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Spatial and temporal variation of the Formicidae assemblage in different forest types of the Chaco Seco ecoregion, Argentina

Gualterio Barrientos[1,2,✉]; Antonela Dettler[1,2]; Emilia Martínez[1,2,3]; Florencia Vazquez[1,2,4]; Agustina Ansa[1,2,3,5]; Marina Santadino[1,2,3]; Mauricio Ewens[6]; Elena Craig[1,3] & María Riquelme Virgala[1,2,3,5]

[1] Department of Technology, National University of Luján (UNLu). Buenos Aires, Argentina. [2] Research Group on Bioecology of Arthropods of Agricultural Importance (GIBAIA). Department of Technology, UNLu. [3] Institute of Ecology and Sustainable Development (UNLu-CONICET). Buenos Aires, Argentina. [4] Biological Fight Research Insectarium (IMYZA-INTA). Buenos Aires, Argentina. [5] Faculty of Agronomy of the University of Buenos Aires. Buenos Aires, Argentina. [6] Fernández Experimental Station, Catholic University of Santiago del Estero. Santiago del Estero, Argentina.

Abstract. Ants have been widely used as bioindicators of natural and disturbed environments. In Argentine Chaco Seco, ants represent an important part of the total biodiversity and fulfil various functions in forest ecosystems. With the aim of evaluating β diversity and identifying indicator ants, surveys were carried out in three types of implanted forests: *Neltuma alba* (mesquite), *Eucalyptus tereticornis* (eucalyptus) and mixed forests without intervention for 50 years, mainly composed of *Ceiba speciosa* and *Phoenix canariensis*, located at the Fernández Experimental Station of the Catholic University of Santiago del Estero. The samplings were carried out in spring, summer and autumn, between 2019 and 2022, using pitfall traps that remained active for 24 h. The abundance and composition of Formicidae at each site and season were evaluated using the Jaccard similarity index and generalized linear mixed models. A total of 7366 individuals grouped into 28 species belonging to 6 Formicidae subfamilies were identified. Some species were present at all sites and seasons, with *Solenopsis saevissima*, *Camponotus mus* and *Pheidole bergii* being the most abundant in the mesquite, eucalyptus and mixed stands, respectively. In addition, three exclusive species of *N. alba*, two of *E. tereticornis* and one of the mixed stand were identified. Furthermore, it was observed that the myrmecological composition varied seasonally, mainly during autumn. These results demonstrate that due to the characteristics of each site, representative groups of ants can be found for each that could be used as indicators of each type of environment and that the temporal variation of the communities is favored by the diversification of the habitats, which offer different resources during each season of the year, increasing the turnover rate.

[Keywords: ant community, *Neltuma alba*, *Eucalyptus tereticornis*, diversity, bioindicators]

Resumen. Variación espacial y temporal del ensamble de Formicidae en distintos tipos de bosque de la ecorregión Chaco Seco, Argentina. Las hormigas han sido muy usadas como bioindicadoras de ambientes naturales y perturbados. En el Chaco Seco argentino representan una parte considerable de la biodiversidad total y cumplen diversas funciones en ecosistemas forestales. Para evaluar la diversidad β e identificar grupos de hormigas indicadoras, se hicieron relevamientos en tres tipos de bosques: montes implantados de *Neltuma alba* (algarrobo blanco), montes implantados de *Eucalyptus tereticornis* (eucalipto) y bosques mixtos sin intervenir durante 50 años, compuestos principalmente por *Ceiba speciosa* y *Phoenix canariensis*, situados en la Estación Experimental de Fernández, Santiago del Estero. Las capturas se hicieron en primavera, verano y otoño, entre 2019 y 2022, mediante trampas de caída que permanecieron activas 24 horas. Se evaluó la abundancia y la composición de Formicidae por sitio y estación a través del índice de similitud de Jaccard y modelos lineales generalizados mixtos. Se identificaron 7366 individuos agrupados en 28 especies pertenecientes a 6 subfamilias de Formicidae. Algunas especies estuvieron presentes en todos los sitios y estaciones. Las especies *Solenopsis saevissima*, *Camponotus mus* y *Pheidole bergii* fueron las más abundantes en los montes de algarrobo, eucalipto y mixto, respectivamente. Además, se identificaron tres especies exclusivas de *N. alba*, dos de *E. tereticornis* y una del monte mixto. Asimismo, se observó que la composición mirmecológica varió de manera estacional, sobre todo en el otoño. Estos resultados demuestran que, por las características de cada sitio, algunos grupos de hormigas se podrían utilizar como indicadores de cada ambiente y que la variación temporal de las comunidades se ve favorecida por la diversificación de los hábitats, que ofrecen distintos recursos durante cada estación del año, aumentando la tasa de recambio.

[Palabras clave: comunidad de hormigas, *Neltuma alba*, *Eucalyptus tereticornis*, diversidad, bioindicadores]

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✉ gualteriobarrientos@yahoo.com.ar

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Introduction

Traditionally, degradation of the biological diversity of ecosystems has been described through indices that evaluate the richness and abundance of communities, in other words, they focus on the alpha component of biodiversity (Mori et al. 2018). However, these indices only allow the evaluation of the structure of a community in a specific place and moment, leaving aside its identity when comparing different communities. This was the reason for the growing interest in studying the causes and consequences of the change in the beta component of diversity, which can be used to measure the degree of differentiation between environments through space and time (Loiseau et al. 2016). From this perspective, beta diversity (β) is important to assess the homogenization process of ecosystems, a factor that can influence as much or more than loss of species (Mori et al. 2018). In this sense, the composition of each community can be used to measure the degree of similarity between them and determine the factors that influence turnover. Among the environmental variables that influence species turnover, the human activity can transform natural habitats into totally modified habitats, affecting the local community. These transformations have led to the degradation of biodiversity, causing many species to disappear (Castroverde 2007).

The Chaco Seco ecoregion is characterized as a xerophilous forest (Linares et al. 2013), but due to indiscriminate felling, the expansion of the agricultural frontier, overgrazing, repeated fires and urbanization, this ecosystem is intensely disturbed (Ríos 2017; GFW 2022). Currently, due to the National Law 25080 (renewed by Law 27487) on investments for cultivated forests and Law 26331 on Minimum Budgets for Environmental Protection of Native Forests, indiscriminate logging has been regulated. Although cultivated forests constitute a modification of the ecosystem, since the diversity of plant species is replaced by a monospecific plantation, it is expected that the implantation of native species would have less impact on the environment.

Considering the above, the region is under constant modifications as a result of human activities that affect local biodiversity. The impact generated by these disturbances can be evaluated through biological indicators whose responses could reflect the variation of the communities under study and the ecological integrity of the habitats (Arcila and Lozano-Zambrano 2003). The advantages of using bioindicators are mainly due to the fact that it is not possible or practical to evaluate the response of all species in an environment, and some species adapt to a wide range of environmental conditions, whereas others have very specific habitat requirements, leaving their distribution more restricted (Arcila and Lozano-Zambrano 2003; Morales Salinas 2011). In this sense, organisms sensitive to disturbances and/or modifications of the environment and easy to sample and identify, are good indicators of biodiversity (Morales Salinas 2011). In previous studies carried out in the Chaco Seco ecoregion, it was determined that the Formicidae family is the most abundant taxon in a variety of environments and it is represented by several species (Fuster 2006; Fuster 2012; Barrientos et al. 2022). In addition to these characteristics, ants are widely used as bioindicators due to their wide geographical distribution, its abundance and that can be classified into functional groups due to their diversity (Andersen 1997; Fernández 2003; Arenas Clavijo and Armbrecht 2018). On the other hand, due to the diversity of species that can occur in different communities, it is possible that they could be very dissimilar, which would make comparisons difficult. To overcome this obstacle, several authors use the functional groups proposed by Andersen (1997). These functional groups vary predictably in relation to climate, soil, vegetation and disturbance, and allow comparisons between communities with little species overlap (Fernández 2003; Verzero Villalba et al. 2014; Andersen 2018; Arenas Clavijo and Armbrecht 2018; Andrade Estrada et al. 2023).

The aim of this work was to evaluate the changes induced by the shifting from native implanted forests to exotic implanted forests on the abundance, richness and assembly of the community of epigeal ants, their variation among seasons and their potential as indicators in the Chaco Seco ecoregion, Argentina. The following hypotheses were addressed: 1) exotic species stands possess a lower ant taxonomic and functional diversity than native species stands; 2) the ant community in mixed stands is more similar to pure native or exotic stands, and 3) ant community composition varies among seasons.

Materials and Methods

Study site

The study was carried out at the Fernández Experimental Station (the unit dependent on the Catholic University of Santiago del Estero within the framework of the agreement with the province of Santiago del Estero), located in the Chaco Seco ecoregion, Argentina (27°56′ S - 63°52′ W). The area is characterized by an average temperature of 20 °C and annual rainfall that averages 600 mm, with a marked seasonality towards summer. The station has 63 ha and the evaluated stands were at least 100 m away; each stand had 0.5-1 ha and the distance between trees was 10 m. Three experimental stands of *Neltuma alba* Grisebach and three of *Eucalyptus tereticornis* Smith between 19 and 26-years-old were selected, and three mixed stands without intervention for 50 years, composed mainly of the native *Ceiba speciosa* A. St.- Hil and the exotic *Phoenix canariensis* Chabaud, were selected as an intermediate among natives and exotic stands. It should be noted that mesquite and eucalyptus stands are subject to disturbances caused by pruning, harvesting, grazing and research activities.

Sampling

Sampling was carried out in spring, summer and autumn for two campaigns between 2019 and 2022. Ants were collected using pitfall traps in three stands of each kind of forest. At each stand, 12 pitfall traps were located 10 m apart and arranged in two transects. Traps were 100 mL plastic cups, with approximately 50 mL of water solution with a few drops of detergent. The traps were placed under the canopy of trees and remained functional for 24 h. The collected ants were classified by species using a Stemi 508 Zeiss® stereoscopic microscope and taxonomic keys (Fernández 2003; Schmidt and Shattuck 2014). The material was preserved in 70° alcohol and stored in the Laboratory of Agricultural Zoology of the National University of Luján.

Functional groups

Each species was assigned to a functional group based on the concepts proposed by Andersen (1995) and adapted by Bestelmeyer and Wiens (1996) and Claver et al. (2014) for the Chaco Seco and Monte Desert regions of Argentina. There were nine functional groups: Arboreal, Attini, Camponotini, Climate Specialists, Cryptic Species, Ecitonini, Generalized Myrmicines, Opportunists and Predators.

Data analysis

Rank-abundance curves were plotted to observe dominance patterns between habitats and seasons. To do this, the relative abundances (number of individuals of each species/total of individuals) were calculated and plotted in descending order. The following categories were considered: dominant (≥5%), codominant (4.9 to 2%) and rare (<2%) (Pedraza et al. 2010; Rouaux 2015). Then, the hierarchical cluster analysis method was used to analyse the degree of similarity of the ant communities between sites and seasons. Using this method, a dendrogram was plotted. This plot grouped the different treatments using distance measures, in such a way that the close groups have a composition of similar species. In this case, the Jaccard index (I_J) was used as a measure of distance and it was calculated as:

$$I_J = c / (a + b - c) \qquad \text{Equation 1}$$

where a=number of species present at site A; b=number of species present at site B, and c=number of species present at both sites.

Finally, to examine the effect of the site and season on the relative abundance of each functional group a generalized linear mixed model was used. The fixed effects variables were site and season and the random effects variables were date and plot. A negative binomial distribution of the data was assumed. To analyse the effect of the treatments a deviance analysis was used, and differences among treatments were determined by Tukey's test. All the analyses were carried out using the RStudio software (R Core Team 2022); a significance level of 5% was considered ($P<0.05$).

Results

A total of 7366 individuals were collected. There were 28 species belonging to 6 Formicidae subfamilies (Table 1). The Myrmicinae subfamily was the best represented with 15 species belonging to 10 genera, followed by the Formicinae and Ponerinae with 4 species each within 2 and 4 genera respectively, then Dolichoderinae with 3 species and 3 genera and the subfamilies Dorylinae and Pseudomyrmecinae subfamilies with one species in each. Of all the individuals captured, 83% were represented by the genera *Solenopsis* Westwood (31%), *Camponotus* Mayr (28%) and *Pheidole* Westwood (24%). They were followed in abundance by the genera *Neoponera* Emery (4%), *Brachymyrmex* Mayr (3%) and *Wasmannia* Forel (3%).

When analysing the rank-abundance curves, it was observed that in all types of forests and

Table 1. List of genera found with their respective abundances, in three types of forests in the Chaco Seco ecoregion during three seasons. Na: *Neltuma alba*. Et: *Eucalyptus tereticornis*. M: Mixed forest. Ar: Arboreal. At: Attini. C: Camponotini. Cry: Cryptic species. CS: Climate specialists. E: Ecitonini. GM: Generalized Myrmicines. Op: Opportunists. P: Predators.

Tabla 1. Lista de géneros hallados, con sus respectivas abundancias, en tres tipos de bosque en la ecorregión Chaco Seco durante tres estaciones. Na: Neltuma alba. Et: Eucalyptus tereticornis. M: Bosque mixto. Ar: Arbóreo. En: Attini. C: Camponotini. Cry: Especie críptica. CS: Especialistas en clima. E: Ecitonini. GM: Mirmicinas generalizadas. Op: Oportunistas. P: Depredadores.

Subfamily	Species	Functional group	Spring			Summer			Autumn		
			Na	Et	M	Na	Et	M	Na	Et	M
Dolichoderinae	*Dorymyrmex pyramicus*	Op	22	2	7	42	2	2	4	6	1
	Forelius nigriventris	CS	22	1	0	49	0	1	3	0	3
	Linepithema humile	Op	2	0	1	1	6	1	1	7	0
Dorylinae	*Neivamyrmex* sp.	E	0	0	0	0	0	3	0	0	0
Formicinae	*Brachymyrmex patagonicus*	Cry	40	34	10	30	21	66	16	24	6
	Camponotus blandus	C	53	3	2	60	3	1	4	0	0
	Camponotus mus	C	98	1241	212	18	212	36	11	72	6
	Camponotus substitutus	C	2	2	0	23	6	0	0	4	0
Myrmicinae	*Acromyrmex lundii*	At	5	2	2	11	4	1	2	3	0
	Acromyrmex striatus	At	26	3	0	89	1	0	4	7	0
	Cephalotes pusillus	Ar	0	1	0	0	0	0	0	0	0
	Crematogaster bruchi	GM	1	2	3	4	7	1	7	0	0
	Crematogaster torosa	GM	1	0	0	1	0	0	0	0	0
	Cyphomyrmex rimosus	At	2	1	5	8	0	3	0	1	0
	Nesomyrmex echinatinodis	CS	0	0	0	0	1	0	0	0	0
	Pheidole bergii	GM	195	94	150	238	27	349	164	105	64
	Pheidole fimbriata	GM	24	0	22	48	2	23	23	8	14
	Pheidole spininodis	GM	23	1	34	57	1	42	50	26	11
	Procryptocerus sp.	Ar	0	0	0	1	0	0	0	0	0
	Solenopsis interrupta	GM	18	7	7	56	8	1	7	4	0
	Solenopsis saevissima	GM	500	199	79	808	78	110	253	104	31
	Trachymyrmex sp.	At	4	3	1	22	7	4	11	1	0
	Wasmannia auropunctata	Cry	26	11	2	50	36	3	33	32	0
Ponerinae	*Anochetus neglectus*	Cy	0	0	0	4	0	2	2	1	0
	Neoponera villosa	P	35	16	5	102	60	33	52	13	8
	Pachycondyla sp.	P	0	0	0	1	0	0	2	0	0
	Platythyrea sp.	P	0	0	0	1	0	0	0	0	0
Pseudomyrmecinae	*Pseudomyrmex* sp.	Ar	0	0	1	1	0	0	0	1	0

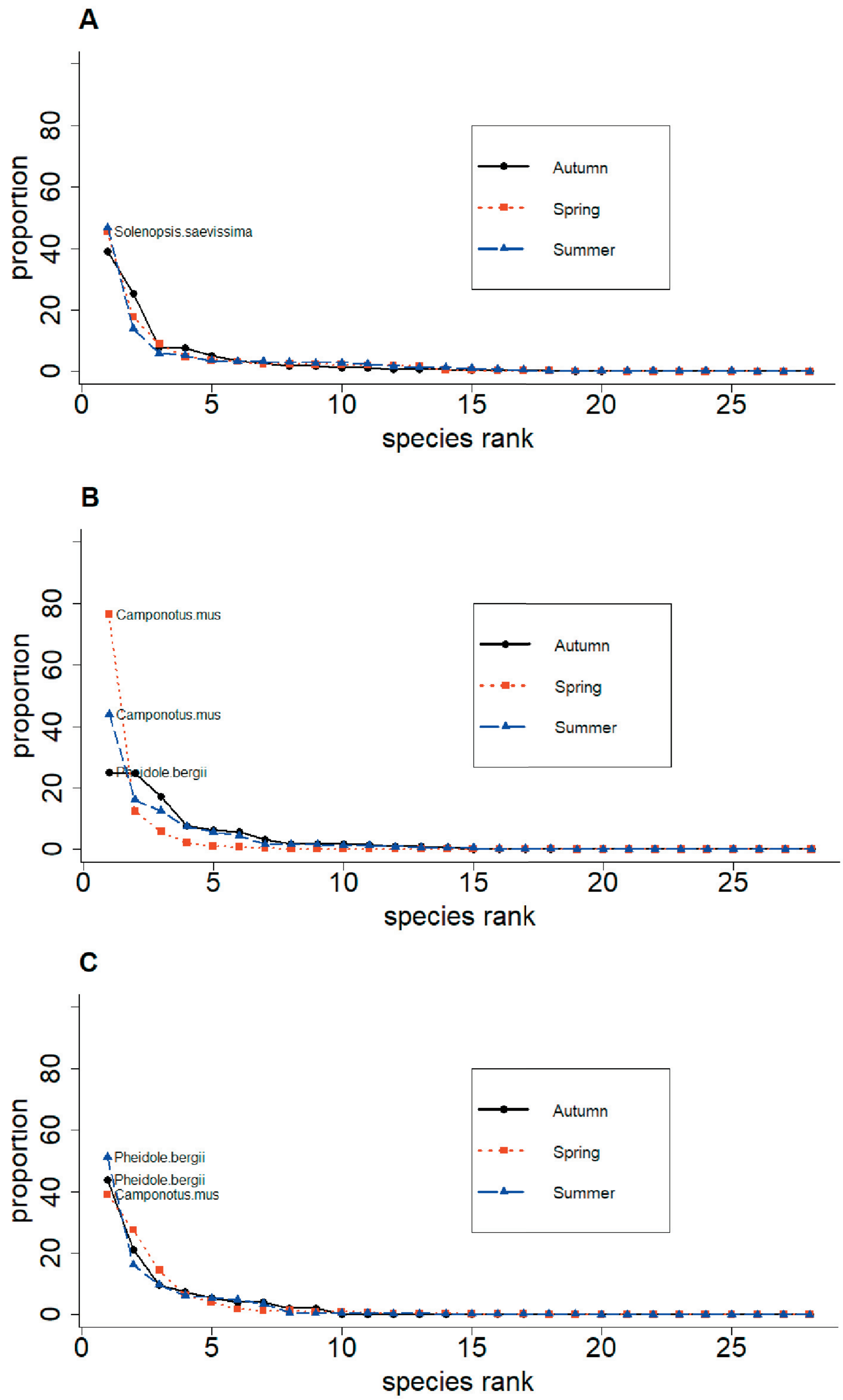

Figure 1. Rank-abundance curves of the ant community found in three seasons during the period 2019-2022 in A) *Neltuma alba*; B) *Eucalyptus tereticornis*, and C) Mixed forest. The most abundant genus of each season is mentioned in each curve.

Figura 1. Curvas de rango-abundancia de la comunidad de hormigas halladas en tres estaciones durante el período 2019-2022 en A) *Neltuma alba*; B) *Eucalyptus tereticornis*, y C) Bosque mixto. En cada curva se menciona el género más abundante de cada estación.

seasons there were between three and six dominant species, of which three stand out as always being the most abundant (Figure 1). The dominance is given mainly by *Camponotus mus*, *Solenopsis saevissima* and *Pheidole bergii*; however, their relative importance varied between environments and seasons. In the mesquite groves, *S. saevissima* represented more than 39% of the total abundance in all seasons and second was *P. bergii*, with values between 18 and 25% (Figure 1A). On the other hand, in the *E. tereticornis* stands, *C. mus* dominated in summer (44%) and in spring (77%); although during the autumn they were among the dominant ones (17%), occupied the third place below *P. bergii* (25%) and *S. saevissima* (25%) (Figure 1B). Finally, in mixed stands, the species with the highest presence during spring was *C. mus* (39%), followed by *P. bergii* (28%); however, during the remaining seasons, *P. bergii* ranked first with more than 43% relative abundance (Figure 1C). At the other end of the curves are the rare species (i.e., those that are equivalent to less than 2% of the total abundance), represented by 8 to 14 species depending on the site and season.

According to the cluster analysis, based on the Jaccard similarity index, all sites had a similar ant community during spring and summer (Figure 2). In addition, the myrmecological composition of the mesquite stands in autumn was similar to the previous ones. In the cases of the eucalyptus stands and the mixed stands in autumn, the communities are so dissimilar that they could not be grouped into any conglomerate.

Species of the genus *Camponotus*, due to their great dominance, and *Cephalotes pusillus* Latreille and *Nesomyrmex echinatinodis* Wheeler, due to their mere presence, were characteristic of *E. tereticornis* stands. In contrast, in the stands of *N. alba* the genus *Solenopsis* was the most abundant and *Procryptocerus* sp. Emery, *Pachycondyla* sp. Smith and *Platythyrea* sp. Roger were exclusive to this habitat, and in mixed stands *Pheidole* was the most present genus and *Neivamyrmex* sp. Borgmeier turned out to be exclusive.

When classifying by functional groups, it was observed that Generalized Myrmicines were the most abundant group and predominated over the other groups in the mesquite and mixed stands on each season (Figure 3). The second most abundant group was Camponotini, which outnumbered Generalized Myrmicines in eucalyptus stands during spring and summer. The remaining

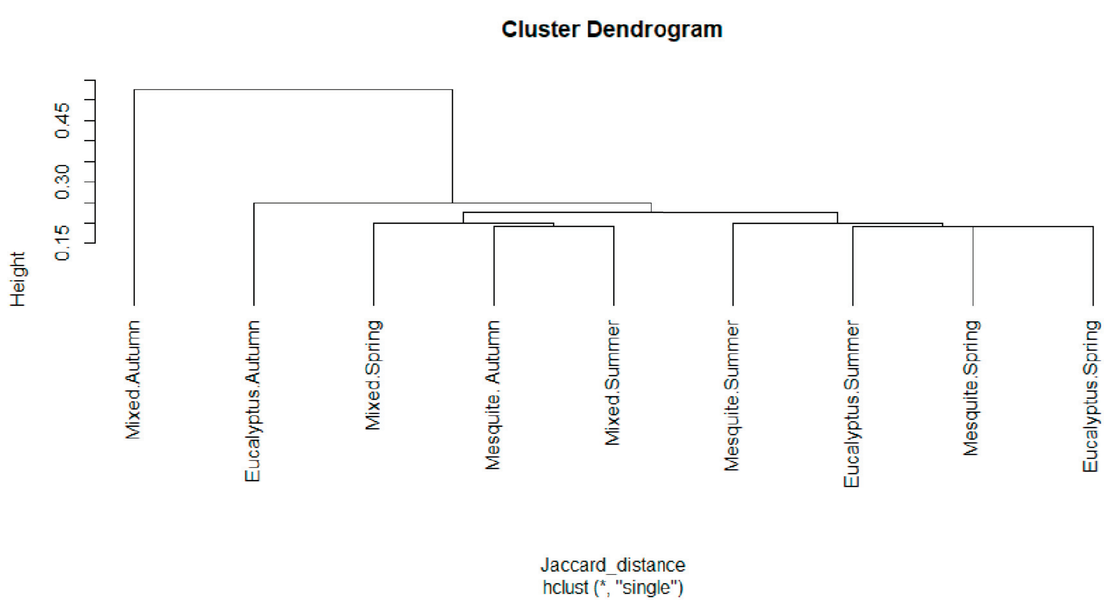

Figure 2. Hierarchical cluster analysis using the Jaccard index as a measure of distance to group ant communities found in the three habitats studied and in three seasons during the period 2019-2022.

Figura 2. Análisis de conglomerados jerárquicos empleando el índice de Jaccard como medida de distancia para agrupar las comunidades de hormigas halladas en los tres hábitats estudiados y en tres estaciones durante el período 2019-2022.

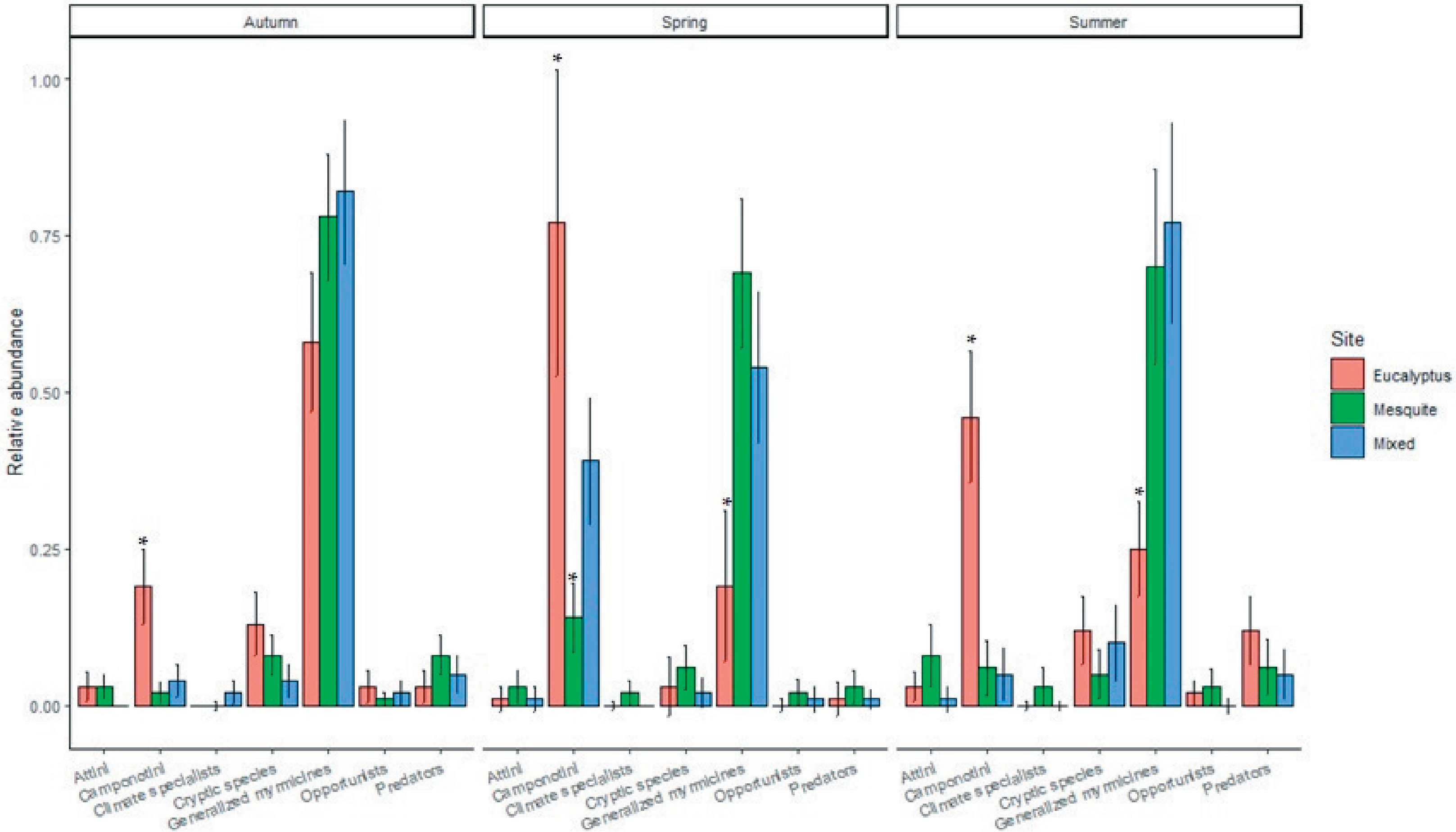

Figure 3. Relative abundance of ant functional groups in each stand by season during the period 2019-2022. Asterisks indicate significant differences between stands for the same functional group (P=7.943e-5).

Figura 3. Abundancia relativa de los grupos funcionales de hormigas en cada rodal por estación durante el período 2019-2022. Los asteriscos indican diferencias estadísticamente significativas entre rodales para un mismo grupo funcional (P=7.943e-5).

groups maintained low abundances at all sites during the seasons.

Discussion

The results of this study indicate that the ant community fluctuates spatially and temporally, since the activity of the species changes according to the seasons of the year and the type of environment that they inhabit. Some authors argue that this fluctuation is associated to the thermophilic nature of ant communities, which regulate foraging activity among seasons, and the quantity and quality of resources available among seasons and environments (Schutte et al. 2007; Nogueira et al. 2020; Queiroz et al. 2022). These results agree with other studies on ant diversity in the Chaco region in which the effect of the type of vegetation, the complexity of the environment and the season of the year were evaluated, demonstrating that communities vary based on these factors (Claver et al. 2014; Silva et al. 2014; Pereyra 2016). However, unlike what was reported by these authors, the variation was mainly due to a change in the relative abundance of the species and not to their composition. At the same time, the rank-abundance curves showed that at each site few species were dominant. The most abundant genera were *Camponotus*, *Solenopsis* and *Pheidole,* coinciding with what was recorded by Fuster (2006) and Pereyra (2016) in their studies carried out in native forests of the Chaco Seco ecoregion with pitfall traps.

In the case of the *E. tereticornis* forests, the dominant genus was *Camponotus*, which in turn forms the functional group Camponotini. Although it has not been evaluated, it has been observed that in the eucalyptus plots there is a large accumulation of litter unlike the other sites, possibly this characteristic generates a favourable microhabitat for the development of this group. In this sense, *Camponotus* ants prefers soils rich in organic matter (Venuste et al. 2018) and the low decomposition rate of litter associated with these plantations could provide favourable environment for the development of populations of this genus (Sayer et al. 2010; Penon 2018).

In the mesquite stands, the dominant genus was *Solenopsis.* This genus, characterized by being generalist and opportunistic, is very abundant in open environments with low coverage, since these provide thermally favourable microclimates for these ants (García Martínez et al. 2016). Previous studies mentioned that the abundance of *Solenopsis* could be favored by soils with herbaceous and grazed vegetation, since this would allow a greater arrival of solar radiation to the soil (Calcaterra et al. 2010; Verzero Villalba et al. 2014). In this sense, sheep and horses is allowed sporadically on mesquite plots that, added to the spacing provided by the plantation framework, would allow a higher surface of insolation. Therefore, these ants could be a good indicator, as they are characterized by their ability to occupy a wide variety of habitats, their wide feeding range, and their ability to colonize and take advantage of new environments (Fernández 2003; da Silva Freitas et al. 2014; Pereyra 2016).

In the mixed stands, the genus *Pheidole*, characteristic of the soils and litter of primary forests, was the predominant one. This result agrees with what was reported by Fuster (2006), who concluded that these ants are a good indicator of forests in the Chaco Seco ecoregion.

The species of the genera *Solenopsis* and *Pheidole* are comprised within the generalized myrmicines group, which has turned out to be the main functional group at all sites in terms of its abundance. Previous studies have already shown that this functional group is representative of the Chaco Seco (Bestelmeyer and Wiens 1996; Claver et al. 2014); this would be mainly due to its generalist nesting and foraging habits, in addition to its high competitiveness for resources (Andersen 1995; Bestelmeyer and Wiens 1996).

Among the co-dominant species, *Wasmannia auropunctata* was very scarce in the mixed forest and its greatest abundance was recorded in the stands of mesquite and eucalyptus. In this sense, Arcila and Lozano-Zambrano (2003) point out that the ants of this species are indicators of disturbance, since their abundance is greater in disturbed sites due to their ability to colonize these environments. Following the same trend, *Neoponera villosa* were found mainly in the pure stands, but especially in the mesquite tree stands. As mentioned by other authors, the simplification of environments induces changes in a series of environmental factors that affect the local invertebrate community; in the case of predatory ants, this simplification generates a selection in favor of those with generalist habits (Wilker et al. 2023). According to Schmidt and Shattuck (2014), *N. villosa* is a generalist arboreal species, which is consistent with the great diversity of arthropods that can be found in the tree canopy (Diodato and Fuster 2016). Along the same line, *Brachymyrmex patagonicus*, which was observed mainly in the stands of mesquite and eucalyptus, is also frequently cited as an indicator of highly simplified environments, preferring open habitats with development of herbaceous species (Martínez et al. 2011; Wilker et al. 2023) and are common ground and leaf litter dwellers, frequently associated with legumes (Fernández 2003; Fuster 2006), which could explain the results presented here.

On the other hand, of the exclusive species found in each environment, between 1 and 3 individuals were recorded, so no conclusions can be drawn about their potential as indicators of the respective environments. Possibly the methodology used to obtain samples was not optimal for capturing these genera, either because of their scarce presence or because their nests were not in the range of action of the traps.

Beyond knowing which species are the dominant of each environment, it is important to take into consideration that the seasonal fluctuation of environmental conditions can affect the distribution of the community, with a species replacement in each environment as a consequence (Ohyama 2022). When interpreting seasonal β diversity, it can be observed that the species shared during spring and summer are similar between the stands, possibly due to the large supply of food resources. During spring, the increase of temperature and the duration of the day generate an increase in the complexity of the habitats and, therefore, provide a greater availability of niches for the ant community (García Martínez et al. 2016; Ohyama 2022; Queiroz et al. 2022). Considering the higher temperatures and that most of the annual precipitation occurs during the summer, herbaceous vegetation can develop better, which could explain this greater ant activity (Claver et al. 2014; Silva et al. 2014; García Martínez et al. 2016; Queiroz et al. 2022). Towards autumn, a large number of pods can be found in the soil in the mesquite plots, which are a good energy resource that can be used by soil fauna. In this sense, it has been shown that when *Neltuma flexuosa* fruits fall to the ground they are quickly located and used by different species of ants (Milesi and López de Casenave 2004). On the other hand, in eucalyptus plots, the litter biomass accumulated on the soil during autumn could generate a favourable microclimate for other species of the ant community (Suguituru et al. 2011). Possibly the mixed forest does not have the same availability of resources during the autumn and therefore only few species of ants can be found during this time. Therefore, the seasonal turnover that occurs in each environment depends mainly on the width of the niche of the set of species that make up the community, since variations in environmental conditions promote the activity of those populations with generalist and opportunistic habits (Santoandré et al. 2019).

The results presented in this work demonstrate that the homogenization of environments caused by anthropic activity, such as monospecific plantations, can increase the similarity among ant communities within a locality. In this sense, it was not possible to verify that there was a lower diversity in the stands of *E. tereticornis* compared to those of *N. alba*, in fact, the myrmecological communities were slightly dissimilar. However, it was observed that seasonality influenced the activity of the different species, generating turnover of dominance of some functional groups. However, if it is possible to maintain a variety of environments, whose supply of resources is different according to the species that compose them and are variable throughout the year, the turnover rate of the local ant community can be maintained, favouring the conservation. Therefore, the promotion of habitat diversification could be favourable to the spatial and temporal variation of Formicidae in different types of forests of the Chaco Seco ecoregion, Argentina. In conclusion, potential threats to ecosystem functioning cannot be completely detected with an approach that points to a single level of biodiversity such as α, so biodiversity studies with a focus on β diversity result in a very useful complementary tool to assess the state of local landscape communities and their spatio-temporal variation more accurately.

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