academicJournals

Vol. 11(32), pp. 2937-2946, 11 August, 2016
DOI: 10.5897/AJAR2016.11173
Article Number: 544B59B59944
ISSN 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Vegetation structure of naturally occurring areas of mangaba *Hancornia speciosa* Gomes in the mid-north region of Brazil

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Received 1 May, 2016; Accepted 26 July, 2016

The unknown potential of the mangaba *Hancornia speciosa* naturally occurring areas in the mid-north region of Brazil has raised the risk of its extinction and contributed to its underutilization. The objective of this study was to characterize the vegetation structure with naturally occurring mangaba in Recanto, Patizal and Recurso, villages in Morros municipality, State of Maranhão to provide the species proper utilization and conservation. The floristic composition was determined by the quadrants method. Two individuals were selected per quadrant, an adult and regenerating. The phytosociological parameters computed were Relative Density, Frequency and Dominance, Importance Value, Cover Value, the Shannon and Weaver Diversity Index and the Sorensen Similarity Index. The species *H. speciosa* reached relevant position in all computed parameters in the three sampled villages with importance values varying from 25.15 to 29.38% for the regenerating and from 29 to 56.64% for the adult strata, indicating the species relative ecological importance.

Key words: Diversity, Savannah-Restinga transition, phytosociology.

INTRODUCTION

The Brazilian natural heritage is relevant for the global biodiversity conservation due to its territorial extension, diversity and endemism of species, genetic heritage and the ecosystem heterogeneity of its biomes (Maracahipes et al., 2011). However, the floristic richness of Brazil is constantly threatened, either by land speculation, deforestation or the predatory exploitation of natural resources.

According to notice of the Ministry of the Environment (2012) the Brazilian Savannah is considered the richest in the world, with 11,627 native plant species already catalogued. However, it has suffered significant loss of

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Table 1. Soil chemical characterization at 0-20 cm depth in the Recurso, Recanto and Patizal villages, P. A. Rio Pirangi, Morros municipality, State of Maranhão.

Villages	O.M.	pH	P	K	Ca	Mg	H+Al	Na	Al	CTC	V%
	g/dm³	$CaCl_2$	mg/dm³	..........................mmol$_c$/dm³............................							
Recurso	5	4	1	0.7	3	6	20	1.7	0	31.4	36.3
Recanto	7	4	1	0.6	4	3	20	1.8	2	29.4	32.0
Patizal	14	5.8	1	0.5	5	2	20	2.8	2	28.3	29.3

O. M. = Organic Matter; P = Posphorus; K = Potassium; Ca = Calcium; Mg = Magnesium; H+Al = Hydrogen plus Aluminum; Na = Sodium; Al = Aluminum; CTC = Cation Exchange Capacity; V% = Base saturation.

habitat and many native species with great socio-economic and environmental importance, as is the case of mangaba (*Hancornia speciosa* Gomes), are at risk of extinction.

The mangaba is an abundant species in the mid-north region of Brazil. It is typical of the Savannah and Restinga (sandbank) environments. The species has broad potential for use and high utility value for both the pharmacological industry including latex, leaves, stem bark and root for very specific purposes; and for the food industry, the fresh consumption of fruit and / or manufacture of juices, jams, pulps, ice cream among others (Lima et al., 2015). Countless families survive as mangaba collectors in the mid-north region of Brazil.

Nevertheless, mangaba production in almost all comes from the extraction collection, and despite their socio-economic importance, studies of the species are limited. This is a species still under domestication phase but with extinction risks, and little is known about its peculiarities in its naturally occurring environment, which is under accelerated devastation process. Therefore, issues related to the development, adaptation and arrangement of species, still need to be investigated further. Based on this approach, this study aimed to characterize vegetation structure of naturally occurring mangaba in the mid-north region of Brazil in order to support the development of a management plan justifying the conservation and proper utilization of the species.

MATERIALS AND METHODS

This research was carried at the Settlement Project Rio Pirangi (P. A.) in Morros municipality, in the State of Maranhão, mid-north region of Brazil, from November, 2014 till April 2015. 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} (Nugeo, 2015).

The P. A. great richness is the mangaba tree composition in the villages of Recurso (2° 58' 42.7" S and 43° 53' 12.7" W), Recanto (2° 58' 30.7" S and 43° 49' 29.0" W) and Patizal (3° 00' 25.4" S and 43° 54' 22.9" W) where this study was conducted. In all villages extractive farmers conserve native mangaba trees and neither slash and burn nor cultivate the land, thus they make their living from the sale of the mangaba fresh and/or processed fruits, except in Recanto, where farmers use native mangaba areas for cultivation and pasture for extensive cattle farming, therefore, the use of mangaba for both the consumption and for marketing fresh and/or processed is minor compared to the other two villages.

Vegetation in the naturally occurring mangaba in the three villages is classified as Savannah-Restinga transition zone (Nugeo, 2015). The soil is classified as Quartzipsamment (Nugeo, 2015). Twenty soil sub-samples were randomly collected per village at 0 to 20 cm, bulked and sent to the Soils Laboratory of the Maranhão State University for performing chemical analysis according the Instituto Agronomico de Campinas methodology (IAC, 2001).

The structure and composition of the adult and natural regeneration strata from vegetation with naturally occurring mangaba was determined by the quadrants method with 20 m spacing between points and 50 m between transects. Four transects were distributed in the sampled vegetation in each village. All transects were georeferenced. Two individuals were sampled per quadrant, one adult with the plant stem diameter at soil level (DSL) of 5 cm or more and one individual from the regeneration community, with DSL of 5 cm or less. The distance point tree and total plant height were measured with an analogical pachymeter, a measuring tape and a graduated ruler, respectively.

The phytosociological parameters computed were density, frequency and dominance (absolute and relative), importance value, cover value, the Shannon Diversity Index (H') and the Sorensen Similarity Index (ISS), according to Mueller-Dombois and Ellenberg (1974). Data were analyzed by means of the software FITOPAC 2.1.2 (Shepherd, 2009).

One extractivist farmer contributed with the identification of the species common names. Thereafter, collection of the botanical material was made for determination of the species scientific names, plants were pressed to prepare exsiccates and were incorporated into the Rosa Mochel Herbarium of the Maranhão State University in São Luis. The floristic list of families and species was organized according to the Angiosperm Phylogeny Group III guidelines (APG III, 2009).

RESULTS AND DISCUSSION

The soil chemical analysis results indicated that the soil in all villages were strongly acid except in Patizal where it was medium acid. Organic matter, P and K contents were low in all villages but Ca content was medium. The Mg and Al contents were low in all areas except in Recurso where their content was medium. The Al content was high in all soils except in Recurso where it was low Therefore soils in the occurring mangaba areas in this study are characterized by low natural chemical fertility (Table 1).

However, mangaba is not demanding in soil fertility because it grows well in poor and acidic soils which are

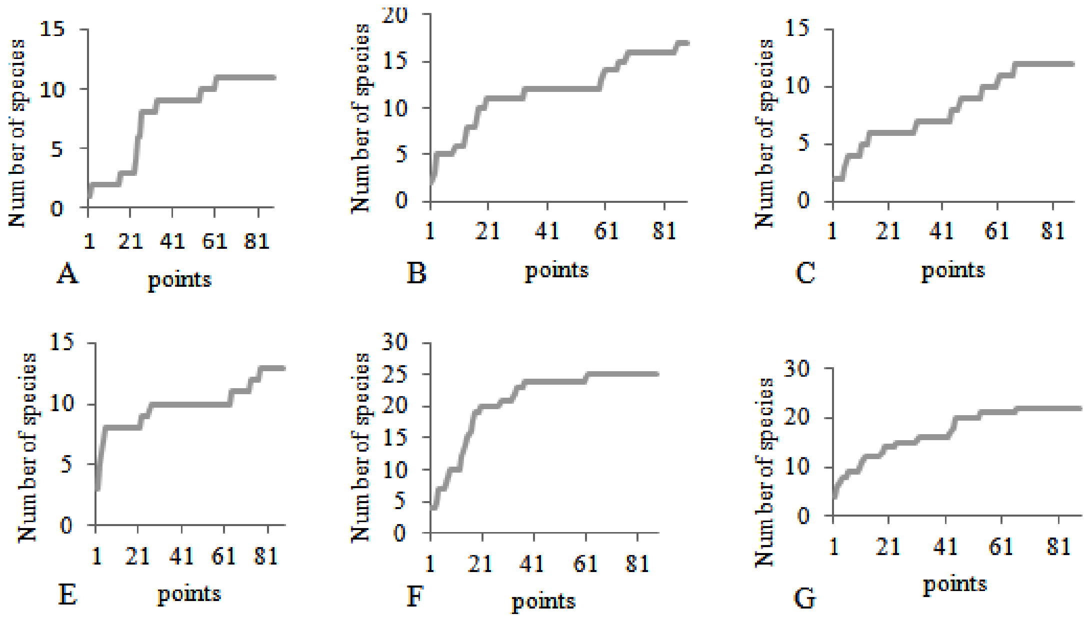

Figure 1. Sampling sufficiency curve for the regenerating (A, B, C) and adult (D, E, F) strata for vegetation sampled in Recanto, Patizal and Recurso villages respectively, in the P. A. Rio Pirangi, Morros municipality, State of Maranhão, mid-north region of Brazil.

major characteristics of the Brazilian savannah soils (Vieira-Neto, 1994). Silva et al. (2011) reported that mangaba emergency percentage, stem diameter and the length of the root system were not significantly affected by different substrates and Oliveira et al. (2014) studying the effect of different culture media on the in vitro germination of mangaba seeds observed that there was no difference in the values of germination average time.

The number of sampled points was determined by the stability of the collector's curve obtained with 61 points for the regenerating and with 85 points for the adult strata for vegetation assessed in Recanto; 66 and 67 points, respectively, for regenerating and adult strata in Patizal, and finally, with 77 and 61 points for regenerating and adult strata, respectively, in the Recurso village (Figure 1). Eighty eight points were sampled per study area despite field observations have shown that the collector's curve stabilized with a lower number of points, thus this suggests a broad flora representation in this study.

Floristic composition of the adult and regenerating strata in naturally occurring mangaba areas

A total of 264 points distributed in 12 transects were sampled totaling 2,112 live individuals, from these, 1,056 individuals from 33 species and 20 families, were from the regenerating stratum and 1,056 individuals from 22 species and 10 families, were from the adult stratum (Table 2). The number of species and families sampled in both the regenerating and adult vegetation strata was higher in Recanto followed by Patizal and Recurso villages (Figure 2). The family Apoycnaceae was the most abundant, with the highest number of individuals in both adult and regenerating strata in all villages (Figure 3). The Shannon Diversity Index indicated that the sampled vegetation floristic diversity was higher in Recanto than Patizal and Recurso villages (Table 3). In general, the floristic diversity was higher in the regenerating than in the adult stratum in all villages (Table 3). The Shannon Diversity Index (H') indicates high species diversity for any type of vegetation when it varies from 3.83 to 5.85 nats. ind.$^{-1}$ (Knight, 1975). Thus, based on the results obtained in this study, it is possible to infer that both adult and regenerating strata from the naturally occurring mangaba areas in the Savannah-Restinga vegetation transition zone in Morros, State of Maranhão showed low species diversity. In a study on natural species regeneration carried out in the Savannah of the Federal District of Brazil, Medeiros et al. (2007), reported a value of 3.21 nats. ind.$^{-1}$.

Marmontel et al. (2014) assessing arboreal vegetation in the Savannah in the State of Minas Gerais, Brazil, described H' value of 2.5 nats. ind.$^{-1}$. Both reported H' values were higher than those obtained in this study. This is because mangaba management and the greater awareness of the mangaba food, nutritional and cultural values have resulted in the mangaba conservation in the villages from this study which contributed for the significant increase in the number of mangaba plants occupying the other species niches thus decreasing the overall species diversity.

Table 2. List of the species and families recorded in the regenerating and adult strata in Recanto, Patizal and Recurso villages, in the Savannah-Restinga transition vegetation zone in Morros municipality, State of Maranhão, mid-north region of Brazil.

Recanto village							
Regenerating stratum							
Familes	**Species**	**NI**	**RD (%)**	**RF (%)**	**RDo (%)**	**CV (%)**	**IV (%)**
Apocynaceae	*Himatanthus sucuuba* (Spruce) Woodson	100	28.41	24.35	25.59	27.07	26.12
Apocynaceae	*Hancornia speciosa* Gomes	89	25.28	20.87	29.3	27.36	25.16
Fabaceae	*Hydrochorea* sp.	3	8.52	9.13	5.4	6.98	7.68
Malphigiaceae	*Byrsonima crassifolia* L. Rich	20	5.68	6.09	5.79	5.75	5.85
Fabaceae	*Parkia platycephala* Benth	17	4.83	5.65	6.64	5.75	5.71
Bixaceae	*Cochlospermum orinocense* (Kunth) Steud	10	2.84	3.91	2.01	2.43	2.92
Hypericaceae	*Vismia brasiliensis* Choisy	12	3.41	3.04	2.0	2.71	2.82
Fabaceae	*Stryphnodendron barbatiman* Mart.	6	1.70	2.61	2.58	2.15	2.30
Myrtaceae	Unidentified species	7	1.99	3.04	1.71	1.85	2.25
Clusiaceae	*Platonia insignis* Mart.	8	2.27	2.17	2.22	2.25	2.22
Fabaceae	*Andira* sp.	6	1.7	1.74	2.24	1.72	2.89
Myrtaceae	*Myrcia* sp.	7	1.99	3.04	0.6	1.3	1.88
Bignoniaceae	*Zeyheria* sp.	7	1.99	1.74	1.58	1.79	1.77
Sapindaceae	*Talisiaretusa* R. S. Cowan	4	1.14	1.74	1.76	1.45	1.54
Sapotaceae	*Manilkara* sp.	4	1.14	0.87	2.48	1.81	1.49
Myrtaceae	*Psidium firmum* Berg.	3	0.85	1.3	1.76	1.31	1.31
Theaceae	*Laplaceae fruticosa*	4	1.14	1.74	0.94	1.04	1.27
Myrtaceae	*Campomanesia* sp.	4	1.14	1.74	0.88	1.01	1.25
Apocynaceae	*Aspidosperma* sp.	3	0.85	0.43	1.17	1.01	0.82
Anacardiaceae	*Myracrodruom urundeuva* Fr. All.	3	0.85	1.3	0.24	0.55	0.80
Commelinaceae	*Commelina benghalensis* L.	2	0.57	0.87	0.94	0.76	0.79
Humiriaceae	*Humiria balsamifera* Jaume St. Hillaire	2	0.57	0.87	0.82	0.7	0.75
Rubiaceae	*Guettarda* sp	2	0.57	0,87	0,59	0,58	0.68
Rubiaceae	*Bathysa meridionalis* Smith & Downs	1	0.28	0,43	0,43	0,36	0.38
Salicaceae	*Casearia* sp.	1	0.28	0.43	0.31	0.30	0.34
Adult stratum							
Apocynaceae	*Hancornia speciosa* Gomes	129	36.65	30.57	31.43	34.04	32.88
Apocynaceae	*Himatanthus sucuuba* (Spruce) Woodson	106	30.11	27.51	31.14	30.63	29.59
Fabaceae	*Parkia platycephala* Benth	34	9.66	10.48	8.12	8.89	9.42
Fabaceae	*Hydrochorea* sp.	28	7.95	10.04	4.68	6.32	7.56
Fabaceae	*Andira* sp.	15	4.26	5.68	6.78	5.52	5.57
Clusiaceae	*Platonia insignis* Mart.	4	1.14	1.31	10.37	5.75	4.27
Fabaceae	*Stryhnodendron barbatiman* Mart.	13	3.69	4.37	3.06	3.38	3.71
Bixaceae	*Cochlospermum orinocense* (Kunth) Steud	7	1.99	3.06	0.41	1.2	1.82
Melastomataceae	*Bellucia* sp.	2	0.57	0.87	2.33	1.45	1.26
Anacardiaceae	*Anacardium occidentale* L.	2	0.57	0.87	0.98	0.78	0.81
Anacardiaceae	*Myracrodruom urundeuva* Fr. All.	3	0.85	1.31	0.13	0.49	0.76
Sapindaceae	*Talisia retusa* R. S. Cowan	3	0.85	1.31	0.08	0.47	0.75
Malphigiaceae	*Byrsonima crassifólia* L. Rich	2	0.57	0.87	0.33	0.45	0.59
Hypericaceae	*Vismia brasiliensis* Choisy	1	0.28	0.44	0.06	0.17	0.26
Sapotaceae	*Manilkara* sp.	1	0.28	0.44	0.05	0.17	0.26
Apocynaceae	*Aspidosperma* sp.	1	0.28	0.44	0,04	0.16	0.25
Myrtaceae	*Campomanesia* sp.	1	0.28	0.44	0.03	0.16	0.25
			Patizal village				
			Regenerating stratum				
Apocynaceae	*Hancornia speciosa* Gomes	108	30.68	24.24	32.97	31.83	29.30
Apocynaceae	*Himatanthus sucuuba* (Spruce) Woodson	75	21.31	19.48	26.98	24.14	22.59
Fabaceae	*Machaerium* sp.	40	11.36	12.55	7.79	9.58	10.57

Table 2. Contd.

Fabaceae	*Myracrodruon urundeuva* Fr. All.	18	5.11	6.06	10.76	7.94	7.31
Salicaceae	*Casearia* sp.	26	7.39	8.66	2.14	4.76	6.06
Fabaceae	*Hydrochorea* sp.	13	3.69	3.9	5.84	4.77	4.48
Sapotaceae	*Manilkara huberi* (Ducke) A. Chev.	13	3.69	5.63	3.51	3.61	4.28
Bixaceae	*Cochlospermum orinocense* (Kunth) Steud	8	2.27	2.6	2.52	2.4	2.46
Bignoniaceae	*Zeyheuria* sp.	10	2.84	3.03	1.17	2.01	2.35
Myrtaceae	*Myrcia* sp.	10	2.84	3.03	0.36	1.6	2.08
Malpighiaceae	*Byrsonima crassifolia* L. Rich	4	1.14	1.3	1.83	1.48	1.42
Rubiaceae	*Guettarda* sp.	4	1.14	1.73	1.07	1.11	1.31
Hypericaceae	*Vismia brasiliensis* Choisy	5	1.42	0.87	0.53	0.98	0.94
Caryocaraceae	*Caryocar villosum* (Aubl.) Pers	4	1.14	0.87	0.54	0.84	0.85
Fabaceae	*Hymenaea courbaril* L.	3	0.85	1.3	0.39	0.62	0.85
Fabaceae	*Parkia platycephala* Benth	2	0.57	0.87	0.48	0.53	0.64
Sapindaceae	*Talisia retusa* R.S. Cowan	2	0.57	0.87	0.27	0.42	0.57
Fabaceae	*Peltogyne* sp.	2	0.57	0.87	0.26	0.42	0.56
Theaceae	*Laplaceae fruticosa*	2	0.57	0.87	0.14	0.36	0.52
Apocynaceae	*Aspidosperma* sp.	1	0.28	0.43	0.28	0.28	0.33
Fabaceae	*Bauhinia forficata* Link	1	0.28	0.43	0.08	0.19	0.27
Anacardiaceae	*Anacardium occidentale* L.	1	0.28	0.43	0.08	0.19	0.27
Adult stratum							
Apocynaceae	*Hancornia speciosa* Gomes	226	64.2	46.24	62.23	63.15	57.56
Apocynaceae	*Himatanthus sucuuba* (Spruce) Woodson	63	17.9	25.43	23.94	20.9	22.43
Anacardiaceae	*Myracrodruon urundeuva* Fr. All.	22	6.25	7.51	2.40	4.32	5.39
Fabaceae	*Parkia platycephala* Benth	8	2.27	4.05	4.91	3.59	3.74
Fabaceae	*Machaerium* sp.	8	2.27	2.89	2.20	2.24	2.46
Bixaceae	*Cochlospermum orinocense* (Kunth) Steud	8	2.27	4.05	0.4	1.33	2.24
Fabaceae	*Hydrochorea* sp.	6	1.70	3.47	0.39	1.05	1.85
Malvaceae	*Pachira aquatica* Aubl.	4	1.14	2.31	0.44	0.78	1.29
Sapotaceae	*Manilkara huberi* (Ducke) A. Chev.	3	0.85	1.73	0.86	0.85	1.15
Malpighiaceae	*Byrsonima crassifolia* L. Rich	2	0.57	1.16	0.45	0.51	0.72
Anacardiaceae	*Anacardium occidentale* L.	1	0.28	0.58	0.99	0.64	0.62
Salicaceae	*Casearia* sp.	1	0.28	0.58	0.79	0.64	0.55
			Recurso village				
			Regenerating stratum				
Apocynaceae	*Hancornia speciosa* Gomes	97	27.56	24.12	36.47	32.01	29.38
Apocynaceae	*Himatanthus sucuuba* (Spruce) Woodson	57	16.19	17.11	21.23	18.71	18.18
Fabaceae	*Machaerium* sp.	61	17.33	16.23	9.78	13.55	14.45
Myrtaceae	Unidentified species	53	15.06	15.79	4.84	9.95	11.9
Bixaceae	*Cochlospermum orinocense* (Kunth) Steud	41	11.65	12.72	11.01	11.32	11.79
Malpighiaceae	*Byrsonima crassifolia* L. Rich	27	7.67	8.33	12.26	9.97	9.42
Unknown	Not identified 1	8	2.27	2.19	0.80	1.53	1.76
Sapotaceae	*Manilkara* sp.	2	0.57	0.88	0.58	0.57	0.67
Rubiaceae	*Guettarda* sp.	2	0.57	0.88	0.49	0.53	0.65
Fabaceae	*Parkia platycephala* Benth	1	0.28	0.44	1.05	0.66	0.59
Fabaceae	*Hymenaea courbaril* L.	1	0.28	0.44	0.92	0.6	0.55
Anacardiaceae	*Myracrodruon urundeuva* Fr. All.	1	0.28	0.44	0.55	0.41	0.42
Hypericaceae	*Vismia brasiliensis* Choisy	1	0.28	0.44	0.02	0.15	0.25
Adult stratum							
Apocynaceae	*Hancornia speciosa* Gomes	233	66.19	50.29	53.44	59.82	56.64
Apocynaceae	*Himatanthus sucuuba* (Spruce) Woodson	81	23.01	29.82	35.16	29.09	29.33
Malpighiaceae	*Byrsonima crassifólia* L. Rich	21	5.97	9.94	2.47	4.22	6.13
Anacardiaceae	*Anacardium occidentale* L.	4	1.14	2.34	4.77	2.96	2.75

Table 2. Cont'd.

Fabaceae	*Parkia platycephala* Benth	2	0.57	1.17	2.15	1.36	1.30
Anacardiaceae	*Myracrodruon urundeuva* Fr. All.	4	1.14	2.34	0.39	0.77	1.29
Sapindaceae	*Talisia retusa* R.S. Cowan	2	0.57	1.17	1.07	0.82	0.94
Bixaceae	*Cochlospermum orinocense* (Kunth) Steud	2	0.57	1.17	0.15	0.36	0.63
Curcubitaceae	*Luffa operculata* Cogn	1	0.28	0.58	0.24	0.26	0.37
Sapotaceae	*Manilkara* sp.	1	0.28	0.58	0.11	0.2	0.33
Sapotaceae	*Machaerium* sp.	1	0.28	0.58	0.50	0.17	0.31

NI = number of individuals, RD = Relative density, RF = Relative frequency, RDo = Relative Dominance, IV= Importance Value, CV = Cover Value.

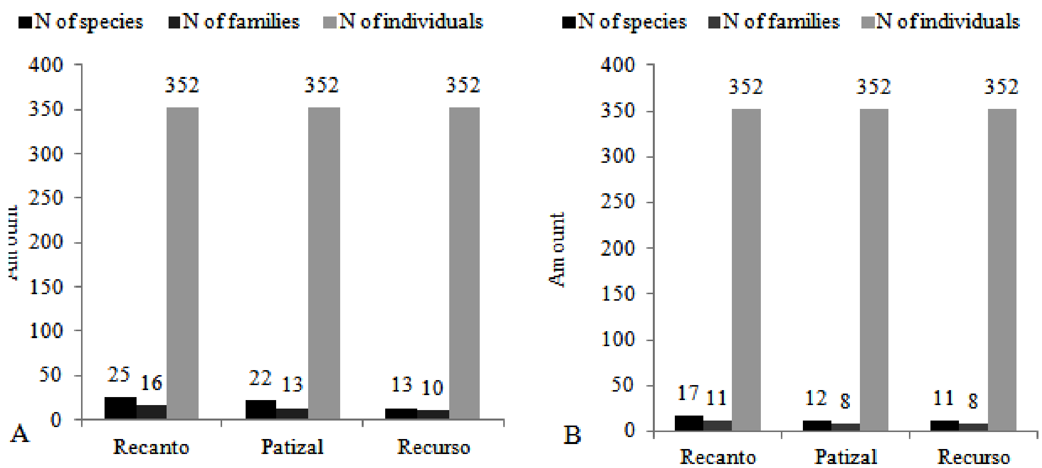

Figure 2. Number of species, families and individuals from both adult (A) and regenerating (B) strata recorded in sampled areas of Recanto, Patizal and Recurso villages in the P. A. Rio Pirangi, Morros municipality State of Maranhão, mid-north region of Brazil.

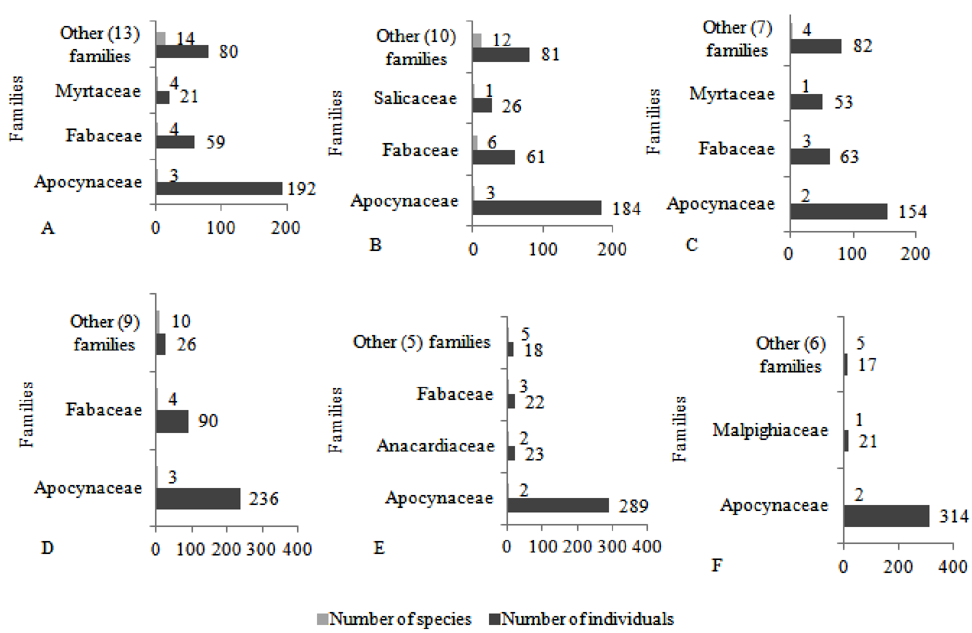

Figure 3. Number of individuals, species and families sampled in the vegetation regenerating (A, B, C) and adult (D, E, F) strata in Recanto, Patizal and Recurso villages respectively, in the P. A. Rio Pirangi, Morros municipality State of Maranhão, mid-north region of Brazil.

Table 3. Shannon Diversity Index of species sampled in the adult and regeneration strata in the Recanto, Patizal and Recurso villages in the Savannah-Restinga vegetation transition zone, Morros municipality, State of Maranhão, mid-north region of Brazil.

Recanto		Patizal		Recurso	
Sampling area (ha)	**H'nats.ind.$^{-1}$**	**Sampling area (ha)**	**H' nats. ind.$^{-1}$**	**Sampling area (ha)**	**H' nats. ind.$^{-1}$**
Vegetation regenerating stratum					
0.5	2.34	1.74	2.23	0.3	1.89
Vegetation adult stratum					
1.44	1.77	4.9	1.25	2.07	1.09

The Sorensen Similarity Index (SSI) was 30% for the regenerating and 40% and for the adult strata in the three villages. This indicates that, despite their proximity, the villages vegetation species composition in both regenerating and adult strata have low similarity, taking into account that only SSI values higher than 50% are considered as indicators of high similarity (Felfili and Resende, 2003).

Conversely, great similarity was observed among the three villages, with SSI values of 65, 62, and 58% for Patizal, Recanto and Recurso respectively, indicating vegetation stability.

Density, frequency and relative dominance by sampled species in the naturally occurring mangaba areas

With regards to the regenerating stratum, *H. speciosa* occupied a relevant position for the phytosociological parameters Relative Density (RD), Relative Frequency (RF), and Relative Dominance (RDo) of the sampled vegetation in the Recanto, Patizal and Recurso villages. The species with higher RD in the Recanto were *H. sucuuba* (RD = 28.41%) with 100 individuals, followed by *H. speciosa* (RD = 25.28%) with 89 individuals. The other 23 species (92%) amounted 46.31% of the RD.

The species *H. speciosa* also occupied the first position in Patizal (RD = 30.86%) with 108 individuals followed by *H. sucuuba* (RD = 21.32%) with 75 individuals and *Machaerium* sp. (RD = 11.36%) with 40 individuals. The other 19 species (86.36%) responded for 36.65 % of the RD. The higher RD values in Recurso were recorded for *H. speciosa* (RD = 27.56%) with 97 individuals, followed by *Machaerium* sp. (RD = 17.33%) with 61 individuals, *H. sucuuba* (RD = 6.19%) with 57 individuals, one unidentified species of the Myrtaceae (RD = 15.06%) with 53 individuals, and *Cochlospermum orinocense* (Kunth) Steud (RD = 11.65%) with 27 individuals. The other eight species (61.53%) responded for only 12.21% of the total RD.

The higher Relative Frequency (RF) values in Recanto were recorded for *H. sucuuba* (RF = 24.35%) and *H. speciosa* (RF = 20.87%) The other 23 species (92%) represented 54.78% from the total RF. In Patizal, the higher RF values were 24.24, 19.48 and 12.55%, respectively for the species *H. speciosa*, *H. sucuuba* and *Machaerium* sp. The other 19 species (86.36%) amounted 43.73% from the total RF. The higher RF values in Recurso were observed for the species *H. speciosa* (RF = 24.12%), *H. sucuuba* (RF = 17.11%), *Machaerium* sp (RF = 16.23%), Myrtaceae (RF = 15.79%) and *C. orinocense* (RF = 12.72%). The other eight species (61.53%) represented only 14.03% of the total RF.

With regards to Relative Dominance (RDo), the most relevant species in Recanto village were *H. speciosa* (RDo = 29.30%) and *H. sucuuba* (RDo = 25.59%). Other 23 species (92%) amounted 45.11% from the total RDo. The higher RDo values recorded in Patizal were for *H. speciosa* (RDo = 32.97%), *H. sucuuba* (RDo = 26.98%) and *M. urundeuva* (RDo = 10.76%). The other 19 species (86.36%) reached 29.29% from the total RDo. In Recurso village the dominant species were *H. speciosa*, (RDo = 36.47%), *H. sucuuba* (RDo = 21.23%), *B. crassifolia* (RDo = 11.01%), and *C. orinocense*, (RDo = 69.23%). The other nine species (23%) amounted 19.03% from the total RDo.

Studies on natural species vegetation regeneration are still scarce, mainly due to the difficulty of regenerating species identification. Phytosociological surveys carried out on other naturally occurring mangaba environments had different results from those obtained in this study. For example, Barreira et al. (2002), studying floristic similarity between adult and regenerating strata in Savannh environment in the State of Minas Gerais, described for *H. speciosa* RD and RF values of 0.04 and 0.17% respectively. Similarly, Medeiros et al. (2007), in research carried out in Savannah environment in Central Brazil reported that the values of RD, RF and RDo for mangaba were so inexpressive that were not even cited by the authors.

With respect to the adult stratum sampled in Recanto village, the species with higher RD were *H. speciosa* (RD = 36.65%) with 129 individuals, followed by *H. sucuuba* (RD = 30.11%) with 106 individuals. The other 15 species (88.23%) amounted to 33.24% of the total RD. The higher RD values obtained in Patizal were for the species

H. speciosa (RD = 64.20%) with 226 individuals, and *H. sucuuba*, (RD = 17.9%) with 63 individuals. The other 10 species (83.33%) amounted to 17.9% of the total RD. The species with higher RD values in Recurso were *H. speciosa* (RD = 66.19%) with 233 individuals followed be *H. sucuuba* (RD = 23.01%) with 81 individuals. The other nine species (81.81%) amounted only 10.8% of the total RD.

With respect to RF, the species that reached higher values in Recanto village were *H. speciosa* (RF = 30.57%) and *H. sucuuba* (RF = 27.51%). Other relevant species were *P. platycephala* (RF = 10.48%) and *Hydrochorea* sp. (RF = 10.04%). The other 13 species (76.47%) amounted 21.40% of the total RF. The species with higher RF values in Patizal were *H. speciosa* (RF = 46.24%) and *H. sucuuba* (RF = 25.43%). The other 10 species (83.33%) represented 28.33% of the total RF. In Recurso the higher RF values were recorded for the species *H. speciosa* (RF = 50.29%) and *H. sucuuba* (RF = 29.82%). The other nine species (81.81%) represented only 19.89% of the total RF.

With regards to RDo, the species *H. speciosa* and *H. sucuuba* occupied the first and second positions respectively in all villages. For example, in Recanto *H. speciosa* (RDo = 31.43% and *H. sucuuba* (RDo = 31.14%. However *P. insignis* (RDo = 10.37%) also deserves to be highlighted. The other 14 species (82.35%) represented 27.06% of the total RDo. In Patizal, the higher RDo values were for *H. speciosa* (RDo = 62.23%) and *H. sucuuba* (RDo = 23.94%). The other 10 species (83.33%) totaled 13.83% of the total RDo. In Recurso, *H. speciosa* (RDo = 53.44%) and *H. sucuuba* (RDo = 35.16%) were prevalent species. The other nine species (81.81%) amounted 11.4% of the total RDo.

Marmontel et al. (2014) reported for *H. speciosa* RD the value of only 1.27% with occurrence of 40 individuals and RDo of 0.92% in sampling area of 1.5 ha. Similarly Castro and Conceição (2009) in a survey carried out in the Savannah vegetation at the Parque of Mirador, State of Maranhão, reported that *H. speciosa* did not stand out among the sampled species, with RD value of 0.31% with eight individuals, RF value of 0.69% and RDo of 0.36%.

Besides the proximity among the villages in the naturally occurring areas of mangaba in Morros, the results obtained in this research indicated remarkable differences with respect to vegetation structure and composition for both the adult and regenerating strata. Differences observed among species diversity and number of mangaba plants per area are probably due to the different use of the plant among the villages assessed in this study. Besides the greater diversity observed in Recanto village, the number of mangaba plants was lower in both the adult and regenerating strata when compared to the other villages. This can be explained by the intense use of the mangaba naturally occurring areas in agricultural activities by the surrounding community. Conversely, in Recurso and Patizal villages, greater awareness of the mangaba food, nutritional, economic and cultural values, resulted in the conservation of mangaba by the local population, which in fact, contributed to the significant number of mangaba plants in these villages.

Importance value and cover value per species sampled in the mangaba naturally occurring areas

The species *H. speciosa* and *H. sucuuba* reached relevant positions for the parameters Importance Value (IV) and Cover Value (CV) for both the adult and generating strata sampled in the three villages sampled in Morros. With regards to the regenerating stratum in Recanto village, the higher IV values were recorded for *H. sucuuba* (IV = 26.12%) and *H. speciosa* (IV = 25.16%) while the higher CV values were observed for *H. speciosa* (CV = 27.36%) and *H. sucuuba* (CV = 27.07%). The other 23 species (92%) amounted 48.72% of the total IV and 45.57% of the total CV. In Patizal, *H. speciosa* occupied the first position (IV = 29.3%) and (CV = 31.83%) followed by *H. sucuuba* (IV = 22.59%) and CV = 24.14%). The other 20 species (90.9%) amounted 48.11% of the total IV and 44.03% of the total CV. Finally, in Recurso, besides *H. speciosa,* (IV = 29.38% and VC = 32.01%); and *H. sucuuba* (IV = 18.18% and CV = 18.71%), other noteworthy species were *Machaerium* sp. (IV = 14.45% and CV = 13.55%), Myrtaceae (IV = 11.9% and VC = 9.95%); and *Cochlospermum orinocense* (IV= 11.79% and CV = 11.32%). The other eight species (61.53%) amounted 14.3% of the total IV and 14.46% of the total VC.

In the results reported by Barreira et al. (2002), *H. speciosa* obtained IV of only 1.39%, thus, it was not an important species to characterize the regenerating stratum of the assessed vegetation. This is very different from the results obtained in this study carried out in Morros. The more important species in the adult stratum in the Recanto village were *H. speciosa* (IV = 32.88% and CV = 34.04%); and *H. sucuuba* (IV = 29.59% and CV = 30.63%). The other 15 species (88.23%) of the total of 17 species amounted 38.12% of the total IV and 35.33% of the total CV. In Patizal, *H. speciosa* was the most important species (IV = 57.56%) and (CV = 63.15%), followed by *H. sucuuba* (IV = 22.43%) and CV = 20.9%). The other 10 species (83.33%) amounted 20.01% of the total IV and 15.95% of the total CV. In Recurso, the higher IV values of 56.64 and 29.33% and the higher CV values of 59.82 and 29.09%, were again for the species *H. speciosa* and *H. sucuuba*, respectively. The other nine species (81.81%) amounted 14.03% of the total IV and 11.09% of the total CV.

In contrast, Castro and Conceição (2009) described for *H. speciosa* (CV = 0.64% and IV = 1.33%). These authors observed that the species was not highlighted by these parameters. Similar results were obtained by

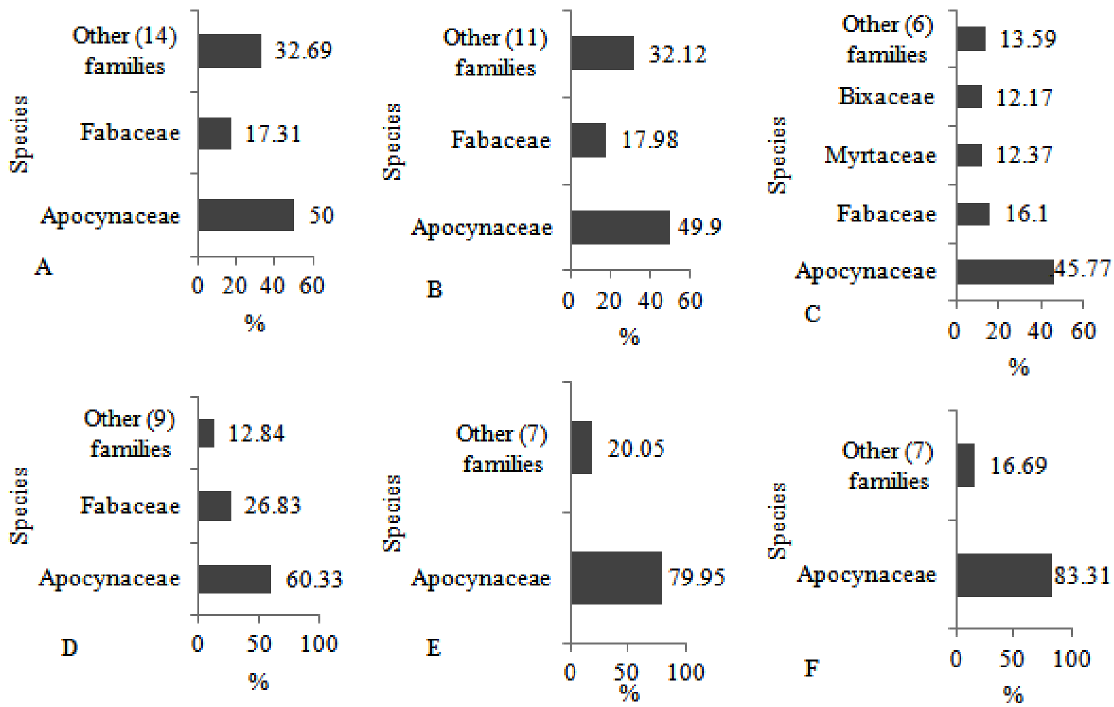

Figure 4. Importance Value per family sampled for the regenerating (A, B, C) and adult strata (D, E, F) of the vegetation assessed in Recanto, Patizal and Recurso villages respectively, in the P. A. Rio Pirangi, Morros municipality, State of Maranhão, mid-north region of Brazil.

Marmontel et al. (2014), who reported that the species reached IV value of only 3.27%; as well as in results described by Mota et al. (2014) in phytosociological survey carried out in Biribiri State Park, in Diamantina municipality, State of Minas Gerais where the mangaba did not stood out among the other species, reaching IV value of only 1.23%. It should be pointed out that the presence of the species *H. sucuuba* with IV values between 18.18 and 29.59% may be indicative of suitable area of growing and conservation of mangaba, however other studies are needed to quantify the relationship between the two species.

Importance value (IV) per family sampled in the mangaba naturally occurring areas

The Apocynaceae family reached the higher IV values in three villages assessed. The IV values varied from 45.77 to 50% for the regenerating and from 60.33 to 83.31% for the adult strata (Figure 4). This suggests high ecological importance of this family for the vegetation assessed in this study.

These results are similar to those reported in research carried out by Castro and Conceição (2009) in Savannah vegetation in the Parque of Mirador in the State of Maranhão where the authors noted the same families described in Morros, although the highlights were for the families Myrtaceae (IV = 34.54%) and Malpighiaceae (IV = 28.17%).

Conclusions

The more important species for the characterization of the Savannah-Restinga transition vegetation zone sampled in the mid-north of Brazil were *H. speciosa* and *Himatanhus sucuuba*, both had the higher importance value for the regenerating and adult strata. The *H. speciosa* importance value varied from 25.16 to 29.38% for the regenerating and from 32.88 to 57.56% for the adult strata among the vegetation sampled areas of Recanto, Patizal and Recurso villages, suggesting high ecological importance of this species for the sampled ecotone. The vegetation with naturally occurring mangaba showed low species diversity with H' varying from 1.89 to 2.34 nats.ind.$^{-1}$ for the regenerating and from 1.09 to 1.77 nats.ind.$^{-1}$ for the adult strata. The high Sorensen similarity indices among the vegetation strata in Recanto (65%), Patizal (62%) and Recurso (58%) suggest stability of the sampled vegetation in the naturally occurrence areas of mangaba.

Conflict of interests

The authors have not declared any conflict of interests.

ACKNOWLEDGMENTS

The authors would like to thank Maranhão State University, FAPEMA (Foundation for Research and Scientific and Technological Development of Maranhão State, Brazil), coordination for the Improvement of Higher Level Personnel (CAPES, Brazil), Tijupá Agroecological Association and farmers at Recurso, Recanto and Patizal villages from the Settlement Project Rio Pirangi, (P. A.) Morros municipality, State of Maranhão, mid-north region of Brazil, for the support given to carry out this research.

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