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Phytosociology in areas of the Brazilian Cerrado: Cerrado *stricto sensu*, municipality of Porto Nacional, State of Tocantins

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ABSTRACT. Phytosociological studies are essential for the elaboration of conservation strategies for the Cerrado. The goal of this study was to survey two areas of cerrado *stricto sensu*: Fazenda Canaã and Fazenda Providência, located in the Municipality of Porto Nacional, State of Tocantins. There were 10 plots of 100 m^2 allocated in each area. All individuals with circumference equal to or greater than 10 cm, at ground height ⩾10 cm were sampled, soil samples were taken for physical-chemical analysis. Sampling in Canaã resulted in 379 individuals belonging to 28 families and 50 species. In Providência, there were 300 individuals from 27 families and 49 species. The Shannon-Wiener Index for the Canaã was 3.48 and for Providência, 3.45. The studied areas presented a large number of small sized individuals, presenting a reverse J-shaped diameter structure. The Canonical Correspondence Analysis showed significant scores for the first axes ($p < 0.05$) according to the Monte Carlo test, which explained 70% total variability of the data. The variables with the highest structure coefficient in axis 1 were clay (0.94), pH (0.62) and magnesium (-0.32). On axis 2, the most important variables were aluminum (0.29), silt (0.25) and potassium (-0.078). These soil variables show a differentiation of the study areas.

Keywords: diversity; species richness; soil-vegetation.

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Introduction

Cerrado has a high diversity of plant species and 45% of these species are endemic to this formation, with a high risk of extinction, for this reason it is considered one of the conservation hotspots, i.e., the most diverse tropical savanna in the world (Klink & Machado, 2005).

Felfili, Nogueira, Silva Júnior, Marimon, and Delitti (2002) stated that about 37% of the original Cerrado cover has already been destroyed by human activities responsible for the formation of pasture and crop areas. The degradation of natural ecosystems has been considered as one of the major threats to the biodiversity of this Biome (Klink & Machado, 2005). In the State of Tocantins, according to Santos and Ferreira (2012), the native vegetation has been devastated due to agricultural production, hydropower plant operation and fires. Given this, there is a growing need for information to help understand the structure and functioning of this Biome (Lindenmaier & Budke, 2006).

Thus, phytosociological surveys provide relevant data on plant communities and also enable the verification of possible relationships between species (Silva, Costa, Santo Filho, Ferreira, & Brandão, 2002). In addition, these studies define ecological values of varied environments mainly for conservation of species diversity considering the different spatial scales (Gomes, Lenza, Maracahipes, Marimon, & Oliveira, 2011).

Given the above, this study conducted phytosociological surveys in two areas of Cerrado *stricto sensu* in the municipality of Porto Nacional, State of Tocantins, Brazil, aiming to understand the structure of these communities and expand the ecological information on these areas to support strategies of conservation and preservation.

Material and methods

Study areas

This study was carried out in two areas of Cerrado *stricto sensu*, Porto Nacional, State of Tocantins, Brazil. The field work was performed in 2015. The two areas studied were Fazenda Canaã and Fazenda Providência, located on private rural properties, but not used for agricultural purposes.

Fazenda Canaã (10°40'23,1"S and 48°20'54,3"W) is located 10 km from Porto Nacional, Fazenda Providência (10°33'31,2"S and 48°24'43,8"W) is located 18 km from Porto Nacional (Figure 1).

The region has two well-defined seasons, one rainy, from October to April, and one dry, from May to September (Ribeiro, Petrere Junior, & Juras, 1995). According to the same authors, the climate is tropical, with the lowest levels of rainfall occurring in September.

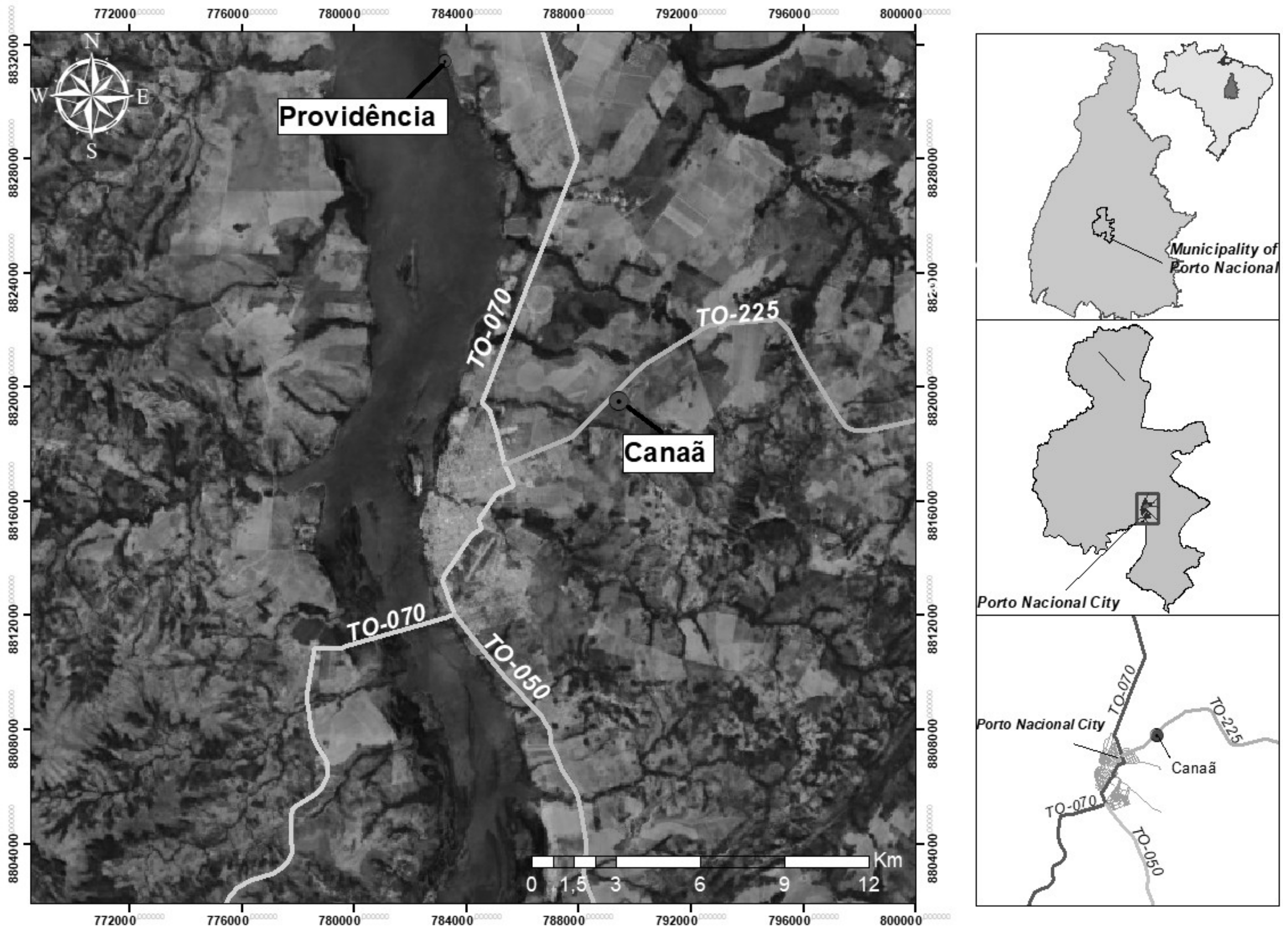

Figure 1. Location of study areas in the Cerrado *stricto sensu* in the municipality of Porto Nacional, State of Tocantins, 2015.

Phytosociological survey

For this study, 10 plots of 100 m² (10 x 10 m²) were assessed in each sampling area according to Dombois and Ellenberg (1974). Plot distribution was random. All individuals with circumference equal to or greater than 10 cm, at ground height (CGH), measured with the aid of a measuring tape, were sampled. The height (m) of all sampled individuals was estimated.

Individuals branched at the base of the ground were sampled when at least one of their branches met the inclusion criteria (CGH ≥ 10 cm) thus all branches were measured, including those that did not meet the inclusion criteria. In addition, dead standing woody individuals were also considered in the samples.

All individuals sampled were identified in the field, when it was not possible to identify, vegetative and/or reproductive materials were collected and sent to the Tocantins Herbarium (HTO) of the *Universidade Federal do Tocantins* - Campus of Porto Nacional. The botanical materials collected were herborized for later identification through comparisons with exsiccates already identified in the Tocantins Herbarium (HTO) and/or through consultations with specialized literature and experts.

The taxonomic names of the identified species were classified according to the Angiosperm Phylogeny Group IV (APG IV) classification system (APG, 2009). The scientific names of the species were corrected and checked by consulting the Brazilian Flora Species List (2015).

For soil analysis, samples were taken at a depth of 20 cm. Each sample was placed in transparent containers, identified and taken for analysis in the laboratory.

Data analysis

With the aid of the Fitopac 2 software (Shepherd, 2010) the following phytosociological parameters were calculated: Relative Density (DR), Relative Frequency (FR), Relative Dominance (DoR), Importance Value Index (IVI), Pielou Evenness (J') and Shannon-Wiener Index (H').

To analyze the vertical structure of the vegetation in the studied areas, histograms of heights were constructed at intervals of 1 meter for each class, with the maximum class of 9 m for Canaã and 8 m for Providência. In order to analyze stem circumference distribution, histograms were constructed at 10 cm intervals for each class, with a maximum of 110 cm for Canaã and 90 cm for Providência. The circumference distribution was made by histograms, stem circumference averages were obtained from the individuals branched at the base.

In order to check the intensity of the associations of the plots of the studied areas with the soil characteristics, an ordination diagram was constructed through the Canonical Correspondence Analysis (CCA) by the Past software (Hammer, Harper, & Ryan, 2001). The soil variables used were: Magnesium, Potassium, Aluminum, Sand, Organic Matter, Silt, Cation Exchange Capacity, Hydrogen potential and Clay.

Results and discussion

In Canaã, 379 individuals were sampled, 367 alive and 12 standing dead individuals, belonging to 28 families, 43 genera and 50 species. While in Providência, a smaller number of individuals and families were sampled, with a total of 300 living individuals belonging to 27 families and 49 species, and 44 genera were identified. The number of species and families observed in both areas was very close, however it was observed that these areas have only 36 species in common. Such observation evidences the high heterogeneity of the Cerrado, besides indicating the mosaic distribution of vegetation.

The most species-rich family was Fabaceae, which was already expected, as it has been considered as the richest in studies performed in cerrado *stricto sensu*, such as Marmontel, Delgado, and Santos (2014) in the Jequitinhonha Valley, State of Minas Gerais; Umetsu, Faria, and Corrêa Neto (2012) in Mirassol D'Oeste, State of Mato Grosso; Fernandes, Zoch, Mata, and Walter (2013) in the eastern portion of the Federal District; Pedreira, Alves, Lolis, and Viana (2011) in the Municipality of Porto Nacional, State of Tocantins; Costa, Cunha, and Costa (2010) in two areas in the northern portion of the State of Minas Gerais and Giácomo, Carvalho, Pereira, Souza, and Gaui (2013) at the Pirapitinga ecological station, State of Minas Gerais. According to Costa, Cunha, and Costa (2010) this family presented high phytosociological importance in their study in the Cerrado in the Pantanal do Poconé, State of Mato Grosso. Further, they have plasticity of habits and symbiosis with bacteria that facilitates the absorption of nitrogen (Souza, 2012).

The families Fabaceae and Apocynaceae were present in all sampled plots of the two areas, which is why they presented one of the highest relative frequencies and consequently the highest Importance Value Index (IVI).

There were no standing dead individuals in Providência, in contrast to Canaã (Table 1), where 12 individuals identified as standing dead were sampled. These were identified as a single group; it was among the ten highest values of importance (Figure 2 and Table 1). In the study by Fernandes et al. (2013), in a cerrado area in Planaltina, Federal District, the standing dead individuals also had the highest value of importance (46.18%). The number of standing dead individuals found in the present study in Canaã is lower than that observed by Medeiros and Walter (2012), which recorded 20 individuals in the cerrado stricto sensu in the Municipality Filadélfia, State of Tocantins. Due to this small number of dead individuals in Canaã and their absence in Providência, it is suggested that these communities have not been subjected to recent disturbances. The presence of many dead individuals in an area confirms the need for conservationist attitudes that prevent actions that cause disturbances in the community, such as the disposal of debris and fires (Assunção & Felfili, 2004).

Among the ten most abundant species observed in Canaã, we found *Qualea grandiflora*, *Myrcia splendens*, *Ouratea hexasperma*, *Rourea induta*, *Hancornia speciosa* (Table 1). While in Providência, the most abundant were *Erythroxyllum suberosum*, *Handroanthus ochraceus*, *Tocoyena formosa*, *Leptolobium dasycarpum*, *Hancornia speciosa* (Table 1). These species, both in Canaã and Providência, presented the highest Absolute Density and consequently the highest Relative Density (Table 1), which is associated with the largest number of individuals presented by these species.

Some of the most abundant species observed in this study were also found in other studies in the cerrado *stricto sensu* among the ten most abundant species, including *Qualea parviflora* found in Mirassol D'Oeste - MT (Umetsu et al., 2012) and in Pirapitinga - MG (Giácomo et al., 2013); *Qualea grandiflora* in Carbonita - MG (Santos, Marmontel, Martins, & Melo, 2010; Marmontel et al., 2014); *Hancornia speciosa* in Porto Nacional - TO (Pedreira et al., 2011). Similarities were observed in the two study areas as the most abundant species, among them *Rourea induta*, *Hancornia speciosa*, *Erythroxyllum suberosum*, *Diospiros hispida* and *Leptolobium dasycarpum*. Species with the greatest number of individuals may reflect a heterogeneous environment, leading to their dominance (Conceição & Castro, 2009).

The species that presented the highest Relative Density values in both areas were also observed in other phytosociological studies carried out in the cerrado *stricto sensu*, among them *Qualea grandiflora* in Carbonita - MG (Santos et al., 2010; Marmontel et al., 2014), *Qualea parviflora* in Filadélfia - TO (Medeiros & Walter, 2012) and *Salacia crassifolia* in the rupestrian cerrado at the Serra de Caldas Novas State Park - GO (Lima, Pinto, Lenza, & Pinto 2010). Values of Density of species found in the two communities studied are of great importance for the understanding of their structure, since Santos et al. (2010) consider this index to be responsible for measuring the degree of participation of plant species in a particular community.

Species with the highest Relative Frequency values recorded in Canaã were *Hancornia speciosa*, *Qualea grandiflora*, *Erythroxyllum suberosum*, *Rourea induta*, *Diospiros hispida* and *Psidium myrtoides* (Table 1). And in Providência were *Hancornia speciosa*, *Leptolobium dasycarpum*, *Erythroxyllum suberosum*, *Tocoyena formosa*, *Handroanthus ochraceus* and *Rourea induta* (Table 1). Comparing the data from this study with Mews, Marimon, Maracahipes, Franczak, & Marimon-Junior (2011) in typical cerrado in Nova Xavantina – MT, the authors sampled a lower frequency for *Qualea parviflora* and *Davilla elliptica*, and higher frequency for *Qualea grandiflora*, *Connarus suberosus*, *Erythroxyllum suberosum*, *Leptolobium dasycarpum*, *Rourea induta*, *Casearia sylvestris* and *Tocoyena formosa*.

The ten species with the highest Relative Dominance in Canaã include *Caryocar brasiliense*, *Qualea grandiflora*, *Hancornia speciosa*, *Myrcia splendens*, Dead Species (Table 1). In Providência, include *Hancornia speciosa*, *Anacardium occidentale*, *Caryocar brasiliense*, *Vochysia rufa*, *Leptolobium dasycarpum* (Table 1). These values were higher than those reported by Lima et al. (2010) in the rupestrian cerrado at the Serra de Caldas Novas State Park – GO for *Qualea grandiflora*, *Hancornia speciosa*, *Leptolobium dasycarpum*, *Vochysia rufa* and *Handroanthus ochraceus*, *Ouratea hexasperma* and *Caryocar brasiliense*, and these last two species, in Providência, presented lower values. Medeiros and Walter (2012) in the cerrado stricto sensu in Filadélfia - TO found higher values for *Qualea parviflora* and lower values for *Diospiros hispida*, *Handroanthus ochraceus*, *Erythroxyllum suberosum*, *Leptolobium dasycarpum* and *Dimorphandra. mollis*. Giácomo et al. (2013) in areas of grassland with scattered bushes and trees "campo sujo" and cerrado *stricto sensu* in Morada Nova de Minas - MG, found lower values for dead individuals, *Leptolobium dasycarpum*, *Qualea grandiflora*, *Hancornia speciosa*, *Erythroxyllum suberosum*, *Caryocar brasiliense* and *Handroanthus ochraceus*, the latter species presented a higher value than the one found in Canaã; and *Qualea parviflora* presented a higher value than the one calculated in Canaã and Providência.

Some of the species with the highest values of importance in Canaã were *Qualea grandiflora*, *Hancornia speciosa*, *Caryocar brasiliense*, *Myrcia splendens*, *Ouratea hexasperma* and others (Table 1). In Providência, they were *Hancornia speciosa*, *Erythroxyllukm* suberosum, *Tocoyena formosa*, *Leptolobium dasycarpum*, *Handroanthus ochraceus* (Table 1). Some of these species were also the most important in studies already conducted in the cerrado *stricto sensu*, such as *Qualea grandiflora*, *Caryocar brasiliense* in Carbonita - MG (Marmontel et al., 2014); as *Qualea parviflora* in Grão Mogol - MG (Costa, Cunha, & Costa, 2010); in Filadélfia - TO (Medeiros & Walter, 2012) and in the typical cerrado in Nova Xavantina - MT (Mews et al., 2011).

Some species were observed in few plots (Table 1), but they presented many individuals indicating an aggregate distribution. In Canaã, the species that presented this trend were *Xylopia aromatica, Simarouba versicolor* and *Hymenaea stigonocarpa*. While in Providência, they were *Erythroxyllum deciduum, Salacia crassifolia* and *Cybistax antisyphilitica.*

Table 1. Phytosociological parameters of two areas of Cerrado stricto sensu located in Porto Nacional, State of Tocantins. DR (%): Relative Density; FR (%): Relative Frequency; DoR (%): Relative Dominance and IVI: Importance Value Index.

Espécies	Canãa				Providência			
	DR	FR	DoR	IVI	DR	FR	DoR	IVI
Qualea grandiflora Mart.	9.76	5.29	10.24	25.29				
Hancornia speciosa Gomes	4.75	5.88	8.34	18.98	5.00	7.04	20.72	32.76
Caryocar brasiliense Cambess.	1.85	1.76	13.62	17.23	0.67	0.70	4.54	5.91
Myrcia splendens (Sw.) DC.	7.12	2.35	7.10	16.58	1.67	1.41	1.23	4.31
Ouratea hexasperma (A.St.-Hil.) Baill.	6.86	2.94	4.57	14.37	0.67	0.70	0.25	1.62
Standing dead trees	3.17	3.53	7.06	13.76				
Rourea induta Planch.	5.54	4.12	2.52	12.18	5.00	4.23	3.03	12.26
Diospyros hispida A.DC.	4.22	4.12	3.68	12.02	4.00	3.52	2.12	9.64
Qualea parviflora Mart.	3.43	3.53	4.95	11.91	2.00	2.82	2.38	7.20
Erythroxylum suberosum A.St.-Hil.	4.49	4.71	1.70	10.89	9.33	5.63	4.24	19.20
Leptolobium dasycarpum Vogel	3.43	3.53	3.44	10.39	5.33	6.34	4.27	15.94
Vatairea macrocarpa (Benth.) Ducke	3.43	3.53	2.10	9.06	0.33	0.70	0.16	1.20
Psidium myrtoides O.Berg	2.11	4.12	2.52	8.75	1.67	2.11	0.40	4.18
Curatella americana L.	1.58	2.35	4.14	8.07	0.33	0.70	0.14	1.18
Connarus suberosus Planch.	2.90	2.35	2.43	7.69	1.33	2.82	0.98	5.13
Cenostigma macrophyllum Tul.	3.96	1.76	1.86	7.59				
Davilla elliptica A.St.-Hil.	2.37	3.53	1.56	7.47				
Eriotheca gracilipes (K.Schum.) A.Robyns	1.32	2.35	2.25	5.92	0.67	1.41	0.56	2.63
Tocoyena formosa (Cham. & Schltdl.) K.Schum.	1.58	2.94	0.96	5.48	7.67	5.63	2.84	16.14
Lafoensia pacari A.St.-Hil.	2.64	1.76	0.90	5.30	0.33	0.70	1.52	2.56
Salacia crassifolia (Mart. ex Schult.) G.Don	1.32	2.94	0.39	4.65	3.33	2.11	2.71	8.15
Couepia grandiflora (Mart. & Zucc.) Benth.	1.58	2.35	0.56	4.50	0.67	1.41	0.57	2.65
Schefflera macrocarpa (Cham. & Schltdl.) Frodin	1.85	1.18	1.22	4.24				
Dimorphandra mollis Benth.	1.32	2.35	0.50	4.18	2.33	2.11	3.17	7.62
Xylopia aromatica (Lam.) Mart.	1.32	0.59	2.18	4.09	0.67	0.70	0.18	1.55
Heteropterys byrsonimifolia A.Juss.	1.32	1.76	0.47	3.55	2.67	2.11	2.44	7.22
Anacardium occidentale L.	1.58	1.18	0.65	3.41	1.33	2.11	5.99	9.44
Himatanthus obovatus (Müll. Arg.) Woodson	0.53	1.18	1.66	3.36	0.67	1.41	0.46	2.54
Annona coriacea Mart.	1.06	1.76	0.30	3.12	0.33	0.70	0.10	1.14
Simarouba versicolor A.St.-Hil.	2.11	0.59	0.35	3.05	0.33	0.70	0.53	1.57
Casearia sylvestris Sw.	1.06	1.76	0.17	2.99	2.33	3.52	1.16	7.02
Handroanthus ochraceus (Cham.) Mattos	0.79	1.76	0.36	2.92	8.00	4.23	3.61	15.84
Hymenaea stigonocarpa Mart. ex Hayne	0.79	0.59	1.50	2.88				
Bowdichia virgilioides Kunth	0.53	1.18	0.70	2.41				
Miconia albicans (Sw.) Triana	0.79	1.18	0.25	2.21	1.00	1.41	0.46	2.87
Aspidosperma nobile Müll.Arg.	0.53	1.18	0.38	2.08				
Vochysia rufa Mart.	0.53	1.18	0.18	1.88	3.00	2.82	4.37	10.18
Kielmeyera coriacea Mart. & Zucc.	0.53	1.18	0.17	1.88	0.33	0.70	0.22	1.26
Maprounea guianensis Aubl.	0.53	1.18	0.07	1.78	0.67	1.41	0.27	2.35
Erythroxylum deciduum A.St.-Hil.	0.26	0.59	0.55	1.40	4.67	2.11	1.98	8.76
Pterodon emarginatus Vogel	0.53	0.59	0.23	1.34				
Astronium fraxinifolium Schott	0.53	0.59	0.12	1.24				
Aspidosperma macrocarpon Mart.	0.26	0.59	0.23	1.08				
Byrsonima crassifolia (L.) Kunth	0.26	0.59	0.21	1.06	1.67	2.11	0.49	4.27
Pouteria ramiflora (Mart.) Radlk.	0.26	0.59	0.19	1.05	0.33	0.70	0.11	1.15
Andira cujabensis Benth.	0.26	0.59	0.16	1.01	2.33	1.41	2.59	6.33
Guapira noxia (Netto) Lundell	0.26	0.59	0.14	1.00				
Byrsonima coccolobifolia Kunth	0.26	0.59	0.07	0.92	0.67	1.41	1.10	3.18
Andira sp.	0.26	0.59	0.05	0.90	0.33	0.70	0.85	1.89
Casearia arborea (Rich.) Urb.	0.26	0.59	0.03	0.88				
Vellozia squamata Pohl					4.00	2.82	1.33	8.14
Tabebuia aurea (Silva Manso) Benth. & Hook.f. ex S.Moore					2.33	2.11	3.30	7.75
Cybistax antisyphilitica (Mart.) Mart.					1.67	0.70	3.00	5.37
Handroanthus serratifolius (Vahl) S.Grose					2.00	2.11	0.90	5.01
Plathymenia reticulata Benth.					1.00	1.41	2.25	4.66
Tachigali vulgaris L.G.Silva & H.C.Lima					1.00	1.41	1.78	4.19
Stryphnodendron adstringens (Mart.) Coville					1.00	1.41	1.51	3.91
Salvertia convallariodora A.St.-Hil.					1.00	1.41	1.35	3.76
Palicourea rigida Kunth					1.00	1.41	0.49	2.90
Annona crassiflora Mart.					0.67	1.41	0.28	2.35
Terminalia argentea Mart.					0.33	0.70	0.60	1.64
Alibertia edulis (Rich.) A.Rich.					0.33	0.70	0.45	1.49

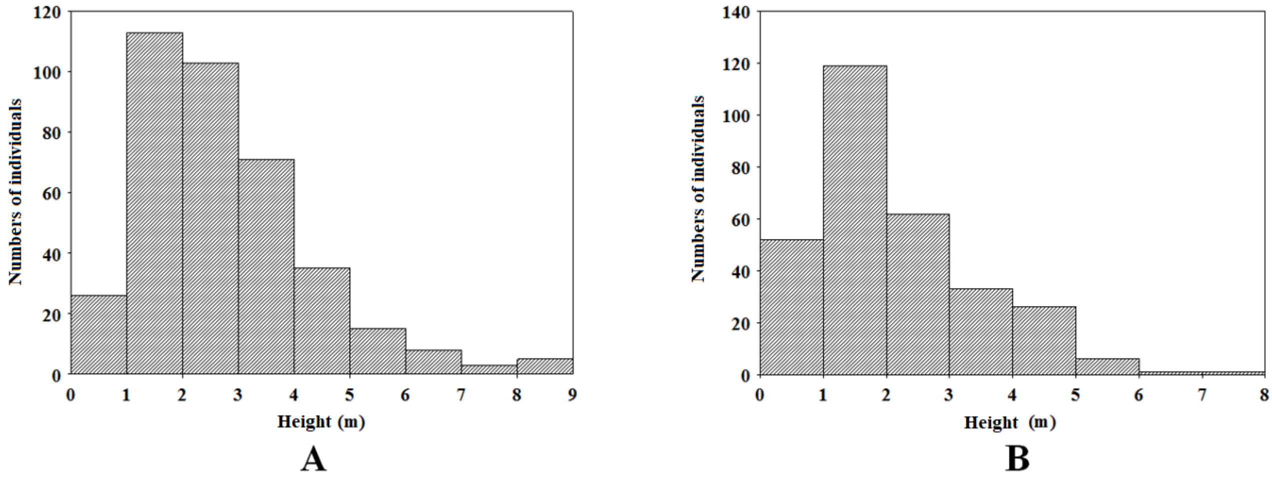

Figure 2. Histogram of height classes of individuals with interval of 1 m, in an area of cerrado *stricto sensu* in Fazenda Canaã (A) and Fazenda Providência (B), Porto Nacional, State of Tocantins.

The Shannon-Wiener Diversity Index (H') calculated for Canaã was 3.48 and for Providência, 3.45. These values were close, but were higher than those found in studies performed in the cerrado *stricto sensu* in other states and lower than those found in other studies in the same phytophysiognomy in the State of Tocantins (Table 2). This shows the high diversity of species present in the cerrado of Tocantins.

Table 2. Comparison between studies performed in the states of Mato Grosso (MT), Tocantins (TO) and Minas Gerais (MG) with the present study in relation to the Shannon Diversity (H') and Pielou Evenness (J').

Authors	Study area	Phytophysiognomy	Shannon Diversity (H')	Pielou Evenness (J')
Umetsu et al. *(*2012)	Mirassol D'Oeste – MT	cerrado *stricto sensu*	3.20	0.91
Medeiros and Walter (2012)	Filadélfia - TO	cerrado *stricto sensu*	3.32	0.83
Marmontel et al*.,* 2014	Carbonita – MG	cerrado *stricto sensu*	2.5	-
Ferreira, Camargo, Souza, & Andrade, 2015	Gurupi – TO	cerrado *stricto sensu*	3.70	0.80
Pedreira et al., 2011	Porto Nacional - TO	cerrado *stricto sensu*	3.687	0.871
Presente estudo/ Canaã	Porto Nacional – TO	cerrado *stricto sensu*	3.48	0.89
Presente estudo/ Providência	Porto Nacional – TO	cerrado *stricto sensu*	3.45	0.89

The Pielou Evenness (J') for the two areas were equal to 0.89 (Table 2). This value was higher than that found in some studies in the same phytophysiognomy in the State of Tocantins (Table 2). The calculated Evenness (J') values in this study were high and close to one, a result close to that reported by Umetsu et al. (2012), which calculated the Evenness (J') value of 0.91 in Mirassol D'Oeste, State of Mato Grosso, being superior, but close to that of the present study. Values of Evenness (J') close to unity show that areas have individuals with uniform distribution in their abundance (Umetsu et al., 2012).

Regarding the height of the individuals sampled in Canaã, one standing dead individual and three individuals of *Caryocar brasiliense* presented the highest heights with nine meters. The species with the lowest height was *Lafoensia pacari* with 0.46 m (Figure 2A). While in Providência area, the tallest individual was *Tachigali vulgaris* with eight meters and the individual with the lowest height belongs to *Tocoyena formosa* species, with 0.29 m (Figure 2B). The highest height value found in this study is lower than that reported by Reys et al. (2013), who found a maximum height of 12 m in the cerrado *stricto sensu* in Itirapina - SP. The average height values calculated for Canaã (2.92 m) and for Providência (2.29 m) were lower than those found by Fina and Monteiro (2013) in the cerrado *stricto sensu* in Aquidauana - MS, which found an average of 4.01 m.

Figure 2 shows the number of individuals in the Canaã area grouped into nine height classes (0-1 m, 1-2 m, 2-3 m, 3-4 m, 4-5 m, 5-6 m, 6-7 m, 7-8 m, 8-9 m). It is observed the concentration of individuals with lower heights grouped in the following classes: second (1 to 2 m), third (2 to 3 m) and fourth (3 to 4 m). Figure 3 shows the individuals in the Providência area distributed in eight height classes (0-1 m, 1-2 m, 2-3 m, 3-4 m, 4-5 m, 5-6 m, 6-7 m, 7-8 m). The largest numbers of individuals are concentrated in the first three classes, which are: the first (0 to 1 m), second (1 to 2 m) with the highest number of individuals and the third (2 to 3 m). After the first classes with higher density concentrations, there was a decrease in the number of individuals as the classes increased. Given this, it can be said that a great part of this plant community is composed of low height individuals in relation to this phytophysiognomy. It is important to emphasize that the presence of small to medium sized trees with tortuous stems is a typical feature of the Cerrado vegetation (Ferreira, Camargo, Souza, & Andrade, 2015).

As for the individual that presented the largest circumference in Canaã, it was a dead individual with 109 cm circumference. Followed by an individual of *Caryocar brasiliense* with 103 cm. The individuals with the lowest CGH were *Cenostigma macrophyllum* and *Hancornia speciosa*, with an average CGH of their branches of 7.33 cm. The average area was 24.31 cm. In Providência, *Caryocar brasiliense* presented the largest CGH with 90 cm and *Pouteria rigida* presented the lowest value, with an average CGH of its branches of 7.43 cm. The average area was 19.11 cm.

Figure 3A illustrates the density of individuals in the Canaã area distributed in 11 classes of circumferences and Figure 3B shows the density of individuals in Providência in nine classes. It is observed that the two areas have a similar shape in the structure of the circumference of the community, since there was the highest density of individuals in the lower classes: in the second (10 to 20 cm) and in the third class (20 to 30 cm). After these, there was a decrease with increasing classes until reaching the lowest density in the highest class, typical of a *reverse* J-shaped *curve* (Souza, Souza, & Meira Neto, 2012). Some studies conducted in the cerrado *stricto sensu* also observed the same trend in the diameter distribution of the community (Giácomo et al., 2013), (Fina & Monteiro, 2013).

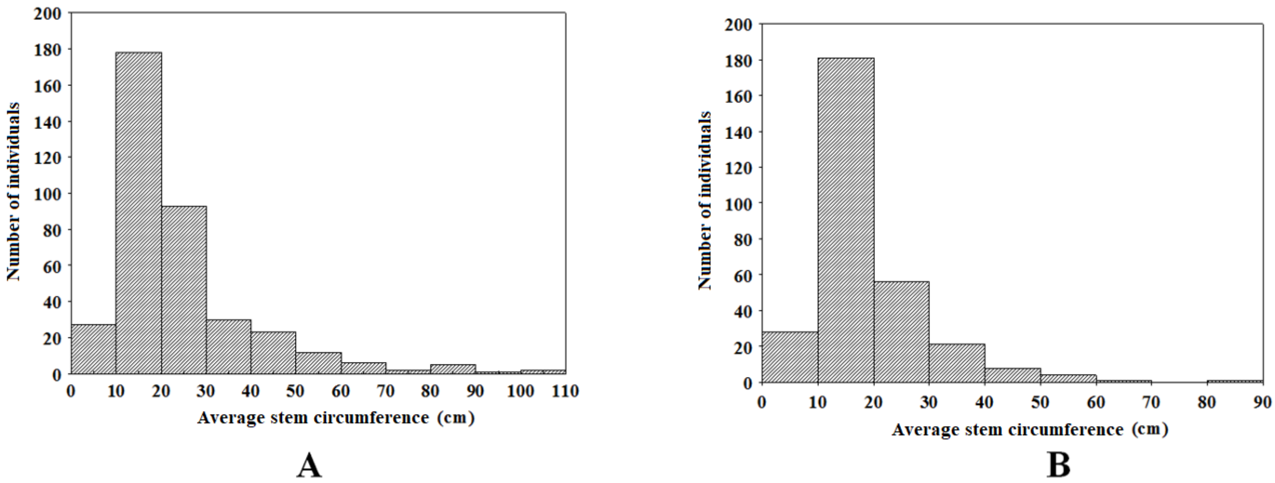

Figura 3. Histogram of average stem circumference classes of individuals with 10 cm-interval, in an area of cerrado *stricto sensu* in Fazenda Canaã (A) and Fazenda Previdência (B) Porto Nacional, State of Tocantins.

The large number of individuals grouped in the lower classes is a characteristic of a stock-community (Souza et al., 2012). Moreover, this characteristic suggests that the studied plant community is in a regeneration stage, and is quite common the observation of this characteristic in the cerrado *stricto sensu*, which can be considered as a common pattern in this phytophysiognomy (Fina & Monteiro, 2013).

Canonical Correspondence Analysis (CCA) evidenced significant scores for the first axes ($p < 0.05$) according to the Monte Carlo test, which explained 70% of the total data variability. The variables with the highest structure coefficient on axis 1 were clay (0.94), pH (0.62) and magnesium (-0.32). These variables show a differentiation of the study areas; on the left are the portions of the cerrado *stricto sensu* located in Canaã, with the highest values of Magnesium; on the right, the cerrado area of Providência with higher values of clay and soil pH. In axis 2, the most important variables were Aluminum (0.29), silt (0.25) and potassium (-0.078), concentrating the Canaã plots in the upper portion of the diagram with the highest values of aluminum, silt and potassium in the soil (Figure 4). Some of these variables influenced the separation of plots from other studies performed in the cerrado *stricto sensu*, such as in the study of Moura Klein, Felfili, and Ferreira (2007) in Pirenópolis, State of Goiás, where the authors observed that the soil characteristics strongly correlated with the distribution of the plots was sand, silt, organic matter and iron, separating this plot from the others. Reys et al. (2013) in Itirapina, State of São Paulo, also registered the association of some plots with the largest canopy opening and higher pH, forming a group, and another associated with a larger amount of aluminum and organic matter. The results found in the present study corroborate those reported by Moura et al. (2007) in the cerrado stricto sensu in Pirenópolis, State of Goiás, where they stated that soil properties may influence the variation of plant structure in the studied areas.

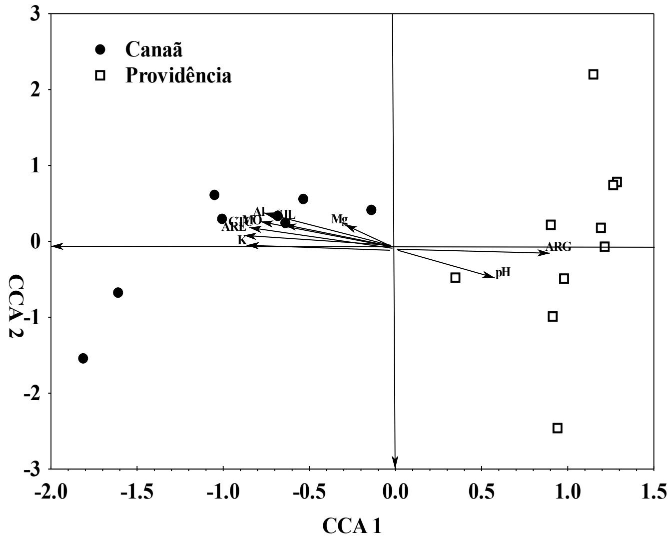

Figure 4. Canonical Correspondence Analysis (CCA) diagram of two areas of cerrado *stricto sensu* in the municipality of Porto Nacional, State of Tocantins, 2015. Magnesium =Mg; Potassium = K; Aluminum = AL; Sand = ARE; Cation exchange capacity = C02; Potential of Hydrogen = pH; Clay =ARG.

Conclusion

The studied areas have typical characteristics of the cerrado *stricto sensu* physiognomy, since a large part of the plant community is small to medium sized. In addition, the diameter structure shows that the studied areas are in the regeneration stage, suggesting that they should be conserved and preserved.

The soil variables clay, pH, magnesium, aluminum, silt and potassium evidenced a differentiation in the study areas.

The number of species identified in the two study areas studied was close, and 36 identified species were common to both areas.

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