadavers (which are significant feeding and/or reproducing resource for other arthropods such as insects), due to their predatory or saprophagous habits (Norris 1965; Seastedt *et al.* 1981; Keh 1985; Smith 1986; Lord 1990; Catts & Goff 1992).

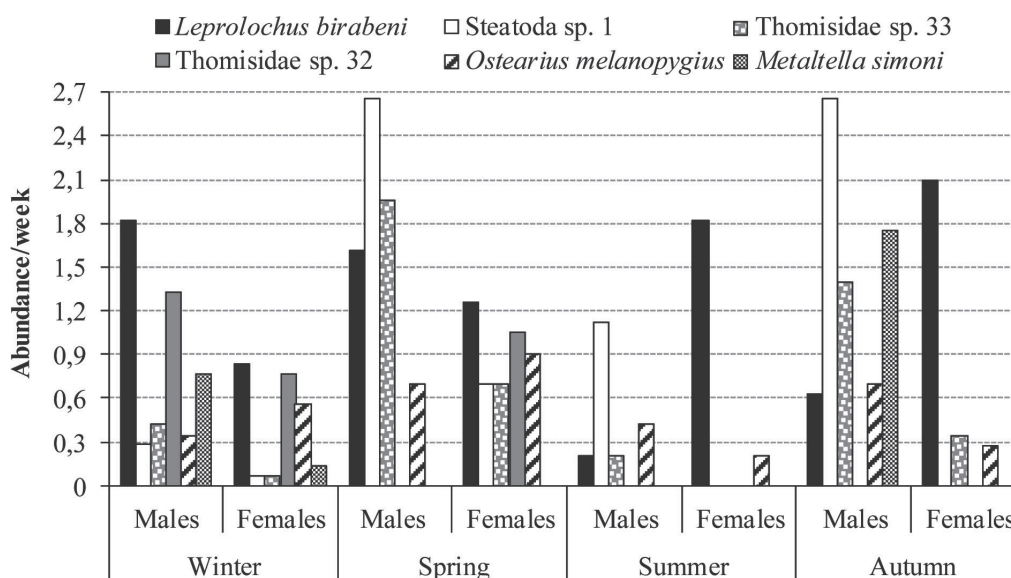
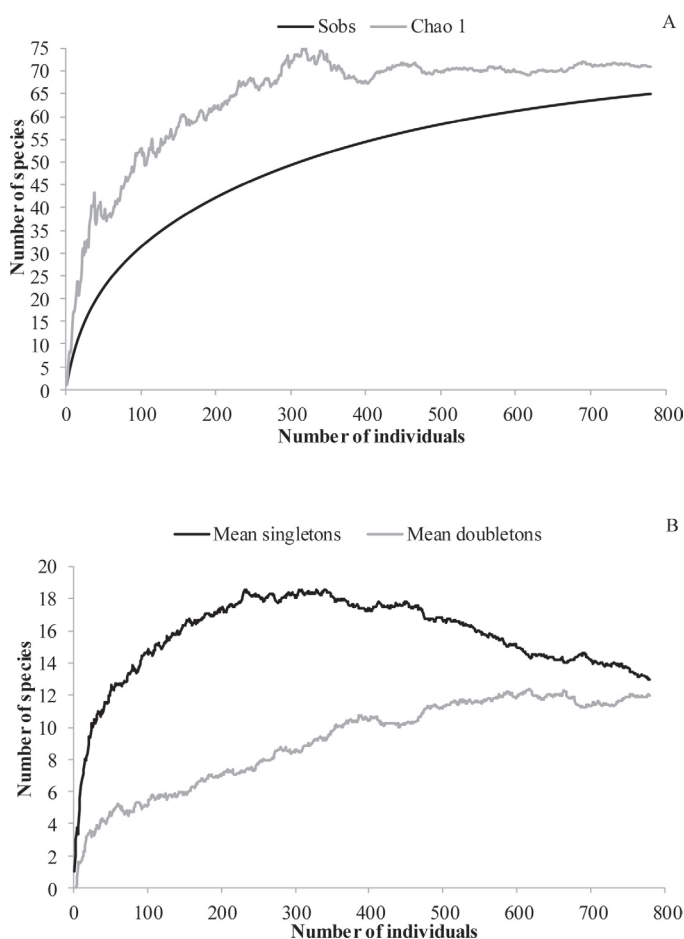


Figure 4. Density of males and females of the six most abundant species per season.





**Figure 5.** Species richness. A) Observed species richness (Sobs) and estimated richness for Chao 1 of the spiders of a semirural area of Bahía Blanca; B) Accumulative curves of singletons and doubletons of spiders of a semirural area of Bahía Blanca.

Regarding abundance, the families with a greatest number of individuals were Lycosidae, Zodariidae, Thomisidae, Theridiidae and Salticidae; Lycosidae, followed by Theridiidae, had the greatest number of species. Several studies also reported Lycosidae as the most abundant family in natural areas (Rubio *et al.* 2008), and agro-ecosystems (Beltramo *et al.* 2006; Armendano & González 2010) as well as the most abundant in the ground substrate of those disturbed environments in Argentina (Minervino 1996; Liljeström *et al.* 2002; Beltramo *et al.* 2006). Because they are active spiders that move above ground and under fallen leaves in search of their prey, and do not spin webs to hunt (Nyffeler & Benz 1988). The families Zodariidae and Salticidae are active hunters who must also move to find their prey. Such find-

ings could also be related to the fact that spiders can use cadavers as a refuge or hunting places (Watson 2004; Gill 2005).

Individuals were grouped into eight guilds, of which the greatest number of individuals corresponded to the ground hunters followed by specialists. This could be explained by the sampling methods as well as the type of environment. Cardoso *et al.* (2011) mentioned that the precise proportions per guild (and family) found are specific to the methods available. They also suggested that functional diversity is positively related with habitat complexity, with more complex habitats being more functionally diverse.

Adults were more abundant than juveniles, and adult males more abundant than females, which could be due to the sampling technique used. Furthermore, males are probably more active in their search for mates; consequently, they have a higher probability of being captured in the traps (Mineo *et al.* 2010; Ferretti *et al.* 2012). Because the highest proportion of adults and juveniles were trapped during spring, it cannot be concluded that many species have their reproductive period during that season.

The species richness was lower than that recorded in degraded woods of the humid Chaco in Corrientes (Avalos *et al.* 2007), but greater than that observed in agro-ecosystems of Buenos Aires (Grismado 2007; Armendano & González 2010) and Santa Fe (Almada *et al.* 2012). The same factors cited for differences in developmental time and abundance may be affecting species richness. The prey availability and the risk of predation or parasitism of spiders could be other important factors influencing the species richness of spiders (Crouch & Lubin 2000). These factors could influence species richness or other parameters of the spiders, alone or in combination with other factors (Halaj *et al.* 1998; Bell *et al.* 2001; New 2005; Spears & MacMahon 2012; Diehl *et al.* 2013). In this way, the great diversity and abundance of arthropods observed (Coleoptera, Diptera, Hymenoptera, amongst other) during the decomposition and succession study, could contribute to the results found in this work.

*Leprolochus birabeni* (Zodariidae) was the most abundant species, which is coincident with the results reported by Pompozzi *et al.* (2011) for La Pampa province. These spiders belong to the specialists guild, so they capture their prey moving over the ground (Grismado *et al.* 2011). The second in abundance was *Steatoda* sp. 1 (Theridiidae), which was probably due to the activity of males (Mineo *et al.* 2010; Ferretti *et al.* 2012). *Metaltella simoni* (Amphinectinae), which was fifth in abundance,



are ground hunters common in places such as cities, gardens and vacant lots (Grismado *et al.* 2011).

The number of singletons was lower than 50%, thus it is unlikely to be underestimation of species (Colwell & Coddington 1994) as reported in other studies (Avalos *et al.* 2007, 2009; Pompozzi *et al.* 2011). The values of Sobs and of Chao 1 were very similar and the expected number of species curve and the curve of doubletons were asymptotic, and the curve of singletons tended to decrease. This could indicate that the effort was enough and the study area was sufficiently sampled (the number of species/morphospecies of the area would not increase with the number of samplings) (Villarreal *et al.* 2004). This was not unexpected because the high proportion of “singletons” is a characteristic of the tropical arthropod fauna in woods and tropical and temperate savannahs (Florez 1998; Sørensen *et al.* 2002; Withmore *et al.* 2002). Such areas are characterized by a high number of species that usually exhibit low population densities or are rare (Florez 1998; Sørensen *et al.* 2002). Some studies have shown that seasonality influences the abundance, growth rate, and size of spiders (Gaston *et al.* 1993; Gasnier *et al.* 2002). This could be related to different factors, as mentioned above, as well as foraging and/or an increase in prey density, which can vary over the season in response to environmental conditions (Kiritani *et al.* 1972; Mahalakshmi & Jeyaparvathi 2014). These factors could account, at least partially, for the increase recorded in the spider density during spring. In this study, climate variables did not affect the spider abundance differently depending on the sex and age of the spiders. The fact that some families were found in certain seasons could be due to juveniles or eggs that hibernate during those periods, as well as to some organisms having two reproductive periods and entering diapause in the adult stage (Jimenez & Navarrete 2010).

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