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Survey of Myrmecofauna in Fragments of an Environmental Protection Area in Caxias, Maranhão-Brazil

Levantamento da Mirmecofauna em Fragmentos de uma Área de Proteção Ambiental em Caxias, Maranhão -Brasil

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Abstract: Ants have several characteristics that can be applied in studies on the biodiversity, monitoring, fragmentation, and ecology of ecosystems. This study aims to contribute to increasing our understanding of the dynamics and biodiversity of the ant fauna in two fragments of the Inhamum Environmental Protection Area (EPA). The investigation was conducted in two areas of Cerrado vegetation in the Inhamum EPA. Provid traps were distributed in both areas, each comprising 30 sampling units. Collections were performed from September to December 2017 and from January to March 2018. Data were subjected to faunal analyses, carried out using ANAFAU software. The richness estimators Chao1 and Chao2 were calculated using R software. Permutational multivariate analysis of variance was used to assess differences in ant assemblage composition between study areas and seasons. A total of 1,845 individuals were sampled, distributed in 29 genera; 1 exclusive and 22 non-exclusive genera were recorded in Area I and 7 exclusive and 18 non-exclusive genera were recorded in Area II. Community structure differed between Areas I and II, but no seasonality effects were observed. The accumulation curves for both areas did not stabilize, showing that a greater sampling effort would be needed to reach the plateau.

Keywords: Cerrado; Diversity; Abundance.

Resumo: As formigas apresentam diversas características que podem ser utilizadas em estudos de biodiversidade, monitoramento, fragmentação e ecologia de ecossistemas. O presente trabalho tem o objetivo de contribuir para o melhor entendimento da dinâmica e biodiversidade da fauna de formigas em dois fragmentos na Área de Proteção Ambiental - APA do Inhamum. O estudo aconteceu em duas áreas de Cerrado na APA do Inhamum. Armadilhas do tipo Provid foram distribuídas nas duas áreas, em cada área com trinta unidades amostrais. As coletas foram realizadas nos meses de: setembro a dezembro de 2017 e janeiro à março de 2018. Os dados foram submetidos a análises faunísticas, realizados no programa ANAFAU. As estimativas de riqueza Chao1 e Chao2 foram realizadas com o auxílio do programa R. A Análise de Variância Multivariada Permutacional foi utilizada para avaliar a diferença entre a composição das assembleias de formigas nas duas áreas de estudos e sazonalidade. Foram contabilizados um total de 1.845 indivíduos com um total de 29 gêneros sendo 22 para Área I 1 gêneros exclusivos e 18 gêneros para Área II, com 7 gêneros exclusivos para esta área. A estrutura

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de comunidade difere entre as áreas Área I e Área II e a estrutura de comunidade não difere entre na sazonalidade. A curva de acumulação das duas áreas não se apresentou estável mostrando assim que seria preciso um maior esforço amostral para atingir o equilíbrio.

Palavras-Chave: Cerrado; Diversidade; Abundância.

1. Introduction

The class Insecta is divided into 30 orders, classified mainly according to structural characteristics of wings and mouthpieces and type of metamorphosis (TRIPLEHORN & JOHNSON, 2015). Insects represent one of the most abundant and diverse taxonomic groups, encompassing 66% of all species in the animal kingdom (ZHANG, 2011; ZHANG, 2013).

The order Hymenoptera, belonging to the class Insecta, includes all ants, bees, and wasps. Ants are classified as eusocial insects and are placed into a single family (Formicidae). Currently, almost 15,800 valid species, 24 subfamilies, and 505 genera are known. Brazil has the highest diversity of ants in the Americas and one of the highest in the world, with 1,541 species formally described, distributed in 13 subfamilies and 118 genera (ANTWEB, 2021). These insects are extremely important for the performance of terrestrial ecosystems, given that they are present in virtually all habitats (GALLEGO-ROPERO *et al.*, 2013).

Ants have several characteristics that can be used to study the biodiversity, level of fragmentation, and ecology of ecosystems (BACCARO, 2006). Furthermore, formicids are an important group for environmental monitoring (OLIVEIRA *et al.*, 2014). In tropical ecosystems, ants are important components of the community structure because of their expressive diversity and large biomass. These insects comprise hyperdiverse groups and are regarded as functional bioindicators because they are sensitive to the conservation state of terrestrial environments (ALBURQUERQUE, 2009).

Numerous studies have assessed the usefulness of ants as bioindicators of environmental quality (see MARINHO, 2002; RIBAS *et al.*, 2003; COSTA MILANEZ *et al.*, 2014; TIBCHERANI *et al.*, 2018). In addition to sensitivity to environmental changes, ants have other characteristics that make them valuable bioindicators of the degree of environmental impact in different biomes, particularly their wide distribution, high species richness, and easy sampling (MAJER, 1983; HÖLLDOBLER & WILSON, 1990). It is essential to study the ecological parameters of ant communities, such as species richness, diversity, and frequency (SILVEIRA *et al.*, 1995), because such information allows to characterize and compare the fauna of different environments (DELABIE *et al.*, 2006).

The Inhamum Environmental Protection Area (EPA), located in the Cerrado biome, comprises a mosaic of environments that provide the ideal conditions for the survival of several species, including ants. The region has been exposed to certain anthropogenic activities, such as deforestation, which can cause catastrophic effects on the environment, compromising its integrity.

In view of the environmental importance of the family Formicidae, this study aimed to contribute to our understanding of the dynamics and diversity of the ant fauna in two phytophysiognomies of the Inhamum EPA, namely gallery forest and Cerrado *sensu stricto*, in Caxias, Maranhão State, Brazil, and present relevant data for our knowledge of the local fauna and biological diversity.

2. Methods

The research was conducted in two phytophysiognomies of the Inhamum EPA, in Caxias, Maranhão, Brazil. The Inhamum EPA was created by Law No. 1,464 of June 4, 2001. It is located on the left bank of BR-316, near the urban perimeter of Caxias. The area is characterized by typical Cerrado vegetation, ranging from *campo limpo* to *cerradão*. Given its geographical position between the Semi-arid Northeast and the Mid-North, the region has humid warm equatorial climate, with two distinct seasons (rainy summers and dry winters). According to Araujo (2012), the area receives regular rainfall, between 1,600 and 1,800 mm, and temperatures are usually high, with the annual average being above 24 °C.

Each area was marked with six parallel transects, about 10 m apart. In each transect, five equidistant sampling units (10 × 10 m) were defined, with 30 points sampled per treatment (area), totaling 60 sampling units.

Soil macrofaunal individuals were captured by using Provid pitfall traps. The trap consists of a 2 L PET bottle with four holes measuring 2 × 2 cm (Araujo, 2010) at a height of 20 cm from the base, containing 200 mL of a 5% detergent solution and 5 drops of formaldehyde (P.A.). Traps were buried with the holes at ground level and were kept in the same location during all collections. Each trap remained in the field for 4 days (96 h). Eight collections were performed, four in the dry period (September, October, November, and December 2017) and four in the rainy period (January, February, March, and April 2018), in both experimental areas.

After the 96 h period, traps were removed from the field and identified with the collection date, area, and sampling point. Then, bottles were transported to the Laboratory of Soil Fauna (LAFS) of the Maranhão State University, where their contents were washed under running water on top of a 0.25 mm sieve to ensure that no individual was lost. Collected specimens were transferred to plastic pots containing 70% ethanol. Subsequently, specimens were identified at the levels of class and order or other taxonomic groups by using the identification key proposed by Triplehorn and Jonnson (2015).

After screening, ant individuals were counted and mounted on size 2 entomological pins by the double assembly method. Cardboard paper triangles and white glue were used for fixation. The material was stored in entomological boxes for further identification at the species level.

Species identification was performed using taxonomic keys (FERNÁNDEZ & SENDOYA, 2004; BACARRO *et al.*, 2015) and by comparison with the Maranhão Ant Collection of LAMIR (CESC/UEMA). Specimens that could not be identified at the species level were then sent to formicid taxonomist Dr. Jacques Hubert Charles Delabie at the Cocoa Research Center (CEPEC/CEPLAC), Ilhéus, Bahia State, Brazil.

At each collection point, soil temperature was measured at 10 cm depth using a digital thermometer. Rainfall data were obtained from the Caxias Meteorological Station. Temperature data were used to calculate the weighted mean at each collection point and the average temperature of each study area.

Data were subjected to faunal analysis based on frequency, constancy, and dominance indices, and the predominant orders, that is, those with the highest faunal indices (SILVEIRA NETO *et al.*, 1976), were selected. Richness estimators were determined. Shannon–Weaner diversity (H'), Pielou evenness (J'), and Margalef richness indices were calculated using ANAFAU software (MORAES *et al.*, 2003).

The frequency (f) of taxonomic orders was determined from the percentage share of the number of individuals of each order in relation to the total number of individuals collected. Frequency classes were defined according to the following criteria: infrequent (IF), frequency lower than the lower limit of the 5% confidence interval (CI); frequent (F), frequency within the 5% CI; and very frequent (VF), frequency higher than the upper limit of the 5% CI.

Constancy was calculated from the percentage occurrence of surveyed orders and classified according to the categories proposed by Bodenheiner (1955) as cited by Silveira Neto *et al.* (1976). Constancy classes were as follows: constant (W), species present in more than 50% of collections; accessory (Y), species recorded in 20–50% of collections; and accidental (X), species found in less than 20% of collections.

Dominance is defined as the ability of an order to modify, for its own benefit, the environmental impacts it receives, which may cause the appearance or disappearance of other organisms (SILVEIRA NETO *et al.*, 1976). Taxonomic groups were classified into one of two dominance classes: dominant (D), when the frequency values were higher than the dominance index, and non-dominant (ND), when the frequency values were lower than the dominance index.

Genus richness was estimated using the Chao1, Chao2, Jackknife1, and Jackknife2 procedures and the Biodiversity R and Vegan packages of R software (R CORE TEAM, 2016). Genus accumulation curves were constructed with 1000 random permutations by using the Specaccum function of the Vegan package.

Permutational multivariate analysis of variance (PERMANOVA) was used to evaluate differences in the composition of ant assemblages between study areas and seasons (ANDERSON, 2001). Homogeneity of variances between groups in relation to species composition were assessed by permutational multivariate analysis of dispersions (PERMDISP) (ANDERSON *et al.*, 2006). Multidimensional relationships between study variables were investigated using principal coordinate analysis (PCoA) and the Bray–Curtis similarity index as a measure of association (LEGENDRE & LEGENDRE, 1998).

3. Results and discussion

3.1 Abundance, frequency, constancy, and dominance of taxonomic genera

A total of 1,845 individuals were recorded, with 329 individuals in gallery forest and 1,516 individuals in Cerrado *sensu stricto*, totaling 29 genera (Table 1).

Table 1 – Subfamily, genera, number of individuals (NI), number of collections, dominance (D), abundance (A), frequency (F), and constancy (C) of myrmecofauna sampled in fragments of gallery forest and Cerrado sensu stricto *in the Inhamum Environmental Protection Area, Caxias, Maranhão State, Brazil.*

Subfamily	**Genus**	**Gallery forest**						**Cerrado *sensu stricto***					
		NI	**NC**	**D**	**A**	**F**	**C**	**NI**	**NC**	**D**	**A**	**F**	**C**
Dolichoderinae	*Azteca* Forel, 1878	5	2	ND	r	IF	Y	2	1	ND	d	IF	Z
Formicinae	*Brachymyrmex* Mayr, 1868	1	1	ND	r	IF	Z	4	3	ND	d	F	W
Formicinae	*Camponotus* Mayr, 1861	65	6	D	va	VF	W	115	6	SD	sa	SF	W
Myrmicinae	*Cephalotes* Latreille, 1802	10	3	D	c	F	W	-	-	-	-	-	-
Ponerinae	*Mayaponera* Schmidt & Shattuck, 2014	6	2	D	d	IF	Y	4	1	ND	ND	F	Z
Myrmicinae	*Trachymyrmex* Forel, 1893	1	1	ND	r	IF	Z	-	-	-	-	-	-
Pseudomyrmecinae	*Pseudomyrmex* Lund, 1831	12	5	D	c	F	W	-	-	-	-	-	-
Formicinae	*Nylanderia* Forel, 1892	3	2	ND	r	IF	Y	-	-	-	-	-	-
Myrmicinae	*Solenopsis* Westwood, 1840	32	3	D	va	VF	W	46	6	D	va	VF	W
Dolichoderinae	*Forelius* Emery, 1888	35	2	D	va	VF	Y	30	6	D	D	VF	W
Myrmicinae	*Pheidole* Westwood, 1841	57	5	D	va	VF	W	690	6	SD	sa	SF	W
Myrmicinae	*Cyphomyrmex* Mayr, 1862	5	2	ND	r	IF	Y	1	1	ND	d	IF	Z
Myrmicinae	*Crematogaster* Lund, 1831	13	1	D	c	F	W	250	4	SD	sa	SF	W
Myrmicinae	*Rogeria* Emery, 1894	1	5	ND	r	IF	Z	-	-	-	-	-	-
Ponerinae	*Odontomachus* Latreille, 1804	18	2	D	c	F	W	-	-	-	-	-	-
Ponerinae	*Leptogenys* Roger, 1861	1	3	ND	r	IF	Z	-	-	-	-	-	-
Myrmicinae	*Hylomyrma* Forel, 1912	4	6	ND	r	IF	W	-		-	-	-	-
Ectatomminae	*Gnamptogenys* Roger, 1863	24	5	D	a	VF	W	10	3	D	c	F	W
Myrmicinae	*Wasmannia* Forel, 1893	28	1	D	va	VF	W	-	-	-	-	-	-
Ectatomminae	*Ectatomma* Smith, 1858	1	5	ND	r	IF	Z	-	-	-	-	-	-
Ponerinae	*Pachycondyla* Smith, 1858	5	5	ND	r	IF	W	12	3	D	c	-	-
Paraponerinae	*Paraponera* Smith, 1858	2	1	ND	r	IF	Z	-	-	-	-	-	-
Myrmicinae	*Acromyrmex* Mayr, 1865	-	-	-	-	-	-	1	1	ND	d	IF	Z
Ponerinae	*Anochetus* Mayr, 1861	-	-	-	-	-	-	1	2	ND	d	IF	Y
Myrmicinae	*Atta* Fabricius, 1804	-	-	-	-	-	-	55	6	D	va	VF	W
Dolichoderinae	*Dorymyrmex* Mayr, 1866	-	-	-	-	-	-	284	6	SD	as	SF	W
Ponerinae	*Hypoponera* Santschi, 1938	-	-	-	-	-	-	2	2	ND	d	IF	Y
Myrmicinae	*Kalathomyrmex* Klingenberg & Brandão, 2009	-	-	-	-	-	-	8	1	D	c	F	Z
Myrmicinae	*Nesomyrmex* Wheeler, 1910	-	-	-	-	-	-	1	1	ND	d	IF	Z
	Total	329						1,516					

Source: the author (2019).

Abbreviations: SD, super dominant; D, dominant; ND, non-dominant; sa, super abundant; va, very abundant; c, common; d, dispersed; SF, super frequent; VF, very frequent; F, frequent; IF, infrequent; W, constant; Y, accessory; Z, accidental.

The following genera were found to be dominant in gallery forest: *Camponotus*, *Cephalotes*, *Mayaponera*, *Forelius*, *Pheidole*, *Pseudomyrmex*, *Solenopsis*, *Crematogaster*, *Gnamptogenys*, *Odontomachus*, and *Wasmannia*. Super dominant genera were not observed. The genera with the highest abundance were *Camponotus*, with 65 individuals, and *Pheidole*, with 57 individuals (Table 1). The genera with the highest frequencies in the gallery site were *Camponotus* (VF), *Solenopsis* (VF), *Forelius* (VF), *Pheidole* (VF), *Gnamptogenys* (VF), *Wasmannia* (VF), *Cephalotes* (F), *Pseudomyrmex* (F), *Crematogaster* (F), and *Odontomachus* (F). The most constant genera in Area I were *Brachymyrmex*, *Cephalotes*, *Pseudomyrmex*, *Solenopsis*, *Pheidole*, *Crematogaster*, *Hylomyrma*, *Gnamptogenys*, *Wasmannia*, and *Pachycondyla* (Table 1).

Trachymyrmex, *Pseudomyrmex*, *Nylanderia*, *Rogeria*, *Leptogenys*, *Odontomachus*, *Wasmannia*, *Ectatomma*, and *Paraponera* were exclusive to the gallery forest. These genera comprise generalist species with a preference for humid forests and environments with a high variety of food resources and suitable sites for egg deposition, which is essential for their reproduction (BACCARO, 2015).

The high occurrence of *Camponotus* in the gallery forest can be attributed to the large amount of plant litter available at the site. Members of the genus are well known for their opportunistic traits. *Camponotus* is composed of omnivorous species with high colonization capacity in new environments. Most of its members are generalist and opportunistic in terms of diet and nesting site. Individuals usually collect food with agility until they are overcome by other more aggressive or numerous species (SILVESTRE, 2000).

The occurrence of *Pheidole* in the gallery forest might be related to its high ability to adapt to different environments. In the two physiognomies sampled, *Pheidole* was observed with high frequency, given that it is hyperdiverse and of wide distribution across a variety of habitats (WILSON, 2003). Santos (2018) found high numbers of *Camponotus* and *Pheidole* individuals, in agreement with our findings. These results are explained by the fact that these genera are known for their diversity and wide geographical distribution.

The following genera were found to be super dominant in the Cerrado *sensu stricto* site: *Pheidole* (690 individuals), *Dorymyrmex* (284 individuals), *Crematogaster* (250 individuals), and *Camponotus* (115 individuals). *Solenopsis*, *Forelius*, *Gnamptogenys*, *Pachycondyla*, *Atta*, and *Kalathomyrmex* were dominant in the area (Table 1). Super abundant genera included *Camponotus*, *Pheidole*, *Crematogaster*, and *Dorymyrmex*. *Solenopsis*, *Forelius*, and *Atta* were very frequent and *Camponotus*, *Pheidole*, and *Crematogaster* were super frequent. The following genera were classified as constant: *Brachymyrmex*, *Camponotus*, *Solenopsis*, *Forelius*, *Pheidole*, *Gnamptogenys*, *Atta*, and *Dorymyrmex*.

Genera exclusive to Cerrado *sensu stricto* included *Acromyrmex*, *Anochetus*, *Atta*, *Dorymyrmex*, *Hypoponera*, *Kalathomyrmex*, and *Nesomyrmex*. Such exclusivity can be attributed to the fact that these genera have wide geographical distribution and high ability to adapt to sandy forests and fertile soils; most tend to forage in trees and prefer more open spaces, as is the case of Area II (BACCARO, 2015).

Given the high representation of *Pheidole*, *Camponotus*, *Crematogaster*, and *Dorymyrmex* in Cerrado *sensu stricto* as compared with the gallery forest, it can be said that these genera are highly selective, abundant, and dominant, with preferences for open, clear environments. These individuals are cunning predators with the capacity to ensure species colonization. Furthermore, the presence of these genera is likely related to Cerrado vegetation. It is known that the occurrence and behavior of insects are influenced by several environmental factors, including luminosity, temperature, humidity, and wind speed (GIANNOTTI *et al.*, 2010).

The super dominance of *Pheidole* in Cerrado *sensu stricto* suggests that the genus is highly dynamic and capable of socializing in different environments with different types of organisms. The dominance of this genus is expected because of its generalist characteristics and wide geographical distribution (SILVESTRE *et al.*, 2003).

The super abundance of *Dorymyrmex* in Cerrado *sensu stricto* might be associated with the fact that the genus builds nests in the ground, preferably in open, sandy regions with little vegetation cover. The individuals are more frequent in arid or semi-arid areas and are often found in anthropized environments, as is the case of Cerrado *sensu stricto* (BACCARO, 2015).

Crematogaster was found in great quantity in Area II. The genus is widely distributed across tropical and temperate terrestrial ecosystems, where most of the species are arboreal. However, nests can be found in the soil, litter, decaying wood, abandoned termite nests, hollow stems, living trees, epiphytes, and myrmecophyte plants (BACCARO, 2015).

Camponotus was found in high numbers in Cerrado *sensu stricto*, as also observed in the gallery forest, and was classified as very diverse. The genus is composed of omnivorous, opportunistic species, with high adaptability to various environments and high colonization capacity (RAMOS *et al.*, 2003).

Martins *et al.* (2021) investigated the soil macrofauna of the same study site and observed abundance of Hymenoptera individuals. Costa (2017), in evaluating the effect of wildfire on the ant community in Cerrado *sensu stricto* in eastern Maranhão State, found similar results to the current study.

3.2 PCoA of ant communities according to study area and season

PCoA of ant communities in gallery forest and Cerrado *sensu stricto* revealed two axes explaining 68.86% of the variance in data, as assessed by using the Bray–Curtis dissimilarity index. The first axis explained 53.44% and the second axis 15.42% of the variance in the dataset (Figure 1). The structure of ant communities differed between gallery forest and Cerrado *sensu stricto* (PERMANOVA: pseudo-F = 10.236; p = 0.001). In assessing the heterogeneity of the dispersion of genus abundance, we found no differences between areas (PERMDISP: F = 3.4265; p = 0.0938); both areas shared similar ant communities (Figure 1).

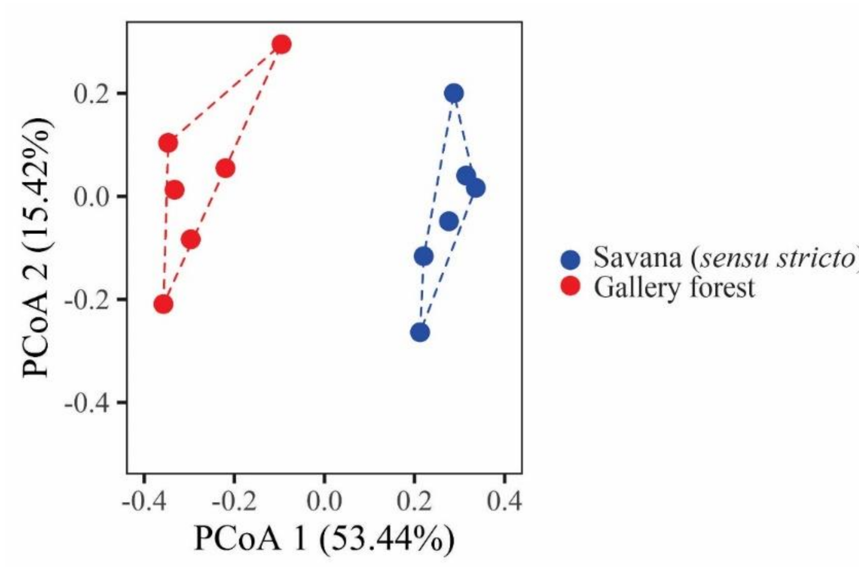

Figure 1 – Principal coordinate analysis (PCoA) of ant communities according to collection area in the Inhamum Environmental Protection Area, Caxias, Maranhão State, Brazil.
Source: The author (2019).

Of the 37 genera collected, 12 were exclusive to the gallery forest (*Cephalotes*, *Trachymyrmex*, *Pseudomyrmex*, *Nylanderia*, *Rogeria*, *Odontomachus*, *Leptogenys*, *Hylomyrma*, *Wasmannia*, *Ectatomma*, *Pachycondyla*, and *Paraponera*) and 10 were exclusive to Cerrado *sensu stricto* (*Acromyrmex*, *Anochetus*, *Atta*, *Mayaponera*, *Dorymyrmex*, *Pachycondyla*, *Nesomyrmex*, *Kalathomyrmex*, *Hypoponera*, and *Cyphomyrmex*).

Community structure (PERMANOVA: pseudo-F = 1.101; p = 0.302) and heterogeneity (PERMDISP: F = 1.2707; p = 0.286) did not vary according to climate season; ant communities were similar in both treatments (Figure 2). Of the 37 genera, 7 were found exclusively in the dry period (*Mayaponera*, *Leptogenys*, *Hylomyrma*, *Acromyrmex*, *Nesomyrmex*, *Hypoponera*, and *Cyphomyrmex*), 7 were exclusive to the rainy period (*Trachymyrmex*, *Rogeria*, *Ectatomma*, *Paraponera*, *Anochetus*, *Mayaponera*, and *Kalathomyrmex*), and 23 were collected in both periods.

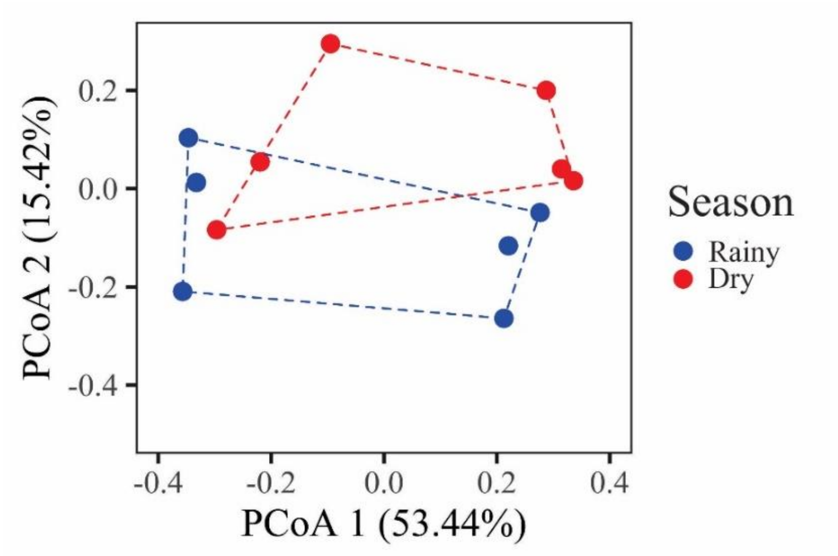

Figure 2 – Principal coordinate analysis (PCoA) of ant communities according to climate season in the Inhamum Environmental Protection Area, Caxias, Maranhão State, Brazil.
Source: the author (2019).

3.3 Shannon–Wiener diversity and Simpson dominance

The Shannon–Wiener diversity index and Simpson dominance index of gallery forest and Cerrado *sensu stricto* are described in Table 3.

Table 3 – Genus diversity and dominance indices for ants collected in gallery forest and Cerrado sensu stricto *in the Inhamum Environmental Protection Area, Caxias, Maranhão State, Brazil.*

Area	**Shannon–Wiener diversity index (*H′*)**	**Simpson index (*D*)**
Gallery forest	2.54	0.90
Cerrado *sensu stricto*	1.63	0.72

Source: author (2019).

The gallery forest had a higher diversity index (*H′* = 2.54) than Cerrado *sensu stricto* (*H′* = 1.63). Likewise, the Simpson dominance index was higher in the gallery forest (*D* = 0.90) than in Cerrado *sensu stricto* (*D* = 0.72) (Table 3). According to the hypothesis of heterogeneity, habitats with a diverse structure have greater species diversity, given the variety of ecological niches and natural resources (COSTA, 2017). As underscored by Begon *et al.* (1996), lower diversity indices represent a high dominance of a given genus in a given area, as observed here for Cerrado *sensu stricto*.

3.4 Estimated richness (*S*) and genus accumulation curve

Genus richness was 21 in gallery forest and 18 in Cerrado *sensu stricto*. Chao1 and Chao2 estimators revealed a richness of 26 for both sites (Table 4).

Table 4 – Observed and estimated richness of ant genera in gallery forest and Cerrado sensu stricto *in the Inhamum Environmental Protection Area, Caxias, Maranhão State, Brazil*

Richness	**Gallery forest**	**Cerrado *sensu stricto***
Observed richness	22	18
Chao1	26	26
Chao2	26	26

Source: the author (2019).

Genus sampling curves revealed that sampling had not stabilized in either site, given that an asymptote was not reached (Figure 4). This finding indicates that the sampling effort was not sufficient to fully quantify the existing genera in both fragments; with a greater sampling effort, it is possible to obtain higher genus richness.

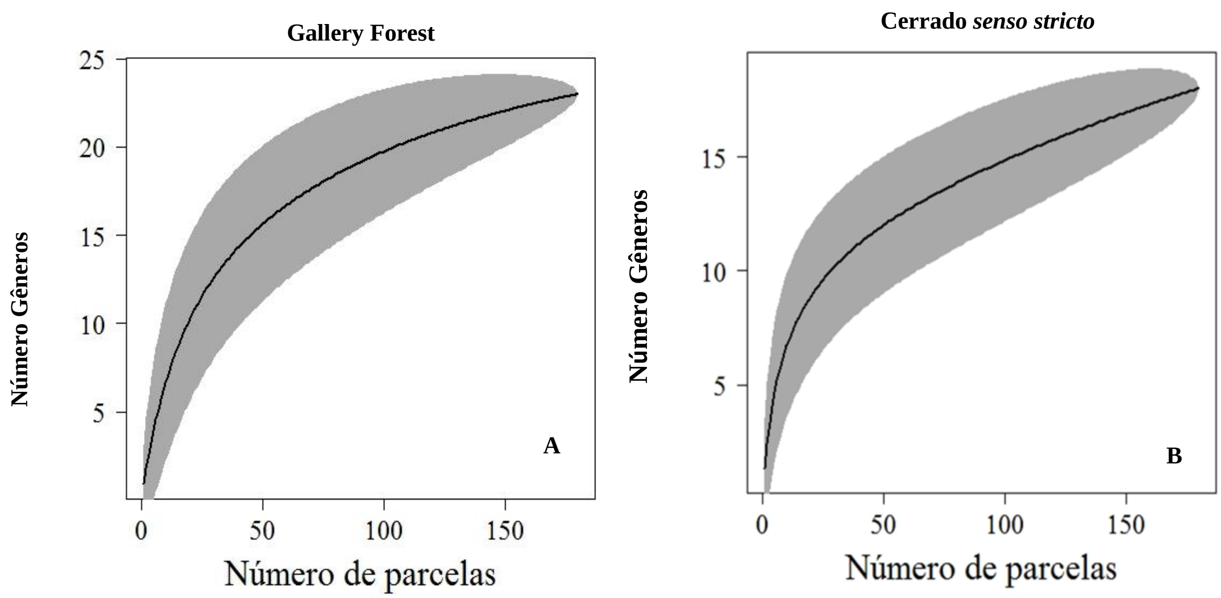

Figure 4 – Genus accumulation curve for ant communities in gallery forest and Cerrado sensu stricto *in the Inhamum Environmental Protection Area, Caxias, Maranhão State, Brazil. Source: the authors (2019).*
Source: The author (2019).

4. Final considerations

- ✓ A total of 29 genera of Formicidae were recorded, 22 in gallery forest, with 11 exclusive genera, and 18 genera in Cerrado *sensu stricto*, with 7 exclusive genera;
- ✓ *Pheidole*, *Camponotus*, *Dorymyrmex*, and *Crematogaster* were found to be super dominant;
- ✓ The most abundant genera in gallery forest and Cerrado *sensu stricto* were *Camponotus*, *Pheidole*, *Crematogaster*, and *Dorymyrmex*;
- ✓ Gallery forest exhibited the highest genus frequency;
- ✓ Community structure differed between areas but not between seasons;
- ✓ Gallery forest had the highest diversity index;
- ✓ Observed richness was highest in gallery forest, but the Chao1 estimator suggested the same degree of richness for both areas.

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