doi:10.12741/ebrasilis.v11i1.703
e-ISSN 1983-0572
Publication of the project Entomologistas do Brasil
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Ecology/Ecologia

Diversity of ants in citrus orchards and in a forest fragment in Southern Brazil

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EntomoBrasilis 11 (1): 01-08 (2018)

Abstract. The landscapes of the South and Southeast regions of Brazil are a mosaic of agroecosystems and vegetation in different stages of preservation, shapes and sizes and sizes and this changes the community structure of ants. Diversity of ants was compared in three different environments: orange orchard, lemon orchard and a forest fragment of the Brazilian Atlantic Forest biome, in the northwestern part of the State of Paraná, Brazil by a sampling method using pit-fall traps. Both richness and diversity of the species of ants were broader in the forest fragment than in the orchards; the fauna components were distributed rather homogeneously, as shown by the indices of equitability. The proximity of the areas sampled and the orchard management could be the main reasons to explain why all the species trapped in the experiments were found at least once in the forest remnant, whereas some groups of ants were not found in the orchards. Furthermore, the species of antes which were collected from the agricultural areas were mostly generalists and less diverse, leading to a monopoly of resources by a few, more prolific species. On the contrary, the ants living in forested areas were more diverse, where fewer individuals were found per species, and these were expected to be more specialized. The establishment of citrus orchards near the forest fragments may facilitate invasion by ants, especially the opportunistic species.

Keywords: Atlantic Forest fragments; *Citrus aurantifolia; Citrus sinensis;* Formicidae; Pitfall.

Diversidade de formigas em pomares cítricos e em fragmento florestal no sul do Brasil

Resumo. As paisagens das regiões Sul e Sudeste do Brasil são um mosaico de agroecossistemas e vegetação em diferentes estágios de preservação, formas e tamanhos e isso altera a estrutura da comunidade de formigas. A diversidade de formigas foi comparada em três ambientes diferentes: pomar de laranja, pomar de limão e fragmento florestal da Mata Atlântica brasileira, no noroeste do Estado do Paraná, por meio de um método de amostragem utilizando armadilhas de queda *pitfall.* Tanto a riqueza como a diversidade das espécies de formigas foram mais amplas no fragmento florestal do que nos pomares; Os componentes da fauna foram distribuídos de forma bastante homogênea, conforme demonstrado pelos índices de equitabilidade. A proximidade das áreas amostradas e a gestão do pomar podem ser as principais razões para explicar por que todas as espécies capturadas nos experimentos foram encontradas pelo menos uma vez no remanescente da floresta, enquanto que alguns grupos de formigas não foram encontrados nos pomares. Além disso, as espécies coletadas nos pomares eram na sua maioria generalistas e menos diversificadas, levando a um monopólio de recursos por algumas espécies mais prolíficas. Ao contrário, as formigas que viviam em áreas florestadas eram mais diversas, onde menos indivíduos eram encontrados por espécie, e esperava-se que fossem mais especializados. O estabelecimento de pomares de citros perto dos fragmentos florestais pode facilitar a invasão por formigas, especialmente as espécies oportunistas.

Palavras-chave: *Citrus aurantifolia*; *Citrus sinensis*; Formicidae; Fragmento de floresta Atlântica; Pitfall.

Nowadays, the landscapes of the South and Southeast regions of Brazil are a mosaic of agroecosystems and vegetation in different stages of preservation, shapes and sizes (Dias *et al.*, 2008). Large areas of the forests have been destroyed or remain as residual fragments surrounded by crop fields or pastures (Oliveira 1999), and the northwestern part of Paraná is considered as one of the most degraded in the state, due to strong anthropogenic interferences. However, our knowledge of the floristic and faunistic composition is still very scant.

A survey of the biodiversity survey is the basis of any task, ecological or monitoring, since it provides helpful information to determine the biological values and to infer the degree of conservation of ecosystems (Willink *et al.* 2000). As such, ants are particularly interesting insects, because they are predominating in most terrestrial ecosystems. They act as bioindicators due to their omnipresence in nature, and their taxa are specialized, widely distributed geographically, easily sampled and identified, as well as sensitive to environmental changes (Andersen 1997; Silva & Brandão 1999; Alonso & Agosti 2000).

Most entomological research in citrus cultivars have been concentrated on developing integrated pest management programs (Kupper *et al.* 2003; Parra *et al.* 2004; Cassino *et al.* 2005; Jahnke *et al.* 2006). Any papers that mention ants in Brazilian orchards are virtually nonexistent, there the ants are always associated with other arthropods, mainly pests (Morais *et al.* 2006; Ferreira *et al.* 2009). However, it is also important to

Edited by:
William Costa Rodrigues
Article History:
Received: 20.iv.2017
Accepted: 11.xi.2017

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Funding agencies:
Without funding declared

understand the ecological role that non-pesty insects or insects that are not associated with pests play in monocultures, as well as the extent of differences in the composition and abundance of these insects between the agroecosystems and the respective adjacent forests.

Lopes *et al.* (2010) suggested a need for studies at local scales that relate the distribution of the species of ants in environments to different land use practices, since there is still no well-defined behavior pattern for the richness and abundance of ants. Some studies have indicated that in more complex environments, these ecological attributes increase (Bustos & Ulloa-Chacón 1997; Roth *et al.* 1994), decrease (Lassau & Hochuli 2004; Punttila *et al.* 1991), or remain unchanged (Belshaw & Bolton 1993).

The current taxonomic and biogeographic knowledge of most terrestrial organisms is still incomplete in Brazil, particularly of the "hyper diverse" ones, including the ants of Formicidae (Silva & Brandão 1999), and as consequence, epigeic ants of the orchards of *Citrus sinensis* (L.) Osbeck, Rutaceae (orange) and *Citrus aurantifolia* (Cristm.), Rutaceae (lemon) were analyzed and compared to myrmecofauna structures of an adjacent forest fragment. Results have indicated the influence of a nearby forest fragment on citrus orchards, as a functional maintenance of the biotope and the dispersion of the species of antes in cultivated areas. The ants in citrus orchards can act as pests to the crop, biological control agents as predators of agricultural pests or as obstacles that hinder the crop management by farmers, due to their aggressiveness.

MATERIAL AND METHODS

This study was conducted from October 2006 to January 2007 in an experimental citrus orchard with an area of 190 hectares (23º06'13.33"S, 52º25'16.90″W), belonging to the Ypiranga Farm, in Paranavaí, northwestern part of the State of Paraná (23°4'26"S, 52°27'55"W). The farm soil is sandy, derived from Caiuá sandstone and its interposition with millimetric-size molten basalt (Rufino*et al.* 1992).

Three contiguous, but distinct, areas were sampled: a) a forest fragment of the tropical pluvial forest (Maack 1981), aka the Paraná River Floodplain Forest (Hatschbach 1999); b), an orange orchard of *C. sinensis*; and c) a lemon orchard of *C. aurantifolia*. The forest fragment is a degraded and expanded riparian forest with large trees; its understory is humid and dark, and a stream runs through it (23º06'35"S, 52º25'47"W).

The orange and lemon orchard at the Ypiranga Farm were divided into plots of approximately 2 hectares each and a density of 1,000 to 1,200 trees per hectare. The orchards are separated by silk oak trees (*Grevillea robusta* A. Cunn., Proteaceae), which are insufficient to provide a physical barrier. Ground-cover grass grows in-between the rows and is mowed every three to five months. Insecticides are sprayed under the orange and lemon trees once a month.

Three data collection sites were selected in each of the three areas, and three parallel transects (each 200 m long) were drawn on a distance 10 m apart from each other. Circular pitfall traps (Bestelmeyer*et al.* 2000) were placed in each transect. The traps were 7.5 cm in diameter and 11.5 cm deep, and they were placed 10 m apart, amounting to 20 traps per transect and thus 60 traps per area. The total of 180 traps placed in all areas remained in the field for 24 h.

The collected specimens were identified at the Myrmecology Laboratory of the Cocoa Research Centre (Centro de Pesquisa do Cacau), CEPLAC, Ilhéus, State of Bahia, Brazil. The reference collections were deposited [collection CPDC] at CEPLAC and a second collection was deposited in the entomological collection of the Zoology Museum (Laboratório de Zoologia), at the State University of Londrina (Universidade Estadual de Londrina), State of Paraná.

The analyses were conducted by use of the EstimateS software (Statistical Estimation of Species Richness and Shared Species from Samples) version 9.1.0, which calculated the following indices of diversity: Shannon-Wiener, in Neperian base (H'), Fisher's alpha, Jaccard similarity (J), jackknife, and bootstrap richness estimators. The Shannon-Wiener index is widely used and provides a *t*-test for evaluating significant differences between samples (Magurran 1988). Jackknife and bootstrap have been shown to reduce bias (Smith & Belle 1984), and they make no assumptions about the underlying distribution. We also determined the constancy index (C) based on the classification by Bodenheimer (1955) and the species dominance (Laroca 1995). The constancy was determined by the following equation: C= P x 100/N, where C= constancy index; P= number of samples containing species; N= total number of samples, and the species constancy was classified as constant (w) when present in more than 50 % of the samples, accessory (y) when present in 25% to 50% of the samples and accidental when present in less than 25% of the samples (Bodenheimer 1955).

The dominant species were determined by calculating the limit of dominance established by the following equation: LD= (1/S) x 100, where LD= limit of dominance and S= total number of species. The parameters obtained allowed us to classify the species per dominance, where dominant species have frequency values higher than the above-mentioned limit (reference limit value), and non-dominant species have lower frequency values than the established reference limit value (Laroca 1995).

Given the relative proximity of the sampling sites, the Mantel test was applied to the matrices of biotic similarity and the geographic distance between the points, with the aim of determining the influence of local spatial autocorrelation on the taxonomic composition of the assemblages (Legendre 1993). The first matrix was generated by the Bray-Curtis distance calculated as the square-root arcsine of the relative abundance of species between the sampling points. The second matrix, referring to the spatial distance between the points, was obtained by calculating the Euclidean distance between the geographic coordinates of each location. This test was performed in the R Software (R Core Team 2014), Vegan package (Oksanen *et al.* 2013).

RESULTS

Thirty-eight morphospecies of ants, belonging to 22 genera of six subfamilies, were collected. The subfamily Myrmicinae had the highest number of species (20) (Table 1).

Only two species were constant in one of the collection series: *Wasmannia auropunctata* (Roger) was constant in all forest fragment samples (50.4%) and so was *Dorymyrmex* sp.1 in the lemon orchard (51.3%).

Following the criteria established by Sakami & Laroca (1971), the species were classified into the following categories: constant (w), present in more than 50% of collections; accessory (y), present in 25 to 50% of collections; and accidental (x) species: present in less than 25% of collections. 21 of the species found in the forest fragment were dominant (frequency value > 2.6) and 17 were non-dominant (frequency value < 2.6) (Table 2). 12 of the 38 types of species studied dominated all three habitats, and there were only two dominant morphospecies in the anthropized areas, both being *Dorymyrmex* (Table 2).

The curves for sampling efficiency using bootstrap as analytical estimator of species richness for each environment (Figure 1) practically reached the asymptote, suggesting that the employed sampling effort was adequate (Colwell & Coddington 1994). The

Table 1. Hymenoptera Formicidae sampled using pitfall traps on soil of three areas at the Ypiranga Farm, Paranavaí/PR. September 2006 to February 2007.

	Species	Forest fragment	Orange orchard	Lemon orchard	Capture frequency (%)
	Subfamily Myrmicinae				
1	*Acromyrmex subterraneusN*Forel	x	x	x	1.67
2	Acromyrmex balzani Emery	x	x	x	6.7
3	*Apterostigma*s p.1 complex *opilosum* Mayr	x	x	x	9.6
4	Cephalotes pileini De Andrade &Baroni	x	-	-	0.2
5	*Cephalotes minutus* Fabricius	x	-	-	0.2
6	*Cephalotes atratus* Linnaeus	x	-	-	0.3
7	*Cremato gastervictima* Smith	x	x	x	2.7
8	*Cyphomyrmex transversus* Emery	x	x	x	26.0
9	*Mycetarotes parallelus* Emery	x	x	x	0.6
10	*Mycocepurus goeldii* Forel	x	x	x	5.2
11	*Pheidole arcifera* Santschi	x	x	x	16.0
12	*Pheidole diligens* Smith	x	x	x	12.7
13	*Pheidole radoszkowskii* Mayr	x	x	x	10.4
14	*Pheidole* sp. *tristis* group	x	x	x	11.6
15	*Pogonomyrmex abdominalis* Santschi	x	x	x	4.1
16	*Pogonomyrmex naegelii* Forel	x	-	-	0.5
17	*Solenopsis* sp. Near *Globularia*	x	x	x	20.7
18	Trachymyrmex cirratus Mayhé-Nunez & Brandão	x	x	x	7.5
19	*Trachymyrmex iheringi* Emery	x	x	x	7.5
20	*Wasmannia auropunctata* Roger	x	x	x	9.4
	Total	**20**	**16**	**16**	
	Subfamily Formicinae				
21	*Brachymyrmex patagonicus* Mayr	x	x	x	28.5
22	*Camponotus cingulatus* Mayr	x	x	x	5.7
23	*Camponotus renggeri* Emery	x	x	x	3.2
24	*Camponotus rufipes* Fabricius	x	-	x	2.2
25	*Camponotus leydigi* Forel	x	x	-	2.0
26	*Camponotus crassus* Mayr	x	-	-	1.3
	Total	**6**	**4**	**4**	
	Subfamily Ponerinae				
27	*Pachycondyla striata* Smith	x	x	x	10.1
28	*Pachycondyla harpax* Fabricius	x	-	-	0.1
29	*Odontomachus* sp. near *bauri*	x	-	-	0.1
30	*Odontomachus meinerti* Forel	x	-	-	0.1
	Total	**4**	**1**	**1**	
	Subfamily Dorylinae				
31	*Labidus praedator* Smith	x	x	x	
	Total	**1**	**1**	**1**	9.7
	Subfamily Dolichoderinae				
32	*Linepithema neotropicum*Wild	x	-	-	0.1
33	*Dolichoderus bispinosus* Olivier	x	-	-	0.5
34	*Dorymyrmex* sp.1	x	x	x	35.5
35	*Dorymyrmex* sp.2	x	x	x	21.8
	Total	**4**	**2**	**2**	
	Subfamily Ectatomminae				
36	Gnamptogenys acuminata Emery	x	x	x	1.2
37	*Gnamptogenys regularis* Mayr	x	x	x	0.6
38	*Ectatomma brunneum* Smith	x	x	x	7.3
	Total	**3**	**3**	**3**	
	Grand Total	**38**	**27**	**27**	

Table 2. Relative frequency of ant capture (%) per area (CF), constancy (C) and dominance (D) of the species sampled using pitfall traps in three areas of the Ypiranga Farm, Paranavaí – PR. September 2006 to February 2007 (x= accidental, y= accessory, w= constant, d= dominant, nd= non-dominant).

Species		CF Forest (%)	C	D	CF Orange (%)	C	D	CF Lemon (%)	C	D
1	*A. subterraneus*	1.8	x	nd	1.6	x	nd	1.5	x	nd
2	*A. balzani*	9.5	x	d	11.2	x	d	4.8	x	d
3	*Apterostigmas*. sp.1 *pilosum* complex	14.5	x	d	6.5	x	d	7.7	x	d
4	*C. pilei*	0.7	x	nd	-	-	-	-	-	-
5	*C. minutus*	0.7	x	nd	-	-	-	-	-	-
6	*C. atratus*	0.8	x	nd	-	-	-	-	-	-
7	*C. victima*	3.1	x	d	2.7	-	nd	1.5	x	nd
8	*C. transversus*	25.2	y	d	40.9	y	d	12.0	x	d
9	*M. paralellus*	0.2	x	nd	0.6	x	nd	0.5	x	nd
10	*M. goeldii*	4.0	x	d	5.5	x	d	5.9	x	d
11	*P. arcifera*	22.5	x	d	22.0	y	d	23.6	y	d
12	*P. diligens*	16.6	x	d	16.1	x	d	10.6	x	d
13	*P. radoszkowskii*	9.5	x	d	12.5	x	d	8.3	x	d
14	*Pheidole* sp.*Tristis* group	8.5	x	d	15.3	x	d	13.4	x	d
15	*P. abdominalis*	2.7	x	d	6.6	x	d	2.6	x	nd
16	*P. naegelii*	1.5	x	nd	-	-	-	-	-	-
17	*Solenopsis* sp. Near *globularia*	13.8	x	d	14.7	x	d	16.5	x	d
18	*T. cirratus*	6.5	x	d	3.3	x	nd	2.6	x	nd
19	*T. iheringi*	9.3	x	d	6.5	x	d	5.9	x	d
20	*W. auropunctata*	50.4	w	d	0.1	x	nd	0.1	x	nd
21	*B. patagonicus*	4.1	x	d	39.4	y	d	41.8	y	d
22	*C. s cingulatus*	14.0	x	d	0.2	x	nd	0.2	x	nd
23	*C. s renggeri*	8.3	x	d	0.9	x	nd	0.1	x	nd
24	*C. rufipes*	6.2	x	d	-	-	-	0.2	x	nd
25	*C. leydigi*	5.5	x	d	0.1	x	nd	-	-	-
26	*C. crassus*	1.1	x	nd	-	-	-	-	-	-
27	*P .striata*	29.7	x	d	0.4	x	nd	0.2	x	nd
28	*P .harpax*	0.4	x	nd	-	-	-	-	-	-
29	*Odontomachus* sp. near *bauri*	0.1	x	nd	-	-	-	-	-	-
30	*O. meinerti*	0.1	x	nd	-	-	-	-	-	-
31	*L. praedator*	9.5	x	d	7.9	x	d	5.3	x	d
32	*L. neotropicum*	0.1	x	nd	-	-	-	-	-	-
33	*D. bispinosus*	1.2	x	nd	-	-	-	-	-	-
34	*Dorymyrmex*. sp.1	1.9	x	nd	46.3	y	d	54.3	w	d
35	*Dorymyrmex*. sp.2	2.0	x	nd	27.5	y	d	35.6	y	d
36	*G. acuminata*	1.1	x	nd	2.0	x	nd	1.1	x	nd
37	*G. regularis*	0.2	x	nd	1.2	x	nd	0.2	x	nd
38	*E. brunneum*	1.2	x	nd	9.3	x	d	11.5	x	d

estimated richness of species was very close to the one observed in the three sites of the study (Table 3).

The analytical estimator curves for sampling the efficiency of richness of species in each environment shows (Figure 1) an asymptote for all, suggesting that the sampling effort was adequate (Colwell & Coddington 1994), as well as showing a higher richness for the forest fragment. The estimated richness of species is very close to the one observed in the three sites of the study (Table 3).

We observed the greatest richness of species (38) as well as higher indices of diversity in the forest fragment. The richness of species (27) in the orchards was the same, but jackknife and bootstrap showed a higher index in the orange orchard than in the lemon orchard, while the Shannon and Fisher's alpha indices indicated a greater diversity in the lemon orchard than in the orange orchard (Table 3), although the Shannon diversity index was higher for the lemon orchard than for the orange orchard. The jackknife and bootstrap richness estimates were greater for the orange orchard. The *t* test of the Shannon-Wiener's index reveals that the forest fragment is significantly different ($P<0.001$) from orange and lemon orchards in terms of the diversity of ants present in them. The lemon and orange orchards failed to exhibit any true difference in the diversity of ants.

Jaccard's similarity index showed a high similarity between the orange and lemon orchard (0.92), and the same value (0.72) between the forest fragment and either orchard, respectively.

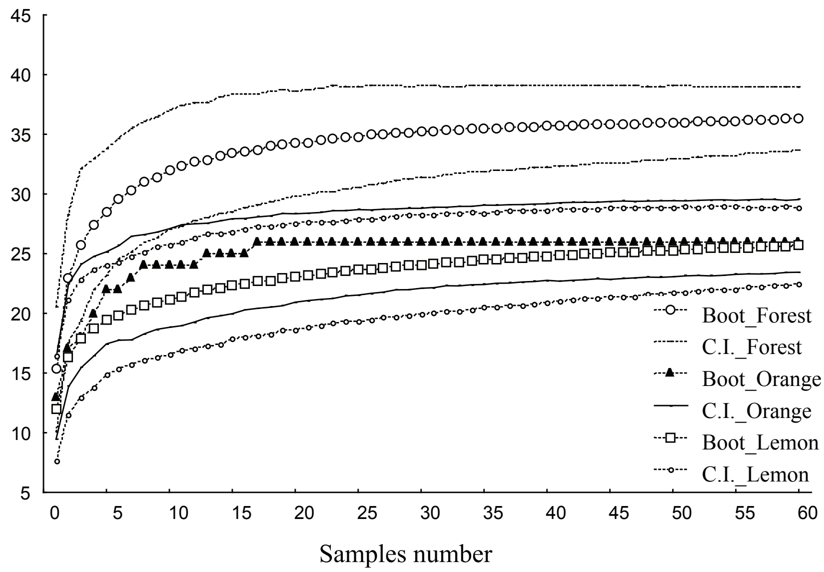

Figure 1. Species accumulation curvesusing bootstrap, 95% confidence intervals, for captured ants with pitfall of the three studies sites forest fragment, orchard orange and orchard lemon.

Table 3. Diversity Indexes Shannon-Wiener's (*significant difference between the others; P<0,001), Fisher-Alpha's, Jackknife and Boostrap (+/-1.96*SE) and Equitability Index for ants collected in a forest fragment, an orange orchard and a lemon orchard at the Ypiranga Farm, Paranavaí-PR. September 2006 to February 2007.

Areas	Shannon-Wiener's	Fisher-Alpha's	Jackknife	Bootstrap	Equitability
Forest fragment	*2.14±0.27	4.51±0.51	37.05±2.25	36.32±2.53	0.59
Orange orchard	1.79±0.25	2.80±0.33	27.23±2.15	26.49±2.94	0.55
Lemon orchard	1.97±0.09	2.82±0.35	26.76±3.04	25.67±3.09	0.60

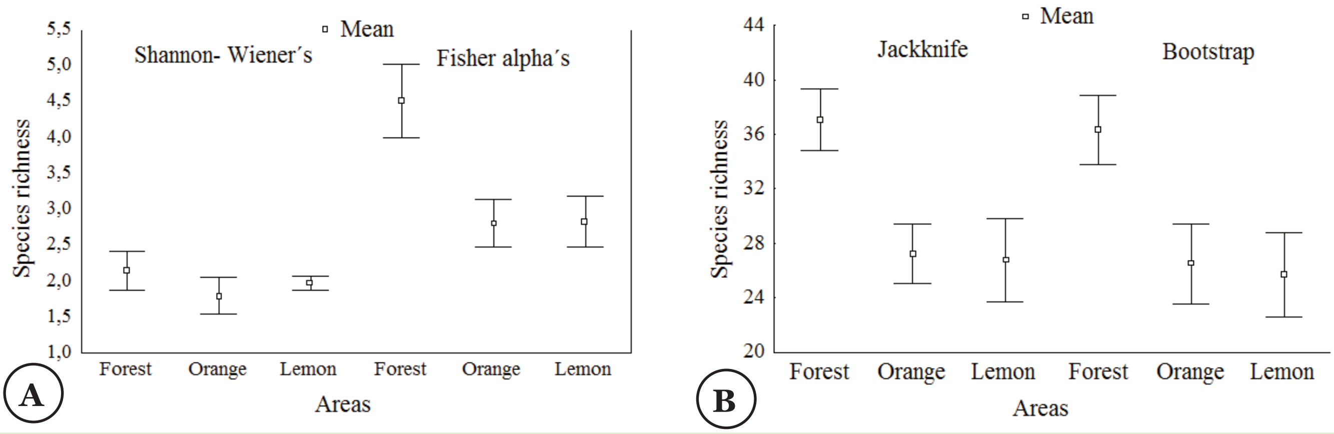

Figure 2A-B. Means and confidence intervals (+/-1.96*SE) of Shannon- Wiener's and Fisher-Alpha's Diversity Indexes in three study areas (A), and means and confidence intervals (+/-1.96*SE) of Jackknife and Bootstrap diversity estimators (B).

The Mantel test revealed that the distance matrix of abundances and spatial distance was uncorrelated (P< 0.05), so the forest fragment and the orchard areas were not spatially correlated.

DISCUSSION

Autocorrelation is a very general statistical property of ecological variables observed across geographic space, and autocorrelated data violate the assumption of independence of most standard statistical procedures (Legendre 1993). Thus, the Mantel test showed that the matrices of biotic similarity and geographic distance between the points were not correlated. In this case, the values of abundance were not related to the proximity of the sampling sites, i.e., the number of individuals per species did not depend on the geographic location of the sites.

In terms of abundance, the orchards habitats were more similar, not because they were closer to each other, but, probably, due to the physiognomy and physical characteristics of the environment. Likewise, the abundance of ants in the fragment showed no difference to the orchards. This probably occurred because the orchards had a more similar vegetation, while the forest fragment had a greater diversity of plants.

We observed a greater richness of species in the forest fragment as compared to the citrus orchards. As expected, the indices also pointed to a greater diversity in the forest fragment for all three ecotopes studied. The *t* test of the Shannon-Wiener's index also reveals that the forest fragment is significantly different (P<0.001) from orchards. However, the Shannon index considers the evenness of the abundances of species and also attribut high weight to rare species (Magurran 1988). The abundance distribution of the lemon orchard was more homogeneous than that of the orange orchard, and abundance of rare species decreased slightly in the lemon orchard and greatly in the orange orchard. And thus, this index was probably influenced by the small difference in evenness of these sites. Nevertheless, the equitability index was almost constant for all three environments, suggesting that the sampled fauna was homogeneously distributed.

On the other hand, when the confidence intervals of the Shannon-Wiener's index are calculated, there is not observed any difference between any of the studied environments (Figure 2). Marrugan (2013) alert that not always a statistic for diversity works and that it is up to the researcher to judge if result is meaningful biologically. The observation of the raw data and the heterogeneity of the structure of the vegetation and the soil make us believe that the forest is able to sustain greater diversity than the orchards, although statistically it is not possible to prove this by our data.

The orchards consisted of young plants, with trees far apart, and sandy soil, with some areas covered by grass. This situation favored the ants with opportunistic habits and the others occasionally leaving the forest fragment to forage.

In addition, all species collected during the study had representatives in the forest fragment, meaning that there were exclusive forest remnant species (genus *Cephalotes*, several Ponerinae, etc.), whereas no species were present exclusively in the orchards. The main reasons for such difference might be that: 1) the proximity of the sampled areas explain the faunistic homogeneity, considering that all species are potentially present in all habitats, and the absence of some species depend exclusively on the management of the experimental fields; 2) the orchard management through selective elimination of vegetation, regular application of insecticides, a small number of micro-habitats, etc., inhibits the availability of nesting sites and food resources, and physically eliminates incipient or fragile colonies. Native forest areas offer more available micro-habitats for a more organisms (decomposing tree trunks, stones, litter, trees, epiphytes) as foraging and nesting sites, and appropriate climate for their development (Ramos *et al.* 2003). Such an abundance of micro-habitats in the forest fragments allows for less inter-specific competition, thus contributing to a higher diversity (Martins *et al.* 2006).

In monocultures, the fewer available micro-habitats lead to a lower fauna richness as compared to natural environments (Giller *et al.*1997). Therefore, the richness of ants is affected not only by biotic factors, but also by the area size and the number of strata (Majer & Delabie 1994), shade, protection against desiccation, wind and slight temperature changes (Lawton 1983), which might have contributed to the greater richness of species found in the forest fragment. This result supports the studies by Oliveira *et al.* (1995), Soares *et al.* (1998), and Marinho *et al.* (2002), among others.

Although the number of species was smaller, a greater abundance of individuals was observed in the orchards than in the forest remnant. This comes as no surprise because the strongly anthropized or monoculture areas have more generalist species and a lower diversity (Smith & Delabie 1995). This allows for fewer and more prolific species to control food resources, whereas forest ants are more diverse. Each of the species also has fewer, although more specialized, individuals.

The high similarity between the orange and lemon orchard showed that a clear interchange of species occurred between the two areas, because they are separated only by a few silk oak trees. Another reason for such similarity might have been the similar management practices for the orange and lemon trees. Per Smith & Delabie (1995), similarities in citrus orchards are inversely proportional to vegetation development, that is, trees provide a wider variety of micro-habitats as they grow, leading to more nesting and food resources (Macedo 2004).

The subfamily Myrmicinae stood out among others as expected. Per Hölldobler & Wilson (1990), this is the most diverse subfamily, both in the region and the whole world. Most published studies on communities of ants of the Neotropical species report that the subfamily Myrmicinae is the most frequent in any sampled environment or stratum (Marinho *et al.* 2002; Lutiniski & Garcia 2005; Conceição *et al.* 2006; Santos *et al.*, 2006).

Wasmania auropunctata, a constant species in all forest fragment samples finds and uses large resources of animal and plant food, such as sap, seeds, leaves, flowers, floral and extra-floral nectar, annelids, arthropods and gastropods, dead insects, as well as oily or greasy materials available in human homes (Delabie 1988; Souza 2007). It can also easily find such resources as compared to other species of ants because they can recruit workers on a massive scale. This kind of species can also produce an allomone with its mandibular glands, which prevents other species from reaching the food resource (Meier 1994; Souza 2007). This behavior may explain the ecological success of the species in forest fragments, such as the one observed in our study. The high frequency of this species of ant in this kind of forest also shows a potentially high degree of anthropic disturbance in the forest remnant (Delabie *et al.* 2007).

Achury *et al.* (2008) also found higher densities of *W. auropunctata* in sugarcane fields and pastures as opposed to biotypes with arboreal coverage. They consider it an indicator of a low diversity because it is a good competitor and dominates food resources rapidly and efficiently, taking advantage when local disturbance increases. However, this species was less common in orchards (accidental species), which are sites with greater anthropogenic disturbance than in the forest fragment (constant species). Maybe *Dorymyrmex* spp., play the role of *W. auropunctata* in the orchards?

The constancy of *Dorymyrmex* sp.1 and its abundance observed primarily in the orchards may be due to the species' frequent association with bare soils and foraging in warmer weather, when other species do not (Macedo 2004). Rossi & Fowler (2004) consider this ant genus as the second most frequent predator of *Diatrea saccharalis* (Fabricius) (sugarcane borer) in sugarcane fields in the State of São Paulo. These ants are aggressive and able to attack the others that approach their nests; they can also monopolize food resources due to their high ability to recruit their own workers.

Two *Dorymyrmex* morphospecies were also found to be dominant in the orchards, maybe due to their foraging abilities using anthropic environments and to their opportunistic behavior. Per Silveira Neto *et al.* (1976), a dominant organism in a community receives any impact suffered by the environment where it lives, responding to or changing it as necessary. Therefore, this kind of organism can either improve the chances of occurrence, or cause the disappearance of all other organisms in the community.

Our study should be considered as the first step toward the understanding the diversity of epigeic ants in agriculture, more specifically the citrus production as compared to ant dynamics in native vegetation (forest associated with the Atlantic Forest biome) in the northwestern part of the State of Paraná. The forest fragment had more species than the citrus orchards, which shows that soils under cultivation affect the dynamics of the ant communities, decreasing their diversity and increasing the abundance of opportunistic species.

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Suggestion citation:

Golias, H.C., J. Lopes, J.H.C. Delabie & F. de Azevedo, 2018. Diversity of ants in citrus orchards and in a forest fragment in Southern Brazil. EntomoBrasilis, 11 (1): 01-08.
Available on: doi:10.12741/ebrasilis.v11i1.703