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Characterization of vegetation structure in areas of natural occurrence of *Hancornia speciosa* Gomes

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Abstract

The mangabeira (*Hancornia speciosa* Gomes) has great food and pharmaceutical values but its production is almost entirely made by people gathering fruits in forests, which increases the risk extinction, particularly in savannah regions. Thus, the objective of this study was to compare floristic, phytosociology and species diversity in five areas of natural occurrence of mangabeira. All plants with a diameter at soil level equal to or greater than five cm were selected by the quadrant method in five villages in the state of Maranhão, northeastern Brazil. The assessed variables for the whole vegetation were number of individuals, number of species, total density, the Shannon Diversity Index (*H'*), the Jaccard Similarity Index, total plant height and diameter at soil level. The phytosociological parameters computed for the mangabeira population were absolute and relative density, frequency and dominance; basal area, importance value and cover value. We recorded 1,696 plants from 26 species and 16 families. Anacardiaceae, Apocynaceae and Fabaceae were the families that stood out most with two species each. The species diversity was low in all villages, varying from *H'*= 0.659 in Santana to *H'* = 1.777 in Recanto. The floristic similarity among the vegetation in all villages was low except between Patizal and Recurso (0.571). For the mangabeira population, the importance value and cover value were higher in Santana, with 79.35% and 85.28% respectively and the highest values of plant height (6.02 meters) and diameter at soil level (13.76 cm) were found in Patizal village. These results could be used for management, preservation and sustainability of the mangabeira in northeastern Brazil.

Keywords: Species diversity; Phytosociology; Floristic similarity.

Introduction

The mangabeira (*Hancornia speciosa* Gomes) is a fruit tree from tropical climate and savannah vegetation. It is native to Brazil, growing spontaneously in the midwest, southeast, north and northeast regions. It is most abundant in the northeast, occurring mainly on the tablelands and lowland coastal plains (Marinho et al., 2011).

According to Monachino (1945) Mangabeira belongs to the genus Hancornia, which is considered monotypic, that is, its unique species is *H. speciosa* Gomes which has six varieties: H. speciosa variety speciosa, maximilliani, lundii, cuyabensis, gardnerie and pubescens.

The mangabeira produces fruits known popularly as mangaba, a word of indigenous origin that means "good thing to eat" (Santos and Vilar, 2014), justifying the characteristic pleasant aroma and sweetish flavor (Hansen, 2011).

The mangabeira has great potential as food, but it has been exploited almost entirely by people gathering fruits in agroforestry. Its main product is the fruit, used both in natura consumption and in production of sweets, syrup, jams, wine, vinegar, juices and ice creams, with great consumer acceptance and great potential for agroindustry (Sá et al., 2011).

In addition to fruits, studies have shown that H. speciosa leaves have bioactive compounds that have antioxidant, antimicrobial and cytotoxic properties (Santos et al; 2016). It also effectively controls diabetes (Pereira et al., 2015), blood pressure (Silva et al., 2011), and the plant latex has anti-inflammatory properties (Marinho et al., 2011). Moreover, it has angiogenesis action, that is, formation of new blood vessels (Almeida et al., 2014) and osteogenic action, that is, bone-forming tissues (Floriano et al., 2016).

Despite the H. speciosa great food and pharmaceutical potential, studies on this species are scarce which contributes to the risk of the species disappearing, particularly from savannah regions, due to the expansion of agricultural borders and intense agricultural activity on soybean, maize and cotton. Therefore, studies on floristic

composition, phytosociology and species diversity in areas of natural occurrence of *H. speciosa* are of great important to gain information about the plant communities from the floristic and structural point of view. This also will increase knowledge about the species, as well as the vegetation structure in which it grows and develop in order to contribute to proper management and sustainability.

These studies are important to obtain information about the plant community structure of a given area, as well as possible affinities among species or groups of species, adding quantitative data about the vegetation structure.

Floristic surveys were carried out in natural occurrence areas of *H. speciosa* savannah areas by several authors (Ribeiro-Silva et al., 2012; Martins et al., 2012; Santos et al., 2012; Campos et al., 2019; Lima et al., 2013; Silva et al., 2016). However, there are still many gaps particularly on phytosociology and species diversity information, which hinders the implementation of management and conservation practices.

In this context, the aim of this study was to carry out a floristic survey on the vegetation in five villages located in the municipality of Morros, state of Maranhão, northeastern Brazil where there is an expressive natural occurrence of mangabeira. In addition, we computed the phytosociological parameters of mangabeira population individually in the plant community among the villages in order to obtain information that could be used for management, preservation and sustainability of this species.

Results and Discussion

Sample sufficiency

Through the analysis of sample sufficiency (Schilling and Batista, 2008; Béguinot, 2015), the curve was stabilized in all villages (Fig 2.), which confirms a good floristic representativeness in this research.

The number of sampled points was sufficient, since the curve stabilized tending to asymptote. This was obtained with 61 points in the Recurso, Bacaba and Santana and with 63 points in the Recanto and Patizal villages. It is noteworthy that 88 points were sampled in Recurso, Recanto and Patizal, and 81 points in Bacaba and Santana. Therefore, the curve stabilization occurred in a number of points lower than the total sampled points.

In research carried out in two savannah areas under quartzarenic neosols in the city of Cuiabá, state of Mato Grosso, Oestreich-Filho (2014) described the sample sufficiency curve stabilization from plot 22 in the sampled area one and from plot 24 in the sampled area two. This shows that, in local conditions, more sampled points are needed for the sample sufficiency curve stabilization, which possibly suggests greater diversity.

Floristic composition

In total, we sampled 1,696 living individuals, distributed in 26 plant species and 16 plant families. Recurso, Recanto and Patizal contributed with 352 individuals each and Bacaba and Santana with 320 each (Table 1).

The number of plant species and plant families was lower than those reported by Santos (2000), who found 60 species from 33 families in Palmas, state of Tocantins, by Oestreich-Filho (2014), who recorded 82 species and 31 families, and by Batalha et al. (2011) who observed 55 species in savannah areas. The plant families with higher number of plant species in the five villages studied were: Fabaceae (6), Apocynaceae (3) and Anacardiaceae (2) (Fig. 3).

These results corroborate those found by Oestreich-Filho (2014), who emphasized Fabaceae and Apocynaceae as the plant families with the largest number of individuals with 16 and 5 plant species, respectively.

It is worth noting that mangabeira, the main species studied in this research, belongs to the plant family Apocynaceae, which was the second species richness family. This result indicates that the species belonging to this botanical family have greater adaptability to the study site.

The highest number of plant species and plant families, as well as the highest Shannon Diversity Index values (H') were observed in Recanto (Table 1). In contrast, Santana obtained the lower values. In general, the Shannon Diversity Index was low in all villages, varying from 0.659 in Santana to 1.777 in Recanto (Table 1).

According to Knight (1975), the Shannon Diversity Index indicates that vegetation has a high species diversity when H' values range from 3.83 to 5.85 nats / individuals. The low diversity values in this study can be explained by irregular timber harvesting, vegetation burning for native pasture renewal and opening of areas for implantation of cultivation.

The families that had the highest number of species in common were Anacardiaceae, Apocynaceae and Fabaceae (Table 2).

Regarding the floristic richness in Recurso, the plant families Anacardiaceae, Apocynaceae and Fabaceae were those that stood out most with two species each, and there was no specific family in that village. (Table 2).

The family with the highest number of species in Recanto was Fabaceae (4), followed by Apocynaceae (3). The families Myrtaceae, Clusiaceae and Melastomastaceae were exclusive to this village.

The family that stood out most in the Patizal was Fabaceae with three species followed by Apocynaceae and Anacardiaceae with two species each. Only the Bombacaceae family was found specifically in this village.

Fabaceae also stood out most in Bacaba village with three species, followed by Apocynaceae and Anacardiaceae with two species each. Three new families, namely: Bignoniaceae, Combretaceae and Urticaeae were recorded in this village.

Finally, in the Santana village there was prominence for Fabaceae (4) and Anacardiaceae (2). Only the family Arecaceae appeared specifically in this village. Thus, it is possible to observe that, in spite of the proximity of the areas, they present heterogeneity in their floristic composition (Lehmann et al., (2014).

Phytosociology of mangaba

Analyzing the phytosociological parameters obtained by mangabeira (Table 3), one can observe that there were variations in the sampled mangabeira population among the villages. The number of mangabeira individuals in Santana was 271 (84.69% of the total number of individuals in the sampled area) and the lowest was in Recanto with 129 individuals (36.65%) (Table 3). This result may be explained by the greater conservation of the native mangaba plantation by the farmer community of Santana. On the other hand, in Recanto there are greater incidences of irregular timber harvesting and disordered vegetation burning.

Table 1. Number of indivíduals, families and species and Shannon Diversity Index (*H'*) in the Recurso, Recanto, Patizal, Bacaba and Santana villages, in the municipality of Morros, state of Maranhão, northeastern Brazil.

Villages	Number of individuals	Number of families	Number of species	*H*'
Recurso	352	7	10	1.019
Recanto	352	10	17	1.777
Patizal	352	8	12	1.247
Bacaba	320	8	12	1.148
Santana	320	5	9	0.659

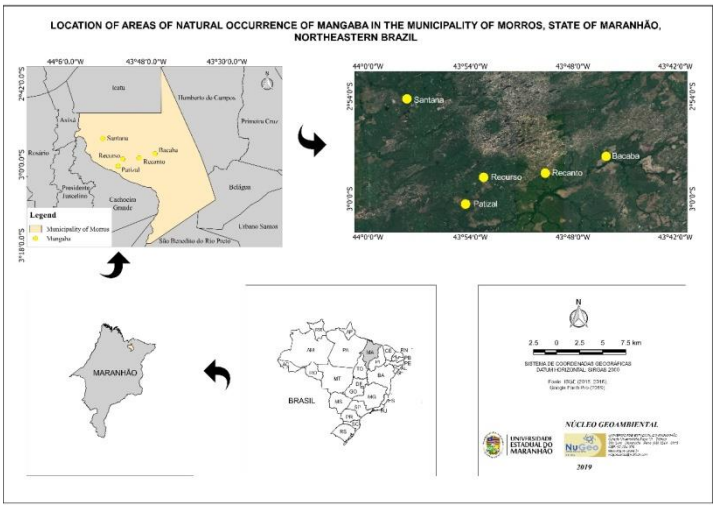


Fig 1. Location of the five villages of natural occurrence of mangabeira in in the savannah-restinga (sand bank) transition zone the municipality of Morros, state of Maranhão, northeastern Brazil.

Table 2. List of species and families in recorded in Recurso, Recanto, Patizal, Bacaba and Santana villages, in savannah restinga transition zone in the municipality of Morros, state of Maranhão, northeastern Brazil.

Recurso village		
Families	Species	Common Name
Anacardiaceae	*Myracrodruom urundeuva* Fr. All.	Aroeira
	Anacardium occidentale L.	Cajú
Apocynaceae	*Hancornia speciosa* Gomes	Mangaba
	Himatanthus sucuuba (Spruce) Woodson	Janaúba
Bixaceae	*Cochlospermum orinocense* (Kunth) Steud	Algodão Bravo
Fabaceae	*Machaerium* sp.	Farinha seca
	Parkia platycephala Benth	Fava de bolota
Malphigiaceae	*Byrsonima crassifolia* L. Rich	Murici
Sapindaceae	*Talisia retusa* R. S. Cowan	Pitomba de leite
Sapotaceae	*Manilkara huberi* (Ducke) A. Chev.	Maçaranduba
Recanto village		
Anacardiaceae	*Myracrodruom urundeuva* Fr. All.	Aroeira
	Anacardium occidentale L.	Cajú
	Hancornia speciosa Gomes	Mangaba
Apocynaceae	*Himatanthus sucuuba* (Spruce) Woodson	Janaúba
	Aspidosperma sp.	Gororoba
Bixaceae	*Cochlospermum orinocense* (Kunth) Steud	Algodão bravo
Clusiaceae	*Vismia brasiliensis* Choisy	Lacre
	Platonia insignis Mart	Bacuri
	Dimorphandra mollis Benth	Fava d'anta
Fabaceae	*Parkia platycephala* Benth	Fava de bolota
	Andira sp.	Amargoso
	Stryphnodendron barbatiman Mart.	Barbatimão
Malphigiaceae	*Byrsonima crassifolia* L. Rich	Murici
Melastomataceae	*Bellucia* sp.	Pau terra
Myrtaceae	*Campomanesia* sp.	Guabiraba
Sapindaceae	*Talisia retusa* R. S. Cowan	Pitomba de leite
Sapotaceae	*Manilkara huberi* (Ducke) A. Chev.	Maçaranduba
Patizal village		
Anacardiaceae	*Myracrodruon urundeuva* Freire Allemão	Aroeira
	Anacardium occidentale L.	Cajú
Apocynaceae	*Hancornia speciosa* Gomes	Mangaba
	Himatanthus sucuuba (Spruce) Woodson	Janaúba
Bixaceae	*Cochlospermum orinocense* (Kunth) Steud	Algodão bravo
Bombaceae	*Pachira aquatica* Aubl.	Mamorana
	Machaerium sp.	Farinha seca
Fabaceae	*Parkia platycephala* Benth	Fava de bolota
	Dimorphandra mollis Benth	Fava d'anta

Malphigiaceae	*Byrsonima gardneriana* A. Juss	Murici pitanga
Sapotaceae	*Manilkara huberi* (Ducke) A. Chev.	Maçaranduba
Unknown	Unidentified 1	-
Bacaba village		
Anacardiaceae	*Myracrodruon urundeuva* Freire Allemão	Aroeira
	Anacardium occidentale L.	Cajú
Apocynaceae	*Hancornia speciosa* Gomes	Mangaba
	Himatanthus sucuuba (Spruce) Woodson	Janaúba
Bignoniaceae	*Tabebuia* sp.	Pau d'arco
Bixaceae	*Cochlospermum orinocense* (Kunth) Steud	Algodão bravo
Combretaceae	*Buchenavia* sp.	Mirindiba
	Parkia platycephala Benth	Fava de bolota
Fabaceae	*Hymenaea courbaril* L	Jatobá
	Machaerium sp.	Farinha seca
Sapindaceae	*Talisia retusa* R.S. Cowan	Pitomba de leite
Urticaceae	*Cecropia* sp.	Embaúba
Santana village		
Anacardiaceae	*Myracrodruon urundeuva* Freire Allemão	Aroeira
Apocynaceae	*Hancornia speciosa* Gomes	Mangaba
	Himatanthus sucuuba (Spruce) Woodson	Janaúba
Arecaceae	*Syagrus cocoides* Mart	Ariri
	Parkia platycephala Benth	Fava de bolota
Fabaceae	*Dimorphandra mollis* Benth	Fava d'anta
	Machaerium sp.	Farinha seca
	Andira sp.	Amargoso
Sapindaceae	*Talisia retusa* R.S. Cowan	Pitomba de leite

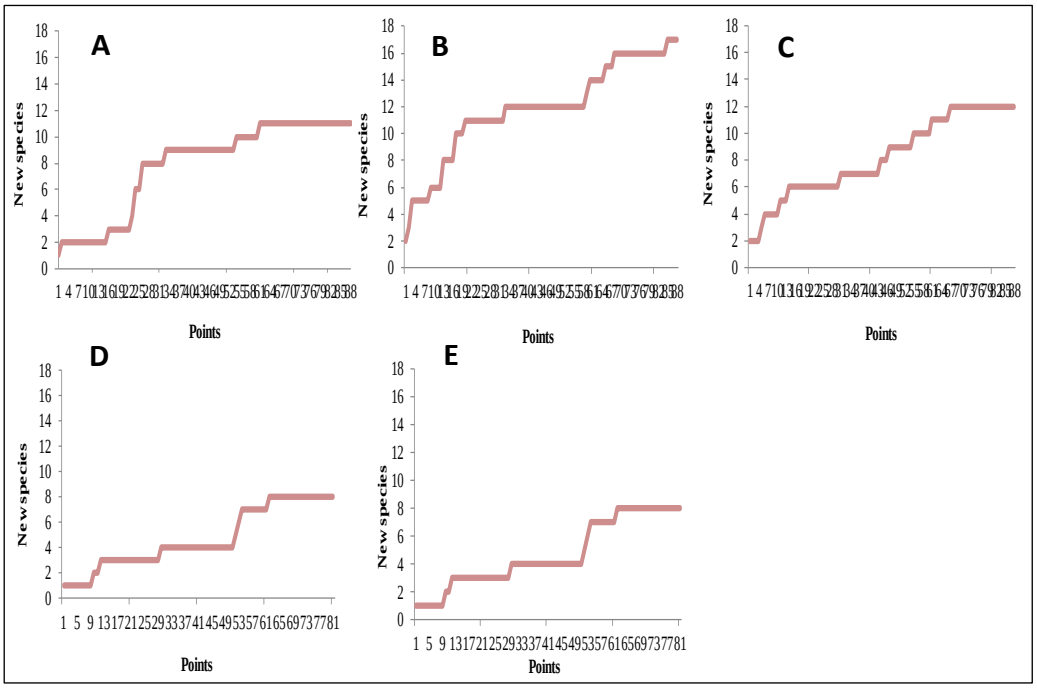


Fig 2. Sample sufficiency curve in natural occurrence areas of mangabeira in the Recurso (A), Recanto (B), Patizal (C), Bacaba (D), and Santana (E) villages, in the savannah-restinga (sand bank) transition zone in the municipality of Morros, state of Maranhão, northeastern Brazil.

Table 3. Number of individuals, Relative Density (RD), Relative Frequency (RF), Relative Dominance (RDo), Importance Value (IV) and Cover Value (CV) of mangabeira in Recurso, Recanto, Patizal, Bacaba and Santana villages, in the municipality of Morros, state of Maranhão, northeastern Brazil.

Villages	Number of individuals	RD (%)	RF (%)	RDo (%)	IV (%)	CV (%)
Recurso	233	66.19	50.29	53.44	56.64	59.81
Recanto	129	36.65	30.57	31.43	32.87	34.04
Patizal	226	64.20	46.24	62.50	55.56	63.35
Bacaba	229	71.56	51.66	57.83	60.35	64.70
Santana	271	84.69	67.52	85.86	79.35	85.28

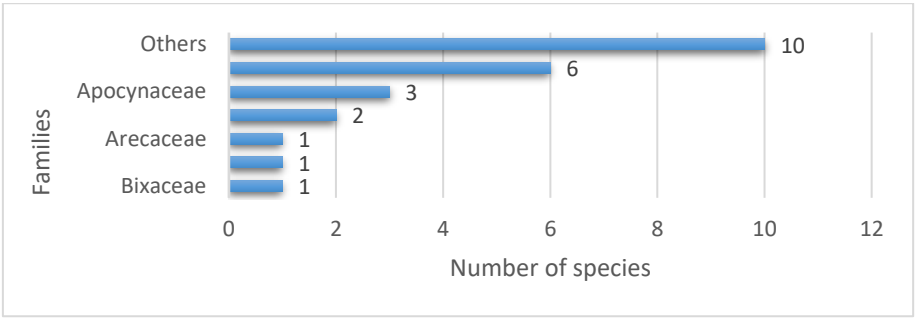
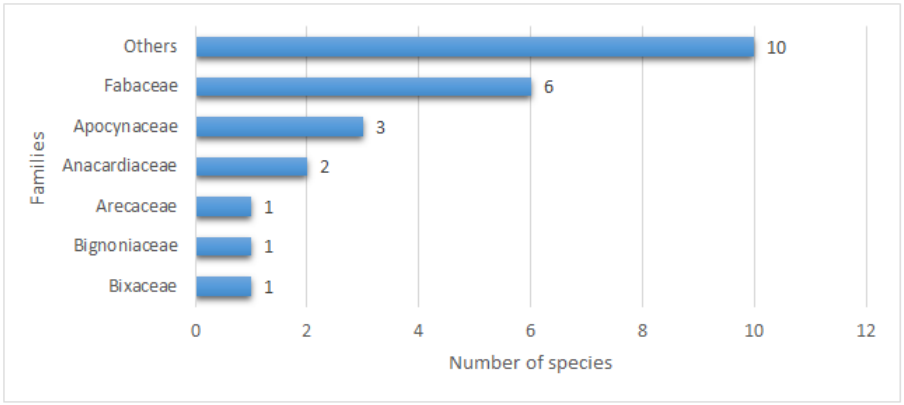


Fig 3. Number of species per family in natural occurrence areas of mangabeira in in the Recurso, Recanto, Patizal, Bacaba and Santana villages in the savannah-restinga (sand bank) transition zone in the municipality of Morros, state of Maranhão, northeastern Brazil.



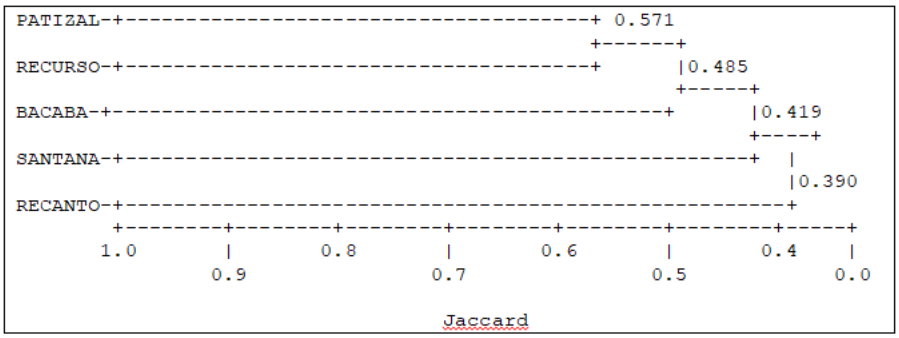


Fig 3. Dendrogram (Jaccard) among five natural occurrence areas of mangabeira in the municipality of Morros, state of Maranhão, northeastern Brazil.

Table 4. Minimum, average and maximum values of plant height and diameter at soil level for mangabeira in Recurso, Recanto, Patizal, Bacaba and Santana villages in the municipality of Morros, state of Maranhão, northeastern Brazil.

Villages	Minimum height (m)	Average height (m)	Maximum height (m)	Minimum diameter (cm)	Average diameter (cm)	Maximum diameter (cm)
Patizal	1.0	6.02	16.7	5.0	13.76	36.6
Recanto	1.25	4.84	12	5.0	13.58	36.6
Santana	1.6	4.18	10	5.5	12.69	32.76
Recurso	1.3	3.75	9.0	5.0	12.03	35.03
Bacaba	1.8	3.73	13.5	5.0	9.36	31.2

Table 5. Floristic similarity matrix (Jaccard) among five natural occurrence areas of mangabeira in the municipality of Morros, state of Maranhão, northeastern Brazil.

	Patizal	Bacaba	Santana	Recurso	Recanto
Patizal	1				
Bacaba	0.4375	1			
Santana	0.4286	0.4000	1		
Recurso	0.5714	0.5333	0.4286	1	
Recanto	0.4000	0.3182	0.3684	0.4737	1

Couto et al. (2009), in savannah environment in Rio Pardo de Minas, state of Minas Gerais, recorded 26 individuals in *H. speciose*, representing 5.45% of the total sampled area.
The importance value (IV) and cover value (CV) were higher 79.35% and 85.28% in Santana, respectively, and lower in Recanto with 32.87% and 34.04%, respectively (Table 3).
Gomes et al. (2014), found low importance value for this species, with 1.30% of IV in savannah areas in the state of Bahia. In relation to the plant height and diameter at soil level, the most expressive values were found in Patizal village with 6.02 meters, ranging from one to 16.70 meters and average diameter at soil level of 13.76 cm ranging from five to 36.60 cm (Table 4).
The highest values for the phytosociological parameters were observed in Santana, except for plant height and mean diameter at soil level, which were more significant in Patizal (Table 4). This is probably due to the systematic gathering of mangaba fruits observed in Santana, where the farmer community is organized to sell fresh fruits and fruit products in agricultural fairs in the municipality of Morros, whereas in Recanto, Recurso and Bacaba, only few residents collect mangaba fruits.
Silva et al. (2016) found average plant height of 5.12 meters for naturally occurring mangaba trees in savannah restinga transition zone fragments in the same villages in the municipality of Morros. This value is higher than those found in all villages reported in this study, except for Patizal.

Floristic similarity

In the five studied villages, there were only four species in common, *H. speciosa*, *H. sucuuba*, *M. urundeuva* and *P. platycephala* (Table 2).
Some species were specific to the villages, indicating floristic differences among the sampled fragments. For example, in Recanto, there were six exclusive species, Bacaba had three and Patizal and Santana only one exclusive species each. In contrast, Recurso did not have any exclusive species. Floristic similarity indices ranged from 0.3182 (Recanto and Bacaba) to 0.5714 (Recurso and Patizal (Table 5).
According to Kent and Coker (1992), similarity index values greater than or equal to 0.5 indicate high floristic similarity. Thus, the analyzed similarity between the areas in this study can be considered low with exception of the Recurso - Patizal areas (similarity = 0.5714) and Recurso - Bacaba (similarity = 0.5333). This indicates that the distance among the villages in this study does not interfere with the floristic similarity among them. Ferreira-Júnior et al. (2008) found a maximum similarity index of 0.961 in research carried out in a semi-deciduous forest fragment in Marcelândia, state of Mato Grosso. The other areas analyzed by the authors were also considered low with a minimum similarity of 0.0046. In this study, similarity indices ranged from 0.390 (Santana and Recanto) to 0.571 (Patizal and Recurso) (Figure 3).
The low floristic similarity indices can be related to the low number of species found in the villages, particularly in Santana (9). Santos (2000) and Oestreich-Filho (2014) also found low similarity in the studied areas of savannah.

Materials and Methods

Study site

The research was carried out in the villages of Recurso (02º58´42,7´´ S and 43º51´12,7´´ W), Recanto (02º58´29,2´´ S and 43º 49´28,6´´ W), Patizal (02º58´42,7´´ S and 43º51´12,7´´ W), Santana (02°54´08´´ S and 43°57´43´´ W) and Bacaba (02°57´30´´ S and 43°46´03´´ W) villages which are part of the Rio Pirangi Settlement Project, located on the right bank of the Munim River, 24 km away from the municipality of Morros, state of Maranhão, northeastern Brazil (Fig. 1).
The climate in the region is sub-humid with average temperature ranging from 25 to 27 °C, relative humidity is between 78 and 82% and rainfall is approximately 1900-2300 mm year^{-1}. The soil is classified as Quartzipsamment, and vegetation in the naturally occurring mangaba in the five villages is classified as Savannah-Restinga (sandbank) transition zone (NUGEO, 2015).

Floristic composition

The individuals were selected using the quadrant method (Kent and Coker, 1995; Hijbeek et al. 2013), with spacing of 20 meters between points and 50 meters between transects, totaling 88 points distributed in four transects in the Recurso, Recanto and Patizal villages, and 81 points in four transects distributed in the Santana and Bacaba villages. Data were collected from January 2014 to December 2016.
In order to observe the floristic representativeness in the research area, the sampling sufficiency curve was elaborated, which is a quantitative (or quasi-quantitative) concept used in phytosociological studies to inform if the sample used is "representative" of the plant community under study (Schilling and Batista, 2008; Béguinot, 2015). In each quadrant, a plant (hereafter individual) with a stem diameter at soil level (DSL) equal to or greater than 5 cm was demarcated, making a total of four individuals per point, measured with the aid of a caliper. In addition to the DSL, the distance point-tree was determined (DPT, in meters) by a measuring tape and the total plant height (TPH, in meters) was measured with a beacon.
We identified all individual at species level by comparing species already identified in the literature and also by consulting experts.
The assessed variables were number of individuals (NI), number of species (NSPP), total density (TD), the Shannon Diversity Index (H'), total plant height (TPH) and diameter at soil level (DSL).

Floristic similarity

The Jaccard Similarity Index (Kent and Coker, 1995; Durigan, 2003) was used to compare floristic similarity. The data obtained were used to elaborate matrices of presence and absence of species, in which each area was considered as a sampling unit. The resulting floristic similarity matrix was used for group analysis by the Unweighted Pair Group Method with Arithmetic Mean (UPGMA) (Legendre and Legendre, 2012).

Phytosociology of mangabeira

The phytosociological parameters computed for mangaba, were: absolute and relative density, frequency and dominance; basal area, importance value and cover value (Mueller-Dombois and Ellenberg, 1974). Data processing were performed by the sofware FITOPAC 2 (Shepherd, 2010), with graphics developed by Excell XP.

Conclusions

Sampling was sufficient since the curve stabilization occurred before reaching the total points in all villages. The families with higher species richness were Fabaceae, Apocynaceae and Anacardiaceae. It is noteworthy that mangaba belongs to the botanical family Apocynaceae, which indicates that species belonging to this family have good adaptability to these areas.

The Shannon Diversity Index (H') was low in all sampled areas, which may be related to disordered deforestation, opening areas for cultivation and vegetation burning for native pasture renewal.

The number of mangabeira individuals was higher and the importance value and cover value were greater in Santana village showing greater ecological importance in the plant community in this village. The lower values for these parameters were observed in Recanto. Finally, most of the villages studied present low floristic similarity (less than 50%), with only four species in common.

Conflict of interest

The authors did not declare any conflict of interest.

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