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Richness and similarity of the Cerrado vascular flora in the central west region of São Paulo state, Brazil

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Abstract: This study aims to characterize and compare three *Cerrado* areas (one *cerradão* and two *cerrado sensu stricto* areas) in Patrânia, São Paulo state, southeastern Brazil, concerning the floristic composition. In total, 250 taxa were found belonging to four species of pteridophytes, one species of an exotic gymnosperm and 243 species of angiosperms. Differences in species number and proportion of the woody and herbaceous components were observed among the three *Cerrado* areas. The similarity analysis revealed that the *cerradão* seems quite peculiar, showing low similarity level with the *cerrado sensu stricto* areas contiguous to it, being more similar to other *cerradão* areas located in nearby municipalities.

Introduction

According to Coutinho (1978, 2002), the *Cerrado* (Brazilian savanna) is a vegetation complex encompassing a series of physiognomies from open grasslands (*campo limpo*) to dense woodlands (*cerradão*) and three intermediate physiognomies (*campo sujo*, grasslands with a scattering of shrubs and small trees; *campo cerrado*, grasslands with more shrubs and trees; and *cerrado sensu stricto*, where trees and shrubs dominate but with a fair amount of herbaceous vegetation).

The *Cerrado* presents great diversity of plant species, and in this biome the occurrence of 385 species of pteridophytes and 11,242 species of phanerogams was registred until this moment (Mendonça *et al.* 2008). This high number of species seems to be related to the wide range of environmental conditions present at the *Cerrado* due to its large area, covering about 25% of Brazil surface (MMA 2009). The environmental diversity that is associated with different physiognomic vegetation in this domain provides a wide variation in the total floristic composition.

Among the several floristic surveys conducted to date in the *Cerrado* remnants of São Paulo state, southeastern Brazil, there is a predominance of inventories encompassing only the woody vegetation, and few studies cover all plant habits. Considering studies that include all plant habits some research previously done in the Pratânia municipality can be highlighted (Machado *et al.* 2005; Carvalho *et al.* 2010), as well as in other municipalities in the region, such as Águas de Santa Bárbara (Meira Neto *et al.* 2007), Assis (Durigan *et al.* 1999) and Botucatu (Gottsberger and Silberbauer-Gottsberger 2006; Ishara *et al.* 2008).

In recent years the *Cerrado* suffered intense destruction in São Paulo state leading to such reduction that this vegetation now occupies less than 1% of the original area (SMA 2010). Hence, studies that provide additional information about the floristic heterogeneity and physiognomic diversity become very important because they can support future actions of management, restoration and conservation in the *Cerrado* region, also expanding knowledge about these different physiognomies.

Therefore, the purpose of this study was to analyze the floristic composition of three different *Cerrado* physiognomies in the Pratânia municipality, Central West region of São Paulo state, Southeastern Brazil, aiming to answer the following questions: 1) Is there variation in species composition among the studied physiognomies? 2) Are there differences in the proportional distribution of the plants habit in the three areas of study? 3) Are there species characteristic of each physiognomy? 4) Are there similarities between the studied areas when compared with other *Cerrado* areas in the same region?

Materials and Methods

The study was carried out at the Fazenda Palmeira da Serra, in a *Cerrado* fragment (ca. 176 ha) located in Patrânia, SE Brazil (22°48' S, 48°44' W: 714–753 m a.s.l.; Figure 1). The regional climate is Cwa (humid temperate climate with dry winter and hot summer) according to Köppen classification. Average annual temperature is 20.8°C and average annual precipitation is 1453.6 mm (CEPAGRI 2010). The soil types found in Pratânia are Red-Yellow Latosol and Red Latosol (Oliveira *et al.* 1999).

Three areas were selected in the fragment of *Cerrado*, that is, one area of *cerradão* and two areas of *cerrado sensu stricto* (named in this study as *cerrado sensu stricto* I and II). The studied fragment is surrounded by pastures and plantations of sugarcane, *Eucalyptus* and *Citrus*.

The location and general characterization of the three studied areas of *Cerrado* were made as a profile diagram considering the altitude, the density and the average height of woody plants present in each area.

The floristic survey was carried out from September 2007 to December 2009, by collecting on a weekly basis in the first two years and then monthly, vascular plants in

reproductive phase preferably. These plants were sampled by the pathway method in the three physiognomies of *Cerrado*, which together make approximately 3 ha of study area.

Species of all habits were included in the survey, following the general descriptions contained in Durigan *et al.* (1999) and Gill and Lorenzi (2007), with some adjustments, as follows: (a) tree: woody plant with branches at 50 cm above the ground level and more to 1 m height; (b) shrub: woody plant with branches emerging from the base of the trunk and larger than 1 m height; (c) subshrub: small woody plant with less than 1 m height; (d) herb: non-woody plant of small size; (e) vine: woody or non-woody plant whose stem requires support, climbing on other plants or substrate; (f) epiphyte: plant which grows on another plant or on some mechanical support to obtain light, but that is not a parasite; (g) hemiparasite: plant which grows on another plant where it penetrates feeder roots to obtain water and salts.

The botanical material was herborized and voucher specimens were deposited in the Herbarium "Irina Delanova Gemtchújnicov" (BOTU), Instituto de Biociências de Botucatu, UNESP. The species identification was performed using specialized bibliography, as well as comparison with specimens of the Herbarium BOTU and UNBA (UNESP, Bauru) and virtual international herbaria through the worldwide web.

The floristic list was compiled in accordance with the classification system based on APG II (2003) for angiosperms and on Tryon and Tryon (1982) for pteridophytes, being the species names and authors confirmed and updated after Mendonça *et al.* (2008), the Missouri Botanical Garden (2010) and The International Plant Names Index (2010).

To analyze the floristic similarity between the three studied areas and other *Cerrado* areas located at the São Paulo state (Table 1), a presence/absence matrix was prepared including all species. The cluster analysis was performed using the Jaccard Index of Similarity (Mueller-Dombois and Ellenberg 1974) and the UPGMA algorithm (Sneath and Sokal 1973) being processed by the BioDiversity Professional Program (McAleece 1997).

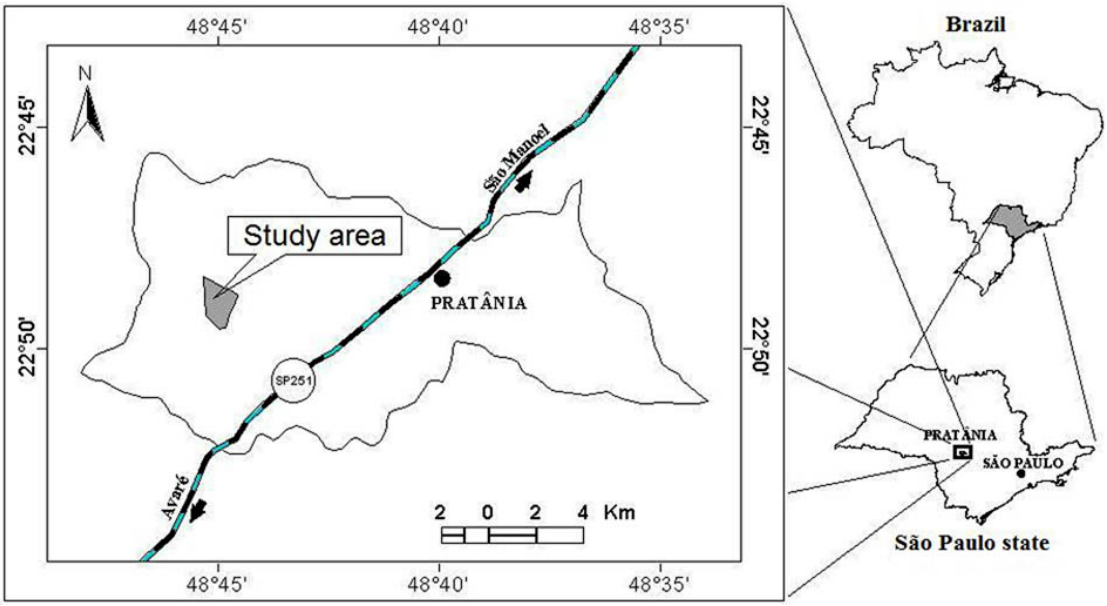

Figure 1. Location of the study area of Cerrado in the Pratânia municipality, São Paulo state, Brazil.

Table 1. *Cerrado* areas of São Paulo state compared with the three studied areas in Pratânia municipality, SP, Brazil.

CODE	STUDY SITE	ALTITUDE (M)	PHYSIOGNOMY	REFERENCE
PRAT_C	Pratânia	742	*cerradão*	Present study
PRAT_SS I	Pratânia	725	*cerrado sensu stricto* I	Present study
PRAT_SS II	Pratânia	718	*cerrado sensu stricto* II	Present study
ASB_1	Águas de Santa Bárbara	600-680	*cerrado sensu stricto*	Meira Neto *et al.* (2007)
ASB_2	Águas de Santa Bárbara	600-680	*cerradão*	Meira Neto *et al.* (2007)
AGUD	Agudos	550	*cerrado sensu stricto*	Bertoncini (unpublished data)
ASS_1	Assis	520-590	*cerrado sensu stricto*	Durigan *et al.* (1999)
ASS_2	Assis	520-590	*cerradão*	Durigan *et al.* (1999)
BAUR	Bauru	580	*cerradão*	Faraco (unpublished data)
BTU_1	Botucatu	500	*cerradão*	Bicudo (unpublished data)
BTU_2	Botucatu	550	*cerrado sensu stricto*	Gottsberger and Silberbauer -Gottsberger (2006)
BTU_3	Botucatu	830	*cerrado sensu stricto*	Ishara *et al.* (2008)
PRAT	Pratânia	720	*cerrado sensu stricto*	Carvalho *et al.* (2010)
SRPQ	Santa Rita do Passa Quatro	600	*cerrado sensu stricto*	Weiser and Godoy (2001)

Species with incomplete identification or recorded in a single location were excluded, according to the methodology described in Ratter *et al.* (2003).

Results and Discussion

The studied *Cerrado* remnant comprises three adjacent areas that differ mainly on the floristic composition, density and height of the woody plants (Figure 2). In the study area a total of 250 taxa were registered. Four species of pteridophytes belonging to two families, one species of exotic gymnosperm and 243 species of Angiosperms, plus two varieties, all distributed in 64 families, were found (Table 2).

According to Ribeiro and Walter (2008) classification for the *Cerrado* physiognomies, in the studied fragment the two *cerrado sensu stricto* areas can be recognized as *cerrado denso* (*cerrado sensu stricto* I) and *cerrado típico* (*cerrado sensu stricto* II), both subtypes of *cerrado sentido restrito*. In the present study the Coutinho (1978, 2002) classification was adopted to allow a more accurate basis in the similarity analysis performed in this study.

Considering the total flora and only the specimens with complete identification, about 94% of the registered species have been already quoted in the inventory of the vascular flora of the *Cerrado* biome (Mendonça *et al.* 2008), and 50% were recognized as belonging to the flora of shrubs and trees reported for the Médio Paranapanema region in São Paulo state (Durigan *et al.* 2004), where the study area is located. A great floristic richness was found and the total of species was significantly higher than that obtained in previous surveys, conducted in the same remnant, encompassing the various physiognomies of the local (Machado *et al*. 2005) or considering only one of the areas of *cerrado sensu stricto* (Carvalho *et al.* 2010). Comparing the total number of species obtained in the present study and the two previous surveys, 81 new species (34.47%) were recorded. Besides, the identification of 12 specimens was possible only to genus level and other one only to family level. Thus, it is possible that an increase occurs in the number of new records for the area.

In the *cerradão* area 52 families were recorded and Myrtaceae (13 species) and Fabaceae (11) were the richest families. In the area of *cerrado sensu stricto* I, 51 families were recorded and among the richest are Fabaceae (25 species), Asteraceae (20), Myrtaceae (13) and Malpighiaceae (10). In the *cerrado sensu stricto* II fewer families (44) were recorded, and the richest were Myrtaceae (15 species), Fabaceae (14) and Asteraceae (12). These families were also the richest in other areas of *cerrado sensu stricto* in Agudos (Bertoncini unpublished data), Botucatu (Ishara *et al.* 2008) and Pratânia (Carvalho *et al.* 2010).

In relation to the proportional distribution of plant habits in the three areas, in the *cerradão* the woody component was predominant (75.83% distributed in 52.50% for trees and 23.33% for shrubs), as well as in the other physiognomies, but in a smaller proportion (*cerrado sensu stricto* II: 57.14%, with 28.57% for trees and 28.57% for shrubs; and *cerrado sensu stricto* I: 52.98% with 23.81% for trees and 29.17% for shrubs). The herbaceous component (subshrubs + herbs + vines + epiphytics + hemiparasites) occurred in greater proportion in the *cerrado sensu stricto* I (47.02%) followed by the *cerrado sensu stricto* II (42.86%), while in the *cerradão* the proportion was only 24.17%. The predominance of woody species in the *cerradão* is consistent with the general characterization of this forest *cerrado* physiognomy (Coutinho 1978). The proportion of vegetation components in the two areas of *cerrado sensu stricto* was similar, with a more equilibrated representation of both woody and herbaceous strata, which is a characteristic of savanna formations that represent the transitional ecotones *cerradão-campo* in

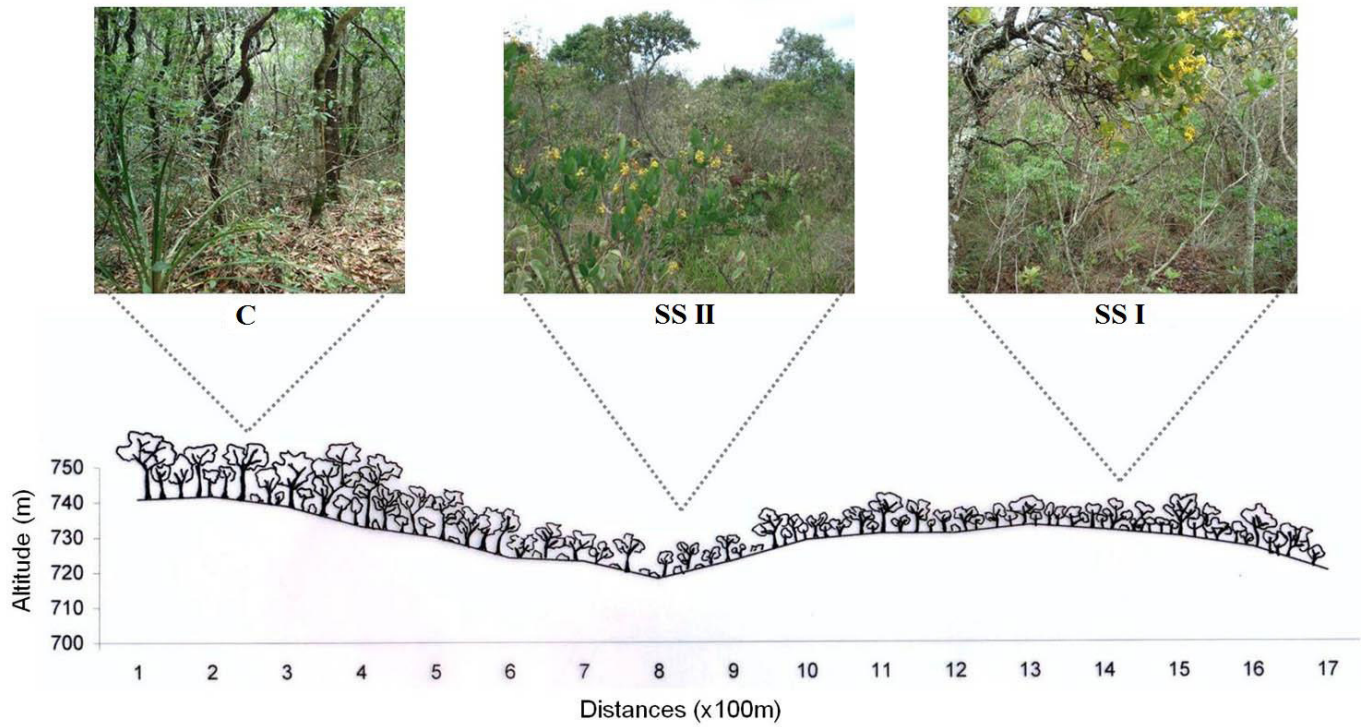

Figure 2. Profile diagram of the *Cerrado* area in the Pratânia municipality, SP, and interior details of the *cerradão* (C), *cerrado sensu stricto* I (SS I) and *cerrado sensu stricto* II (SS II). Diagram with vertical exaggeration of four times.

the *Cerrado* domain (Coutinho 1978). The proportion of species of the woody component to the herbaceous component was 1:0.3 in *cerradão*, 1:0.9 in *cerrado sensu stricto* I and 1:0.8 in *cerrado sensu stricto* II. Considering the fragment as a whole, this relationship would be 1:0.9, which is smaller than the ratio found in other studies involving various physiognomies of *Cerrado*, such as 1:2 in Santa Rita do Passa Quatro (Batalha and Mantovani 2001) and 1:3 in Moji Guaçu (Mantovani and Martins 1993). The existence of more open physiognomies with higher number of herbaceous species in these other localities can explain the numerical differences observed. In areas of *cerrado sensu stricto* a ratio of 1:0.8 was registered in Agudos (Bertoncini unpublished data) and 1:1 in Santa Rita do Passa Quatro (Weiser and Godoy 2001).

In relation to floristic richness, the *cerrado sensu stricto* I had the greatest number of species (168), of which 58 (35%) were exclusive to this physiognomy in relation to the rest of the fragment. Among the 120 species recorded in the *cerradão*, 48 (40%) were exclusive, while the *cerrado sensu stricto* II had the lowest number of species (119), and only 21 of them (18%) were exclusive to this area. According to the concept of forest-ecotone-field, the *cerrado sensu stricto* would present a highest number of species because it has elements of both forest and grassland (Coutinho 1978). In the study area, the lowest richness was observed in the *cerrado sensu stricto* II and this would be probably the result of major impacts that occurred in the past such like the invasion by cattle from adjacent pastures, and other human activities. Another aspect to be considered is related to the soil characteristics in each physiognomy that can be associated to floristic variation (Oliveira-Filho and Ratter 2002). Although this area is currently in process of natural regeneration, it still has the physiognomy and floristic composition different from the other two areas analysed.

Several species present in the fragment are commonly cited as weeds in agricultural areas (Lorenzi 2008; Mendonça *et al.* 2008). In the two *cerrado sensu stricto* areas a high number of invasive species was registered, being 27 in the *cerrado sensu stricto* I and 23 in *cerrado sensu stricto* II, while in the *cerradão* only 12 weeds were collected (Table 2). This indicates that the whole fragment has suffered from anthropogenic interference, especially due to its proximity to agricultural areas and pastures. This fact is also evidenciated by the presence of *Pinus palustris* which arrived in the area probably through wind dispersed seeds from cultivated trees present in the neighbourhood. In addition, seven species occurring frequently in the fragment - *Andira humilis*, *Annona coriacea*, *Arrabidaea brachypoda*, *Arrabidaea florida*, *Byrsonima intermedia*, *Dimorphandra mollis* and *Duguetia furfuracea* – which although typical of the *Cerrado*, are frequently cited as invasive species (Lorenzi 2008) in areas where the original *Cerrado* vegetation was removed to the introduction of crops or pasture. So, these species can be considered as potencially invasive species, in an agricultural concept, in areas previously occupied by *Cerrado*. The high frequency of these species can also be an indication of the occurrence of past disturbances allowing the increase of these more resilient *Cerrado* species.

Some threated species in the São Paulo state, according to the Resolution 48 (SMA 2004), were also registered in the fragment: *Pouteria subcaerulea* (*cerrado sensu stricto* I) and *Psychotria capitata* (*cerradão*), and *Bowdichia virgilioides* (*cerradão* and *cerrado sensu stricto* I) were considered vulnerable species. This supports the importance of conservation of other areas than those of Conservation Units (UC), inasmuch as they can complement the strategies for the biodiversity conservation in the Cerrado (Felfili *et al.* 2008). Furthermore these smaller areas can include restricted species to the local that can be not present in UC (Felfili *et al.* 2008). According Faraco (unpublished data), *Bowdichia virgilioides*, despite being found in several localities, is in the vulnerable category because was recorded only within two UC in São Paulo state, while *Psychotria capitata* and *Pouteria subcaerulea* were not seen in any UC.

The Jaccard Similarity Index calculated among the three studied areas, produced lower values between *cerradão* and the areas of *cerrado sensu stricto* I (27%) and *cerrado sensu stricto* II (26%), being the *cerrado sensu stricto* areas more similar together, with index equal to 43% of similarity. These two areas share a greater number of species (49), while the *cerrado sensu stricto* II and the *cerradão* have only 11 species in common. Only 38 species (15.32%) were registered in common to the three studied areas.

The data matrix organized to perform the floristic similarity analysis among several *Cerrado* areas, as described in Table 1, originally included 841 species. However, 435 species (52%) were eliminated because occurred in just one location. The remaining set (406 species) revealed that only four of them were recorded in all the 14 localities compared: *Machaerium acutifolium*, *Ouratea spectabilis*, *Schefflera vinosa* and *Vochysia tucanorum*. The cluster analysis (Figure 3) showed the segregation of two major groups relatively similar considering they joined at about 25% of similarity (Mueller-Dombois and Ellenberg 1974). The first large group (Figure 3A) assembled seven areas of *cerrado sensu stricto* and only one of *cerradão*, encompassing a subgroup which comprised only *cerrado sensu stricto* areas of Pratânia. The second large group (Figure 3B) was composed by *cerradão* areas and by two *cerrado sensu stricto* areas which are located in the vicinity of some *cerradão* areas to which they joined in the dendrogram, indicating in these cases greater floristic similarity among geographically closer areas, not being conditionated by the physiognomy. This pattern did not occur with the physiognomies of Pratânia, since the *cerradão* of this locality joined to other areas of similar physiognomy found, however, in other municipalities. This shows that in Pratânia, the *cerradão* is quite different not only in terms of physiognomy, but also in relation to the floristic composition. This feature seems to do not occur in the *Cerrados* of Assis and Águas de Santa Bárbara, included in the present analysis.

The causes of these differences need to be examined in a broader context, involving biotic and abiotic factors, as well as the history of human interferences in the compared areas. One possible hypothesis would assume that there was the emergence of the *cerrado sensu stricto* in Assis as a result of significant anthropogenic changes occurred in the past and that, at present, these areas are

in a regeneration process, moving towards a hypothetical original *cerradão* physiognomy, considering that they are today protected from interference, as reported by Durigan *et al.* (1999). The increase of vegetation density in some *Cerrado* grassland areas, which became protected, was also observed by Durigan *et al.* (1987) and Coutinho (1990). In relation to the *Cerrado* areas of Águas de Santa Bárbara it is possible that this same situation has occurred. However, the *cerradão* of Pratânia seems quite peculiar because presented low similarity with the *cerrado sensu stricto* areas contiguous to it, and there are no indications of significative interference, such as deforestation, in these areas. This could be a signal that other environmental factors are conditioning the floristic composition of the physiognomies focused in the present study.

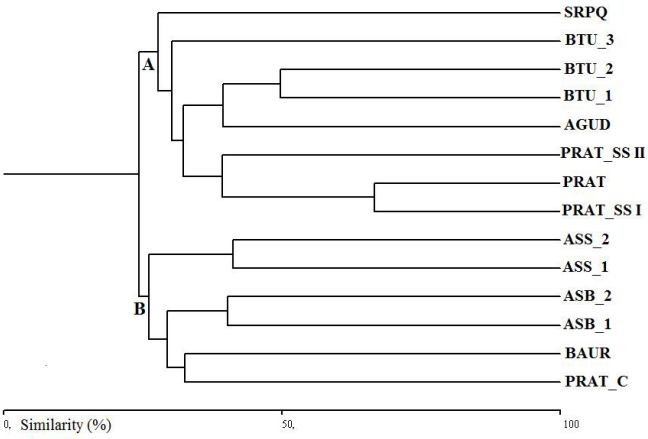

Figure 3. Cluster analysis using Jaccard similarity index for comparing the three *Cerrado* areas of this study, with other *Cerrado* areas of São Paulo state. The description of the areas is in Table 1. The two major groups are noted as A and B (see text).

The results indicate the occurrence of floristic peculiarities in each one of the adjacent *Cerrado* physiognomies in Pratânia. These findings lead to questions about the causes of these significant differences, suggesting future research subjects. Additionally, the results reinforce the importance of the fragment in the maintenance of regional biodiversity which, although somewhat disturbed, can be considered a testimony of the original vegetation, being a reference for future conservation actions and a source of native species with high potential to rational susteinable exploitation. These conclusions find support on the statements of Felfili *et al.* (2008) who consider of primal importance the maintenance of local vegetation remnants, regarding the variation of the *Cerrado* vegetation along the geographic and ecological gradients, which must be observed in all conservation and management actions.

Table 2. Species recorded in three *Cerrado* areas in Pratânia municipality, SP, Brazil. Physiognomies: *cerradão* (C), *cerrado sensu stricto* I (SS I), *cerrado sensu stricto* II (SS II). *Invasive species. ** Potentially invasive species in areas previously occupied by *Cerrado.*

FAMILY/SPECIES	HABIT	PHYSIOGNOMIES		
		C	SS I	SS II
PTERIDOPHYTA				
DENNSTAEDTIACEAE				
Pteridium centrali-africanum (Hieron.) Alston*	herb	x		
POLYPODIACEAE				
Microgramma squamulosa (Kaulf.) de la Sota	epiphytic	x		
*Pleopeltis angus*ta Humb. and Bonpl. ex Willd.	herb	x		
Polypodium latipes Langsd. and Fisch.	herb	x	x	x
GYMNOSPERMAE				
PINACEAE				
Pinus palustris Mill.*	tree	x		
ANGIOSPERMAE				
ACANTHACEAE				
Ruellia geminiflora Kunth	herb		x	x
AMARANTHACEAE				
Alternanthera regelii Seub.	herb		x	x
Gomphrena officinalis Mart.	herb		x	x
ANACARDIACEAE				
Anacardium humile A.St.-Hil.	subshrub			x
Lithraea molleoides (Vell.) Engl.	tree	x		x
ANNONACEAE				
Annona coriacea Mart.**	tree	x	x	x
Annona crassiflora Mart.	tree	x	x	
Annona dioica A.St.-Hil.	subshrub	x	x	
Duguetia furfuracea (A.St.-Hil.) Benth. and Hook.f.**	shrub		x	x
APOCYNACEAE				
Aspidosperma tomentosum Mart.	tree		x	
Blepharodon bicuspidatum E.Fourn.	vine		x	
Blepharodon nitidum (Vell.) J.F.Macbr.	vine		x	
Forsteronia glabrescens Müll.Arg.	vine			x
Himatanthus obovatus (Müll.)Arg.) Woodson	shrub	x		x

Table 2. ***Continued.***

FAMILY/SPECIES	HABIT	PHYSIOGNOMIES		
		C	SS I	SS II
Macrosiphonia virescens (A.St.-Hil.) Müll.Arg.	subshrub			x
Mandevilla pohliana (Stadelm.) A.H.Gentry	subshrub		x	x
Tabernaemontana catharinensis A.DC.	shrub	x	x	
Temnadenia violacea (Vell.) Miers	vine		x	
ARALIACEAE				
Schefflera vinosa (Cham. and Schltdl.) Frodin	tree	x	x	x
ARECACEAE				
Syagrus flexuosa (Mart.) Becc.	tree	x	x	
ASTERACEAE				
Achyrocline satureoides (Lam.) A.DC. *	herb			x
Aspilia reflexa (Sch.Bip. ex Baker) Baker	herb		x	x
Baccharis dracunculifolia A.DC.*	shrub		x	x
Bidens gardneri Baker*	herb		x	x
Blainvillea sp.	herb			
Chaptalia integerrima (Vell.) Burk.*	herb			x
Chresta sphaerocephala DC.	herb		x	
Chromolaena campestris (A.DC.) R.M.King and H.Rob.	subshrub		x	
Chromolaena congesta (Hook. and Arn.) R.M.King and H.Rob.	herb		x	
Chrysolaena platensis (Spreng.) H.Rob.*	herb		x	
Emilia sonchifolia (L.) DC.*	herb		x	x
Eupatorium sp.1	herb			x
Eupatorium sp.2	subshrub		x	
Gochnatia barrosii Cabrera	shrub	x	x	x
Gochnatia polymorpha (Less.) Cabrera	tree	x		x
Gochnatia pulchra Cabrera	shrub	x	x	x
Ichthyothere elliptica H.Rob.	herb		x	
Lepidaploa canescens (Kunth) H.Rob.	shrub		x	
Lessingianthus bardanoides (Less.) H.Rob.	subshrub		x	x
Lessingianthus grandiflorus (Less.) H.Rob.	herb		x	
Mikania cordifolia (L.f.) Willd.*	vine		x	
Piptocarpha rotundifolia (Less.) Baker	shrub	x	x	x
Pterocaulon lanatum Kuntze*	subshrub		x	
Senecio brasiliensis (Spreng.) Less.*	shrub		x	
Vernonanthura phosphorica (Vell.) H.Rob.*	shrub		x	
Viguiera sp.	herb	x		
BIGNONIACEAE				
Amphilophium elongatum (Vahl) L.Lohmann	vine	x		
Arrabidaea brachypoda (A.DC.) Bureau**	vine	x	x	
Arrabidaea florida A.DC.**	vine		x	
Cuspidaria pulchra (Cham.) L.Lohmann	vine	x		
Cybistax antisyphilitica (Mart.) Mart.	tree	x		x
Jacaranda decurrens Cham.	subshrub		x	x
Jacaranda oxyphylla Cham.	shrub		x	x
Pyrostegia venusta (Ker-Gawl.) Miers*	vi	x	x	x
Tabebuia aurea (Manso) Benth. and Hook.f. ex S.Moore	tree	x		
Tabebuia ochracea (Cham.) Standley	tree	x	x	x
Zeyheria montana Mart.	shrub		x	x
BIXACEAE				
Cochlospermum regium (Mart. ex Schrank) Pilger	subshrub			x
BORAGINACEAE				
Cordia sellowiana Cham.	tree	x		
BROMELIACEAE				
Acanthostachys strobilacea (Schult.f.) Klotzsch	epiphytic	x		
Ananas ananassoides (Baker) L.B.Sm.	herb		x	
Bromelia balansae Mez	herb			x
Dyckia leptostachya Baker	herb		x	
Tillandsia recurvata (L.) L.	epiphytic	x		

Table 2. ***Continued.***

FAMILY/SPECIES	HABIT	PHYSIOGNOMIES		
		C	SS I	SS II
BURSERACEAE				
Protium heptaphyllum (Aubl.) Marchand	tree	x	x	
Protium spruceanum (Benth.) Engl.	tree	x		
CARYOCARACEAE				
Caryocar brasiliense Cambess.	subshrub	x	x	x
CELASTRACEAE				
Peritassa campestris (Cambess.) A.C.Sm.	shrub		x	
Plenckia populnea Reissek	tree	x	x	x
CHRYSOBALANACEAE				
Couepia grandiflora (Mart. and Zucc.) Benth. ex Hook.f.	tree	x	x	x
Licania humilis Cham. and Schltdl.	subshrub	x	x	x
CLUSIACEAE				
Kielmeyera coriacea Mart. and Zucc.	tree		x	x
Kielmeyera rubriflora Cambess.	tree		x	
COMBRETACEAE				
Terminalia glabrescens Mart.	tree	x		
COMMELINACEAE				
Commelina diffusa Burm.f.*	herb		x	x
CONNARACEAE				
Connarus suberosus Planchon	shrub		x	
CONVOLVULACEAE				
Evolvulus cressoides Mart.	herb		x	x
Ipomoea procurrens Meissn.	vine		x	
Merremia macrocalyx (Ruiz and Pavon) O'Donnell*	vine	x		
CUCURBITACEAE				
Cayaponia espelina (Manso) Cogn.	vine		x	
CUNNONIACEAE				
Lamanonia ternata Vell.	tree	x		
CYPERACEAE				
Cyperus sp.	herb	x	x	
Rhynchospora sp.	herb		x	
DILLENIACEAE				
Davilla elliptica A.St.-Hil.	shrub		x	x
EBENACEAE				
Diospyros hispida A.DC.	shrub	x	x	x
ERYTHROXYLACEAE				
Erythroxylum cuneifolium (Mart.) O.E.Schulz	shrub	x		x
Erythroxylum pelleterianum A.St.-Hil.	shrub	x		
Erythroxylum suberosum A.St.-Hil.	shrub		x	x
Erythroxylum tortuosum Mart.	shrub		x	x
EUPHORBIACEAE				
Croton glandulosus L.*	herb			x
Dalechampia micromeria Baill.	vine		x	x
Manihot caerulescens Pohl	shrub		x	
Sebastiania serrulata (Mart.) Müll.Arg.	herb		x	
FABACEAE - CAESALPINIOIDEAE				
Bauhinia rufa (Bong.) Steudel	shrub	x	x	x
Chamaecrista campestris H.S.Irwin and Barneby	herb			x
Chamaecrista cathartica (Mart.) H.S.Irwin and Barneby	herb		x	
Chamaecrista desvauxii (Collad.) Killip var. *brevipes* (Benth.) H.S.Irwin and Barneby*	subshrub		x	
Chamaecrista desvauxii (Collad.) Killip var. *langsdorfii* (Kunth ex Vogel) H.S.Irwin and Barneby	subshrub		x	
Chamaecrista flexuosa (L.) Greene*	subshrub		x	x
Chamaecrista labouriaeae (H.S.Irwin and Barneby) H.S.Irwin and Barneby	herb		x	
Copaifera langsdorffii Desf.	tree	x		
Senna rugosa (G.Don.) H.S.Irwin and Barneby	shrub	x	x	
FABACEAE - FABOIDEAE				
Acosmium subelegans (Mohlenb.) Yakovl.	tree	x	x	x

Table 2. ***Continued.***

FAMILY/SPECIES	HABIT	PHYSIOGNOMIES		
		C	SS I	SS II
Andira humilis Mart. ex Benth.**	subshrub		x	x
Andira vermifuga Mart. ex Benth.	tree	x		
Bowdichia virgilioides Kunth	tree	x	x	
Clitoria simplicifolia (Kunth) Benth.	herb		x	x
Crotalaria longifolia Lam.	herb		x	
Crotalaria maypurensis Kunth	herb		x	
Crotalaria micans Link*	subshrub			x
Galactia eriosematoides Harms	shrub		x	
Galactia sp.	vine			x
Machaerium acutifolium Vogel	tree	x	x	x
Platypodium elegans Vogel	tree	x		
Rhynchosia melanocarpa Grear	vine		x	
Stylosanthes acuminata M.B.Ferr. and Souza-Costa	herb		x	x
Vigna peduncularis (Kunth) Fawc. and Rendle	vine		x	
FABACEAE - MIMOSOIDEAE				
Anadenanthera peregrina (L.) Speg. var. *falcata* (Benth.) Reis	tree	x	x	
Dimorphandra mollis Benth.**	tree	x	x	x
Mimosa balansae Micheli	herb		x	x
Mimosa debilis Humb. and Bonpl. ex Willd.*	herb			x
Mimosa debilis Humb. and Bonpl. ex Willd. var. *debilis*	herb		x	x
Mimosa dolens Vell. var. *anisitsii* (Lindm.) Barneby	subshrub		x	
Mimosa gracilis Benth. var. *capillipes* (Benth.) Barneby	subshrub		x	
Stryphnodendron adstringens (Mart.) Coville	tree		x	
Stryphnodendron polyphyllum Mart.	tree	x	x	x
IRIDACEAE				
Trimezia juncifolia (Klatt) Benth. and Hook.f.	herb			x
LACISTEMATACEAE				
Lacistema hasslerianum Chodat	tree	x		
LAMIACEAE				
Aegiphila verticillata Vell.	shrub		x	x
Eriope crassipes Benth.	subshrub		x	
Hypenia macrantha (St.-Hil. ex Benth.) R.Harley	herb		x	
Hyptis crinita Betnh.	herb		x	
Hyptis eriophylla Pohl ex Benth.	shrub		x	x
LAURACEAE				
Ocotea corymbosa (Meissn.) Mez	tree	x	x	x
Ocotea pulchella Mart.	tree	x	x	x
LOGANIACEAE				
Strychnos pseudoquina A.St.-Hil.	tree	x	x	
LYTHRACEAE				
Cuphea carthagenensis (Jacq.) J.F.Macbr.*	herb		x	
Lafoensia pacari A.St.-Hil.	tree	x		
MALPIGHIACEAE				
Banisteriopsis campestris (A.Juss.) E.L.Little	shrub		x	x
Banisteriopsis oxyclada (A.Juss.) B.Gates*	vine	x		
Banisteriopsis variabilis B.Gates	shrub		x	
Byrsonima basiloba A.Juss.	tree	x	x	x
Byrsonima coccolobifolia Kunth	shrub	x	x	
Byrsonima intermedia A.Juss.**	subshrub	x	x	x
Byrsonima laxiflora Griseb.	tree		x	
Byrsonima verbascifolia (L.) L.C.Rich. ex A.Juss.	tree	x	x	x
Heteropterys umbellata A.Juss.	shrub		x	x
Peixotoa tomentosa A.Juss.	shrub		x	
Tetrapterys ramiflora A.Juss.	subshrub		x	
Tetrapterys sp.	subshrub	x		
MALVACEAE				
Eriotheca gracilipes (K.Schum.) A.Robyns	tree	x	x	x

Table 2. ***Continued.***

FAMILY/SPECIES	HABIT	PHYSIOGNOMIES		
		C	SS I	SS II
Luehea grandiflora Mart. and Zucc.	tree	x		x
Peltaea polymorpha (A.St.-Hil.) Krapov. and Cristóbal	subshrub		x	x
Sida linearifolia A.St.-Hil.*	subshrub		x	
Waltheria communis A.St.-Hil.	subshrub		x	x
MELASTOMATACEAE				
Miconia albicans (Sw.) Triana	tree	x	x	
Miconia fallax A.DC.	shrub	x	x	
Miconia langsdorffii Cogn.	shrub	x		
Miconia ligustroides (DC.) Naudin	tree	x	x	
Miconia stenostachya A.DC.	shrub	x	x	
Tibouchina gracilis (Bonpl.) Cogn.	subshrub			x
Tibouchina stenocarpa (Schrank and Mart. ex DC.) Cogn.	tree	x		x
MYRSINACEAE				
Myrsine guianensis (Aubl.) Kuntze	tree	x	x	x
Myrsine umbellata Mart.	tree	x		
MYRTACEAE				
Calyptranthes concinna DC.	tree	x		
Campomanesia adamantium (Cambess.) O.Berg	shrub		x	x
Campomanesia pubescens (A.DC.) O.Berg	shrub			x
Campomanesia cf. *velutina* (Cambess.) O.Berg	shrub	x		
Eugenia albo-tomentosa Cambess.	tree			x
Eugenia aurata O.Berg	tree	x	x	x
Eugenia bimarginata DC.	shrub	x	x	x
Eugenia florida DC.		x		
Eugenia hiemalis Cambess.	shrub	x	x	x
Eugenia livida O.Berg	shrub		x	
Eugenia punicifolia (Kunth) A.DC.	shrub		x	
Eugenia sp.	tree	x		
Myrcia bella Cambess.	tree	x	x	x
Myrcia castrensis (O. Berg) D. Legrand		x		x
Myrcia guianensis (Aubl.) A.DC.	tree	x		
Myrcia lingua (O.Berg) Mattos and Legrand	tree	x	x	x
Myrcia tomentosa (Aubl.) DC.	tree	x		x
Psidium cinereum Mart. ex DC.	shrub		x	x
Psidium guineense Sw.	shrub		x	
Psidium incanescens Mart. ex DC.	subshrub		x	x
Psidium laruotteanum Cambess.	tree		x	x
Psidium salutare (Kunth) O.Berg var. *pohlianum* (O.Berg) Landrum	shrub	x	x	x
Stenocalyx pitanga O.Berg	subshrub			x
NYCTAGINACEAE				
Guapira noxia (Netto) Lundell	shrub	x	x	
OCHNACEAE				
Ouratea spectabilis (Mart.) Engl.	shrub	x	x	x
ORCHIDACEAE				
Rodriguezia decora (Lem.) Rchb.f.	epiphytic	x		
OXALIDACEAE				
Oxalis sexenata Savigny	herb			x
PASSIFLORACEAE				
Passiflora miersii Mart.	vine	x		
PERACEAE				
Pera glabrata (Schott) Baill.	tree	x	x	x
PIPERACEAE				
Piper sp.	shrub	x		
POACEAE				
Andropogon leucostachyus Kunth*	herb			x
Axonopus aureus P.Beauv.	herb		x	
Loudetiopsis chrysothrix (Nees) Conert.	herb		x	

Table 2. ***Continued.***

FAMILY/SPECIES	HABIT	PHYSIOGNOMIES		
		C	SS I	SS II
Panicum olyroides Kunth	herb		x	
Panicum sp.	herb	x		
Rhynchelytrum repens (Willd.) C.E.Hubb.*	herb			x
Urochloa brizantha (Hochst. ex A.Rich.) R.D.Webster*	herb	x	x	x
PROTEACEAE				
Roupala montana Aubl.	shrub	x	x	
RUBIACEAE				
Alibertia concolor (Cham.) K.Schum.	subshrub	x	x	
Alibertia macrophylla K.Schum.	tree	x		
Alibertia sessilis (Vell.) K.Schum.	subshrub		x	x
Amaioua guianensis Aubl.	tree	x		
Borreria capitata (Ruiz and Pavon) DC.	herb		x	x
Coccocypselum lanceolatum (Ruiz and Pavon) Pers.	herb		x	
Declieuxia fruticosa (Willd. ex Roem. and Schult.) Kuntze	subshrub		x	x
Guettarda vuburnoides Cham. and Schldl.	tree	x		
Palicourea rigida Kunth	shrub		x	x
Psychotria capitata Ruiz and Pavon	subshrub	x		
Tocoyena formosa (Cham. and Schltdl.) K.Schum.	shrub		x	x
RUTACEAE				
Zanthoxylum rhoifolium Lam.	tree	x	x	x
SALICACEAE				
Casearia sylvestris Sw.	shrub		x	x
SANTALACEAE				
Phoradendron sp.	hemiparasite	x	x	
SAPINDACEAE				
Serjania erecta Radlk.	shrub	x		x
Serjania gracilis Radlk.	vine	x		
Serjania lethalis A.St.-Hil.	vine	x	x	
SAPOTACEAE				
Pouteria ramiflora (Mart.) Radlk.	tree	x	x	
Pouteria subcaerulea Pierre ex Dubard	herb		x	
Pouteria torta (Mart.) Radlk.	tree	x	x	
SMILACACEAE				
Smilax polyantha Griseb.	vine		x	x
SOLANACEAE				
Cestrum sendtnerianum Mart. ex Sendtn.	shrub	x		
Solanum americanum Mill.*	subshrub		x	
Solanum lacerdae Dusén	shrub	x		
Solanum lycocarpum A.St.-Hil.*	shrub		x	x
Solanum palinacanthum Dunal*	shrub		x	x
Solanum paniculatum L.*	shrub			x
STYRACACEAE				
Styrax camporum Pohl	tree	x	x	x
Styrax ferrugineus Nees and Mart.	tree	x	x	x
SYMPLOCACEAE				
Symplocos pubescens Klotzsch ex Benth.	tree	x		
THYMELAEACEAE				
Daphnopsis racemosa Griseb.	shrub	x		
Daphnopsis utilis Warm.	tree	x		
VERBENACEAE				
Lantana camara L.*	shrub	x	x	
Lantana fucata Lindl.*	shrub	x		x
Lippia lupulina Cham.	shrub		x	
Lippia salviaefolia Cham.	shrub		x	x
undetermined	herb		x	
VIOLACEAE				
Anchietea pyrifolia (Mart.) G.Don	vine	x		

Table 2. ***Continued.***

FAMILY/SPECIES	HABIT	PHYSIOGNOMIES		
		C	SS I	SS II
VITACEAE				
Cissus inundata (Baker) Planchon	vine		x	x
VOCHYSIACEAE				
Qualea dichotoma (Mart.) Warm.	tree	x		
Qualea grandiflora :Mart.	tree	x	x	x
Qualea multiflora Mart.	tree	x		
Vochysia tucanorum (Spreng.) Mart.	tree	x	x	x

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