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SEASONAL DIVERSITY OF VEGETATION STRUCTURE OF *VEREDAS*, MATO GROSSO DO SUL, BRAZIL

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Abstract: Environmental Protection Area Guariroba is an area to protect the headwaters of a creek formed by streams of *Veredas*, generating the main water supply of municipality of Campo Grande, state of Mato Grosso do Sul, Brazil. Some degraded areas have to be restored; thus, it is important to investigate species composition and variations of the vegetation. Our objective was to evaluate the seasonal variation of the vegetation structure of *Veredas* within the hydrographic sub-basin. We estimated species cover in five points, each one with 0.5 x 0.5 m plots along 50 m transects on the five stream banks in two seasonal periods. We found 134 species from 95 genera and 49 families. In both seasons, Poaceae, Cyperaceae and Asteraceae were the richest families and the richest genera were *Eleocharis* (N = 6), *Rhynchospora* and *Utricularia* (N = 4). Species richness varied between *Veredas*, from 31 to 70. We found 41 species exclusive to the rainy season and 38 to the dry season. The analyses identified seven indicator species for the dry season and ten for the rainy season. There are seasonal differences in floristic composition and vegetation cover. Thus, the dynamics of water availability in *Veredas*, which is related to seasonality, is necessary for the maintenance and functioning of these habitats, which have an important role in local flora, fauna and water availability for the municipality.

Keywords: aquatic macrophytes; riparian vegetation; water resources; wetland.

INTRODUCTION

Veredas are responsible for countless headwaters in the Cerrado and for the maintenance and regularity of water courses (Carvalho 1991, Santos *et al.* 2006). They have a typical and unique flora (Munhoz & Felfili 2008, Araújo *et al.* 2013) and provide food, refuge and habitats for aquatic and terrestrial fauna, playing an important role in ecosystem functioning (Carvalho 1991, Meireles *et al.* 2004).

These wetlands are located on organic, hydromorphic soils in the *Cerrado* savannah, with superficial drainage, composed of a slim and ill-defined frame of water paths, basically conditioned by physical factors, of water table outcrop (Ribeiro & Walter 1998). Due to these edaphic features, *Veredas* are characterized by two vegetation strata, the tree palm *Mauritia flexuosa* L.f. (Arecales, Arecaceae),

known as *buriti*, without forming a canopy, and a shrubby-herbaceous grassland, usually very wet, where common families are Cyperaceae, Poaceae and Asteraceae (Ribeiro & Walter 1998). However, the presence of the palm is not mandatory to characterize *Veredas* (Moreira *et al.* 2015). With all these functions and services, these ecosystems are protected by law (no. 12.651/2012), being considered protected areas.

Despite these environments being highly sensitive to alterations and with low resilience (Carvalho 1991), they are being degraded, mainly by agriculture (Ribeiro & Walter 1998), but also fire, grazing, water uptake, deforestation, small dams and roads have impacted *Veredas* (Araújo *et al.* 2002, Meireles *et al.* 2004, Bahia *et al.* 2009). In Mato Grosso do Sul, *Veredas* also are threatened by drainage and silting from erosion around, causing water table lowering and, consequently, alterations in their structure (Moreira 2015).

Despite the anthropic pressure and its ecological importance, there are yet few studies about its characteristics and dynamics (Bahia *et al.* 2009). Most reports on the vegetation of *Veredas* refer to its floristic composition, followed by studies about structure, dynamics and usages (Moreira 2015). Some information about *Veredas* from Mato Grosso do Sul is given in Moreira *et al.* (2011, 2015). According to Moreira (2015), to relate the vegetation structure of wetlands with edaphoclimatic and other environmental factors, is necessary to understand its dynamics, contributing to its conservation.

The vegetation can vary throughout the year, according to the seasons, being important to know this for restoration and conservation purposes. The herbaceous communities are especially responsive and normally present more seasonal variations than the woody vegetation, yet little known regarding *Veredas* in general (Munhoz & Felfili 2008, Amador *et al.* 2012, Rebelato & Nunes da Cunha 2012).

Studies carried in the Pantanal (Amador *et al.* 2012, Bueno *et al.* 2014, Bao *et al.* 2017a) and in *Veredas* (Munhoz & Felfili 2008) indicate differences in the herbaceous component in areas under moisture seasonality, *i.e.*, with variation in soil water content. However, such fluctuation is yet scarcely known about *Veredas*. Therefore, seeking to contribute to the knowledge about their structure, the aim of this study is to evaluate the seasonal variation of the vegetation structure of *Veredas* within the hydrographic sub-basin of Guariroba creek.

MATERIAL AND METHODS

Study area

The *Veredas* studied are wetlands located in the environmental protection area of the headwaters of the Guariroba creek, named Área de Proteção Ambiental (APA) Guariroba (hereafter APA), in the municipality of Campo Grande, state of Mato Grosso do Sul, Brazil. The APA with *ca.* 360 km² was created in 1995 with the purpose of recovery and conservation of the main system producer of gross water for the capital city (PMCG 2008). The Guariroba creek is an affluent of the Botas brook, contributor of the Pardo river, a tributary of the Paraná river (PMCG 2008), an important Brazilian river. In addition to the main watercourse, the Guariroba creek, the APA has four tributary streams: Tocos, Saltinho, Açude and Rondinha (Figure 1). This system produces nearly 60% of the water resources to Campo Grande human population. Cultivated pastures occupy more than 82% of the APA (PMCG 2008), some being replaced by eucalyptus plantations.

According to Köppen's classification (1984), the region has a climate Aw, having as main feature two well defined seasons: rainy summer and dry winter (Mato Grosso do Sul 1990). During the studied period, the average rainfall was 82.73 mm for the dry season and 210 mm for the rainy season (Mato Grosso do Sul 2015, INPE).

Data collection and analysis

We chose five sampling areas in *Veredas* in the APA, distributed along the streams Guariroba, Tocos and Saltinho and the Guariroba reservoir, until the distal part of this dam. The coordinates of each area are: Area 1: 20°33'30.7" S, 54°23'26.6" W; Area 2: 20°36'02.7" S, 54°21'09.3" W; Area 3: 20°39'41.7" S, 54°22'44.1" W; Area 4: 20°40'17.5" S, 54°17'45.5" W; Area 5: 20°31'55.1" S, 54°16'09.0" W, *datum* SAD 69 (Figure 1). These coordinates were taken indistinctly at the beginning or end of the transect. The sampled *Veredas* varied from marshy along shallow (1-50 cm deep) diffuse stream bed near the top of the headwater to rather drained close to a more defined channel (0.5-2 m deep)

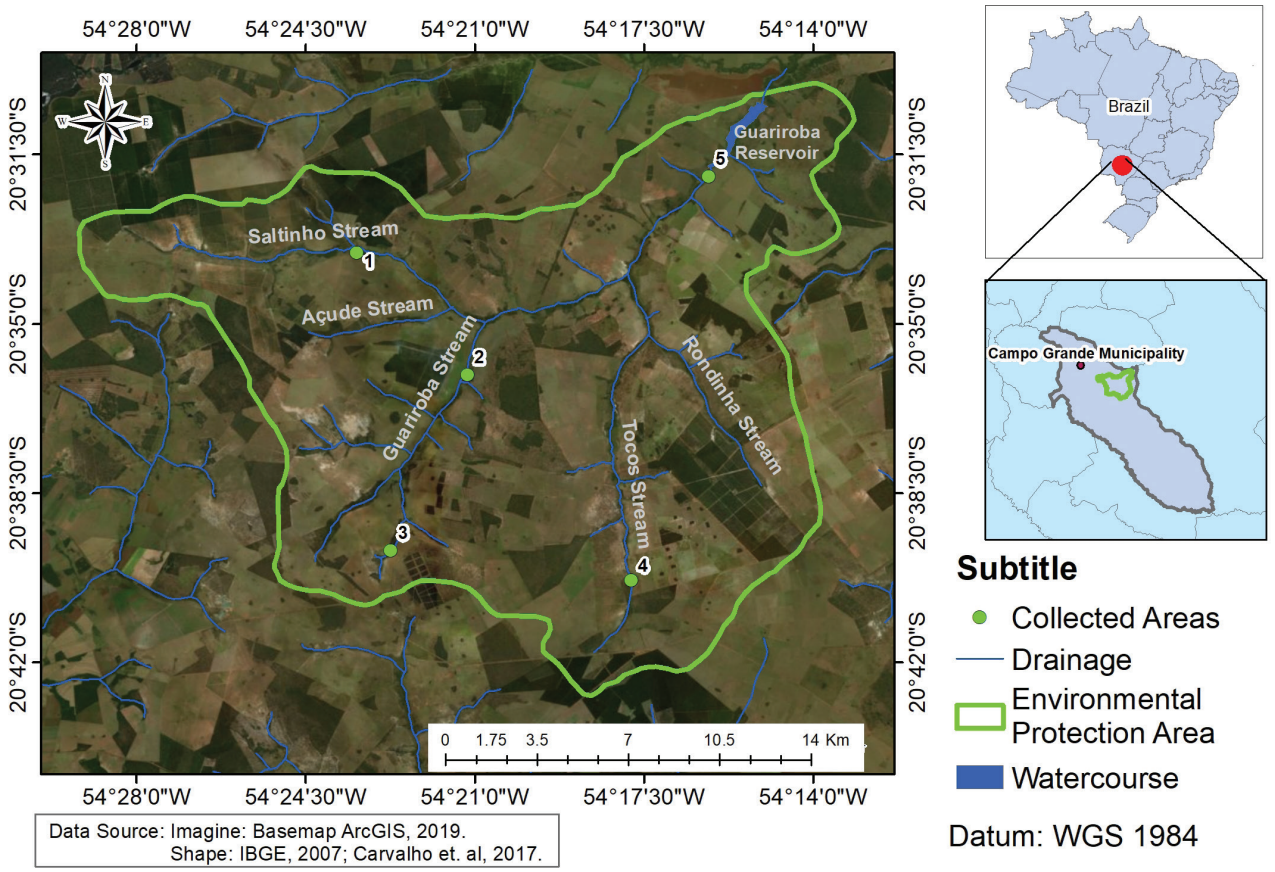

Figure 1. Study area with location of sampled points along streams in *Veredas* and the reservoir in the *Área de Proteção Ambiental* do Guariroba, municipality of Campo Grande, state of Mato Grosso do Sul, Brazil.

further downstream. To compare the seasons, we conducted fieldwork between August 2012 and April 2013, just once per sampling area in each season, totaling ten sampling points. The five sampling points in the dry season occurred between August and October 2012, and those of the rainy season from February to April 2013.

In each sampling area of the *Vereda*, we established a transect line containing 50 m along the stream margin, wherein every 2 m we placed a 0.50 m x 0.50 m quadrat, to record the plant species present and to estimate their cover. In both seasons, the coverage of the plant community in the sampling frame was visually estimated using the Braun-Blanquet scale (1979), that gives a number to each species presenting in the plot, according to its coverage percentage, since inexpressive coverage which has the value 1 to more than 76% coverage which is attributed as 5. For analysis, these numbers were converted in percentages again.

The collected plants were pressed between corrugated cardboard and aluminum and dried in an air circulating oven at 50ºC. Plants not recognized in the field were identified by comparison with specimens determined by specialists, in the Herbarium CGMS. For plant names, we consulted the database Flora do Brasil (Flora do Brasil under construction). The recorded data were fed into the database of the Herbarium CGMS and we printed the labels of the incorporated material.

We compared two seasons in relation to floristic composition and vegetation coverage. The Braun Blanquet scale was transformed into percentages of cover for the analysis. Thereafter, we build up a matrix with the percentage of cover of each species in each season. Permanova analysis (Permutational analysis of variance) was utilized to verify if there are differences in composition between the two seasons and PCoA analysis (Principal Coordinates Analysis) with Bray Curtis distance to see in the graph. We also applied the Indicator Species Analysis to detect typical species of each season. We performed all analyses in R (R Core Team 2018) using Vegan package (Oksanen *et al.* 2018) for PCoA, Permanova and INDICSPECIES package (Caceres & Jansen 2016) for Indicator Species Analysis.

RESULTS

We recorded 134 species from 95 genera and 49 families (Appendix 1). In the rainy season, we found 96 species, whereas in the dry season, 93. Among these, 55 species (41%) are shared in both seasons. We found 41 species exclusive to the rainy season and 38 species only recorded in the dry season. Species richness varied between the studied *Veredas*, from 31 to 70 species.

The richest families were Poaceae with 21 species, Cyperaceae (N = 17) and Asteraceae (N = 12), representing 37.3% of the total sampled species. These three families were the richest in both seasons, together with Melastomataceae and Rubiaceae, with different proportions (Figure 2). Eriocaulaceae showed representative species richness just in the rainy season (N = 4), likewise Rubiaceae.

In both seasons, the richest genus was *Eleocharis* (N = 6), followed by *Rhynchospora* and *Utricularia* (N = 4), *Bacopa*, *Eryngium*, *Mikania*, *Paspalum*, *Syngonanthus*, and *Xyris*, with three species each. In both seasons, the richest genera were the same, with some small differences in the number of species. About the rainy season, we just considered three genera with up to three species each.

Both seasons share three richest genera: *Eleocharis, Rhynchospora* and *Utricularia*, typical aquatic macrophytes genera. In the dry season, there are five species of *Eleocharis* compared with four in the rainy season. For *Rhynchospora*, there are four species in the dry season and three in the rainy season. For *Utricularia,* both seasons have three species. In the dry season, the genera *Eryngium* and *Mikania* also have three species each.

More than half of the families (53%) and genera (73.6%) showed just one species. The Permanova identified statistical differences in species composition between dry and rainy seasons (p = 0.001). The indicator species analysis detected eight indicator species for the dry season: *Borreria pulchristipula* (Gentianales, Rubiaceae), *Paspalum glaucescens* (Poales, Poaceae), *Heteropterys procoriacea* (Malpighiales, Malpighiaceae), *Eleocharis nudipes* (Poales, Cyperaceae), *Eriocaulon macrobolax* (Poales, Eriocaulaceae), *Eleocharis capillacea* (Poales, Cyperaceae), *Axonopus uninodis* (Poales, Poaceae), and *Xylopia emarginata* (Magnoliales, Annonaceae); and eleven species for the rainy season: *Hexapetalum radula* (Gentianales, Rubiaceae), *Eleocharis liesneri* (Poales, Cyperaceae), *Rhynchospora marisculus* (Poales, Cyperaceae),

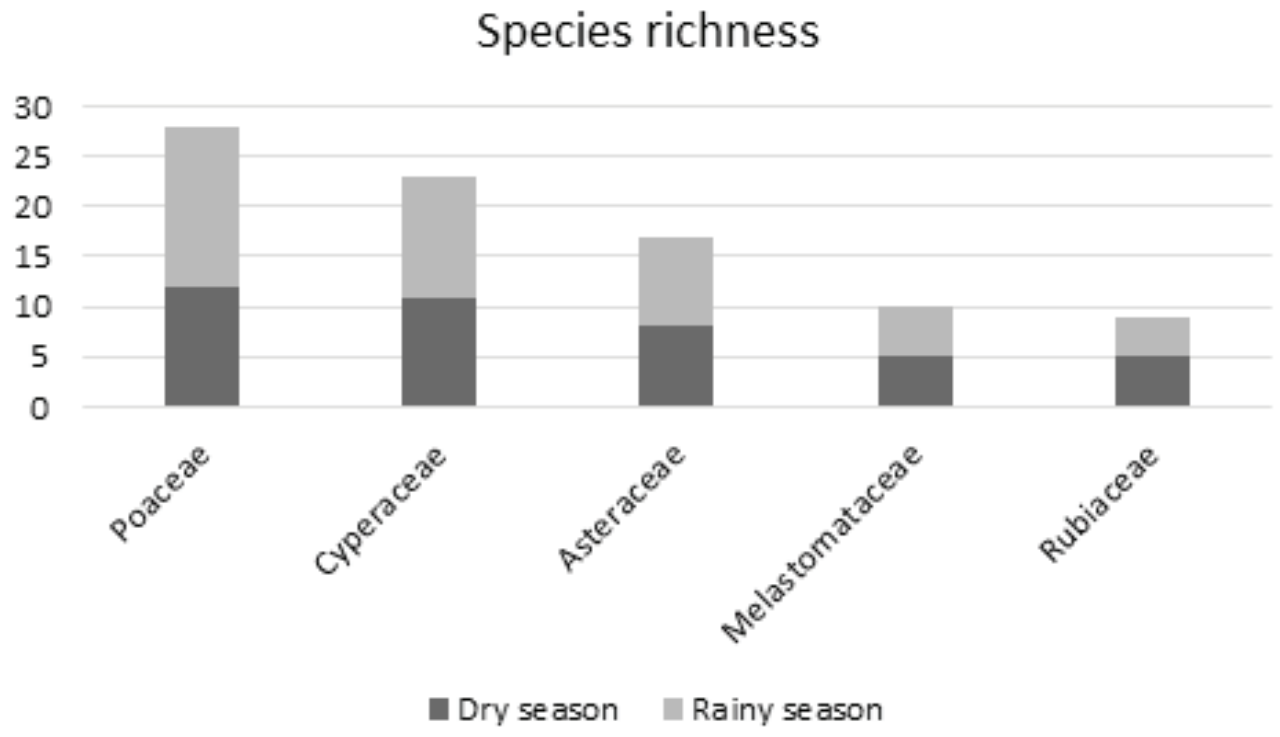

Figure 2. Species richest families in the both seasons in *Veredas* of *Área de Proteção Ambiental* do Guariroba, municipality of Campo Grande, state of Mato Grosso do Sul, Brazil.

Rhytachne rottboellioides (Poales, Poaceae), *Paspalum maculosum* (Poales, Poaceae), *Eriocaulon elichrysoides* (Poales, Eriocaulaceae), *Piper fuligineum* (Piperales, Piperacae), *Anthaenantia lanata* (Poales, Poaceae), *Eleocharis sellowiana* (Poales, Cyperaceae), *Ilex affinis* (Aquifoliales, Aquifoliaceae), and *Nectandra gardneri* (*Laurales, Lauraceae*). For the dry season, 8.6% of the species are indicators, compared with 11.4% for the rainy season. The two species with the greatest cover in the dry season were *B. pulchristipula* and *Miconia chamissois* (Myrtales, Melastomataceae) and in rainy season *H. radula* and *M. chamissois*. Among the 10 species with major cover, five were common to both seasons and seven were exclusive to just one season, such as *H. radula* in the rainy season and *P. glaucescens* in the dry season (Figure 3).

DISCUSSION

The most representative families in this *Vereda* – Poaceae, Cyperaceae and Asteraceae – are the same found in other studies (*e.g.*, Araújo *et al.* 2002, Guimarães *et al.* 2002, Tannus 2007, Munhoz & Felfili 2008, Oliveira 2009, Moreira 2015). These families are reported as the most important in grassland vegetations, such as shrubby grassland ("campo cerrado") and wet grassland (Boldrini *et al.* 1998, Batalha & Mantovani 2001, Tannus & Assis 2004), as well as other environments under full sunlight (Coutinho 1978). Besides, Poaceae and Cyperaceae are mainly filiform tussock species, typical of *Veredas*. The main families (Poaceae, Cyperaceae, Asteraceae, Melastomataceae and Rubiaceae) are the same reported by Moreira (2015) in *Veredas* of Mato Grosso do Sul. Eriocaulaceae, with considerable species richness, is also identified as an important family in *Veredas* (Moreira 2015). These families are responsible for the high representativity of the herbaceous and sub-shrubby strata (Araújo *et al.* 2002, Moreira 2015), forming "grouping of shrubby species surrounded by grassy-herbaceous grassland" (Carvalho 1991), coinciding with what we observed in the studied *Veredas* of the APA Guariroba.

Even though the surrounding sandy slopes are not yet restored, only two ruderal species *Desmodium distortum* (Fabales, Fabaceae) and *Vernonanthura brasiliana* (Asterales, Asteraceae) occurred in the *Veredas*, evidence that at least the sampled top stretches are still in a good state of conservation.

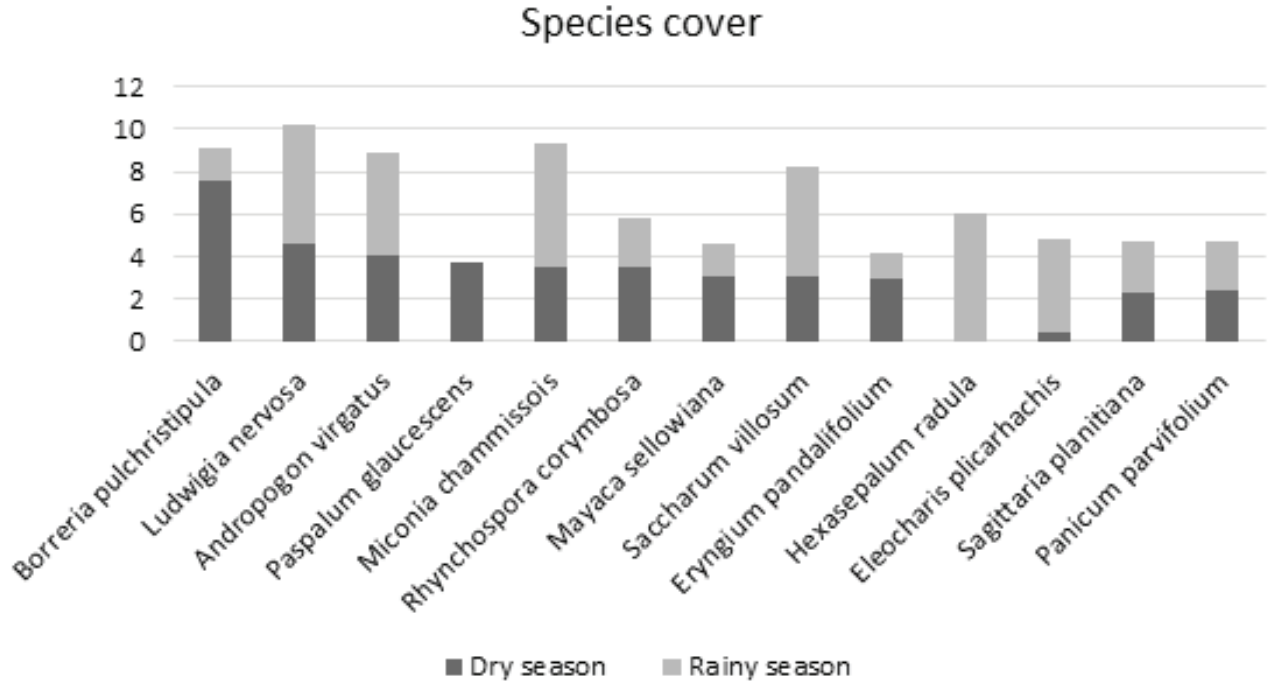

Figure 3. Relative percentage of cover of the 13 most common species on dry and rainy season in *Veredas* of *Área de Proteção Ambiental* do Guariroba, municipality of Campo Grande, state of Mato Grosso do Sul, Brazil.

Just in the rainy period, Eriocaulaceae presented a considerable richness, represented by four species, likewise Rubiaceae. In floristic composition in various edaphic conditions in grasslands of the *Cerrado*, the family Rubiaceae stands out in better-drained soils (Araújo *et al.* 2002, Tannus & Assis 2004), whilst Eriocaulaceae, on the contrary, occur on wet soils (Joly 1975).

More than half of the families had just a single species, in marshy and aquatic habitats, such as Droseraceae and Mayacaceae (Joly 1975, Tannus & Assis 2004). In drier habitats also occur single species families, such as Annonaceae and Anacardiaceae (Araújo *et al.* 2002). Anacardiaceae, Droseraceae and Mayacaceae were recorded in both seasons, but the first only in the dry (Tannus & Assis 2004). The occurrence of singletons is common in tropical environments. It is related to the distribution of these species that can be more frequent and have more cover in other adjacent areas.

Regarding the recorded genera, both seasons share the species richness of *Eleocharis* (N = 6), *Rhynchospora* (N = 4) and *Utricularia* (N = 4), corresponding to 10.4%. These genera are also among the richest in *Veredas* in the State, but with higher species diversity (Moreira 2015). Although Poaceae are among the richest families, only the genus *Paspalum* showed relatively more species (N = 3), distributed in both seasons, the same richest genus of Poaceae found by Moreira (2015). Conversely to verified by Guimarães *et al.* (2002) that Poaceae genera were the richest, in our study the Cyperaceae had genera with the largest number of species in both seasons.

Munhoz & Felfili (2008) stated that the permanent or seasonal wetness in *Veredas* tends to reduce the species richness, given the need for their adaptation to water stress. Yet in floodable grasslands in the Pantanal, the richness of herbaceous species increased in the rainy period compared with the dry period (Rebellato & Nunes-da-Cunha 2005, Amador *et al.* 2012). In our study, in the rainy season, despite the number of species been similar, we found more indicator species, evidencing that they are adapted to conditions of seasonal flooding and that the presence of water provides more niches than during the dry season. A probable reason is that the soil in the studied area is generally very sandy, thus quickly becomes drained and dry. In regard to indicator species, it is important to point out that they are not exclusive of their respective seasons since some species occur in both. However, what varied was the cover which was more expressive in one season or another for the cited species.

Despite the family Rubiaceae standing out in better-drained soils (Araújo *et al.* 2002, Tannus & Assis 2004), in this study, two species stood out: *B. pulchristipula* in the dry season and *H. radula* in the rainy season, both annuals. So, two of the most important species are annuals and are dominating the two seasons. For the Pantanal, Bao *et al.* (2017b) found that annual species have similar strategy preference to occur in post-flooded conditions. However, in *Veredas*, this pattern is unclear, because we found different annual species dominating in both seasons, independently on environmental characteristics.

The family Cyperaceae is abundant in aquatic ecosystems (Gil & Bove 2004). Species of the genus *Eleocharis* are generally aquatic and amphibious (Diego-Pérez 1997 apud Gil & Bove 2007). Considering that the *Veredas* are wetlands, besides their seasonality, and that samplings were close to the streams, we found two indicator species of this genus for each season. In the rainy season, one species of *Eleocharis* and one of *Rhynchospora* were ranked second and third, respectively, as indicators. Yet in the dry season, the genus *Eleocharis* (the sole genus of Cyperaceae) occurred as fourth and sixth.

The genus *Paspalum* (Poaceae) is expressive in floodable grasslands of the Pantanal (Pott *et al.* 2011), somewhat similar to *Veredas* in regard to moisture seasonality. We found a species for each season. In relation to other species of Poaceae in our study (*A. uninodis, R. rottboellioides* and *A. lanata*), Moreira *et al.* (2015) reported all with high importance values in *Veredas*. However, *A. uninodis*, herein shown as an indicator species of the dry period, and *R. rottboellioides* of the rainy season, were expressive in bottom areas of *Veredas*, *i.e.*, under high influence of water. The difference in regard to *A. uninodis* can be partly explained by our sampling since the dry period not necessarily means that the area was totally drained, depending on the variable topography, some streams with defined beds, others not, influencing the soil or surface water level.

The two seasons also shared species of *Eriocaulon*. This genus is reported as being from

aquatic habitat (Flora do Brasil under construction) and specifically from wet grassland (Tannus & Assis 2004), what matches the *Vereda* conditions of the studied seasons. *E. macrobolax* is so far cited only for the state of Minas Gerais (Flora do Brasil under construction), whereas we recorded it in the *Vereda* as an indicator species of the dry season. This new occurrence means that more floristic inventories are needed on *Veredas*.

In relation to the indicator species of the dry season, *H. procoriacea* is mentioned as terrestrial (Flora do Brasil under construction), indicating its preference for habitats little influenced by water, what explains its expression in the dry period. *X. emarginata* was recorded as a treelet in *Vereda* bottom zones, (Moreira *et al.* 2015) and common in gallery forest in the APA Guariroba (PMCG 2008). Two of the indicator species of the rainy season, *P. fuligineum* and *I. affinis* are also reported as species of gallery forest (Flora do Brasil under construction, PMCG 2008), the latter is also important in the *Vereda* bottom zones (Araújo *et al.* 2002, Moreira *et al.* 2015). *Nectandra gardneri* is reported as a species from floodable forests of Cerrado (Alves & Sartori 2009).

With the characteristics given in the literature on the indicator species and what we found in the field, we stress that they are not exclusive to one or another season since they can occur in both, *i.e.*, the species of the rainy season recorded in the dry, and vice-versa. This can have been influenced by the various relieves, with more or less water. Thus, species with different habitat preferences (more or less humid) can be the most sampled in one season or another. Guimarães *et al.* (2002) pointed out seven species as the most important in *Veredas*, tough we sampled only two of those but not as indicators of any season: *Andropogon virgatus* (Poales, Poaceae) and *Loudetia flammida* (Poales, Poaceae), probably because their tussocks do not vary much.

Most reports on variations in vegetation structure in *Veredas* utilized measurements and comparisons with different levels of water table outcrop (Araújo *et al.* 2002, Oliveira *et al.* 2009), instead, we evaluated the vegetation of the same sites, but in distinct periods of the year, with seasonal rainfall. Considering differences in drainage of the zones of edge, middle and bottom in *Veredas*, Araújo *et al.* (2002) and Oliveira *et al.* (2009) described that the bottom zone, with permanently flooded soil, differs from the other two zones in relation to floristic composition, with the soil flooded in part of the or well drained. In wet open grassland with permanently exposed water table also differed in species composition, compared with areas under seasonal fluctuations (Munhoz & Felfili 2008). On the other hand, in the Pantanal frequently the vegetation structure in wet grasslands in regard to the flood regime is assessed, *i.e.*, periods of drought and flood, though Rebellato & Nunes-da-Cunha (2005) did not identify significant differences between both periods in the floristic composition of a floodable grassland.

The difference in floristic composition and cover found in the studied *Veredas* during both seasons seems to be related to the presence of water. Thus, we can understand that the high floristic richness found in *Veredas* is a result of the variation in soil water content during an annual cyclic period (Araújo *et al.* 2002). Through our results we can conclude that the vegetation structure of this wetland is mediated by variations in flood level between dry and rainy seasons. Obviously, some species have preferences for certain conditions provided by this variation and others occur along seasons without a clear preference for the period. The presence of annual species in both seasons also contributed to the variation in species composition. Although this situation is related to environmental changes in dry and rainy seasons, life cycles of these species is genetically determined, selected by evolutive pressures from dry-rainy variations.

This characteristic dynamics in *Veredas* is necessary to the species in both seasons continue with their life cycles and maintain the function of the ecosystem. So, interventions such as deforestation, dams and drainage can damage such dynamics. We reinforce the importance of conservation of these areas of springs, mainly for providing invaluable ecosystem services, such as the conservation of water resources, very important to the people of the municipality, and for being nesting sites, shelter, refuge and food for the associated fauna.

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Appendix 1. Species list found in the five *Veredas,* in dry and rainy seasons, localized in *Área de Proteção Ambiental* Guariroba, municipality of Campo Grande, state of Mato Grosso do Sul, Brazil.

Family	Species	Dry season	Rainy season
Acanthaceae	*Justicia laevilinguis* (Nees) Lindau		X
Adiantaceae	*Pityrogramma calomelanos* (L.) Link	X	X
Alismataceae	*Echinodorus floribundus* (Seub.) Seub.	X	
	Echinodorus longipetalus Micheli		X
	Helanthium bolivianum (Rusby) Lehtonen & Myllys	X	X
	Sagittaria planitiana G.Agostini	X	X
Anacardiaceae	*Tapirira guianensis* Aubl.	X	X
Anemiaceae	*Anemia* sp.	X	
Annonaceae	*Xylopia emarginata* Mart.	X	
Apiaceae	*Eryngium ebracteatum* Lam.	X	X
	Eryngium floribundum Cham. & Schltdl.	X	
	Eryngium pandanifolium Cham. & Schltdl.	X	X
Apocynaceae	*Mandevilla rugosa* (Benth.) Woodson	X	X
	Oxypetalum sp.		X
Aquifoliaceae	*Ilex affinis* Gardner		X
Araceae	*Urospatha sagittifolia* (Rudge) Schott	X	X
Araliaceae	*Hydrocotyle ranunculoides* L. f.	X	X
Arecaceae	*Mauritia flexuosa* L. f.	X	X
Asteraceae	*Acilepidopsis echitifolia* (Mart. ex DC.) H. Rob.	X	X
	Disynaphia multicrenulata (Sch.Bip. ex Baker) R.M.King & H.Rob.		X
	Elephantopus sp.	X	
	Elephantopus palustris Gardner		X
	Lessingianthus bardanoides (Less.) H. Rob.	X	X
	Lessingianthus rubricaulis (Humb. & Bonpl.) H.Rob.		X
	Mikania glabra D.J.N. Hind	X	
	Mikania micrantha Kunth	X	X
	Mikania psilostachya DC.	X	
	Raulinoreitzia crenulata (Spreng.) R.M.King & H.Rob.	X	X
	Vernonanthura brasiliana (L.) H. Rob.	X	X
	Vernonanthura cuneifolia (Gardner) H.Rob.		X
Bignoniaceae	*Handroanthus impetiginosus* (Mart. ex DC.) Mattos	X	
	Tabebuia insignis (Miq.) Sandw.		X
Calophyllaceae	*Calophyllum brasiliense* Cambess.	X	
Chloranthaceae	*Hedyosmum brasiliense* Miq.	X	X
Commelinaceae	*Floscopa glabrata* (Kunth) Hassk.		X
	Murdannia gardneri (Seub.) G. Brückn.		X

Appendix 1. Continued on next page...

Appendix 1. ...Continued

Family	Species	Dry season	Rainy season
Cyperaceae	*Calyptrocarya glomerulata* (Brongn.) Urb.	X	X
	Cyperus haspan L.	X	
	Cyperus lanceolatus Poir.		X
	Eleocharis acutangula (Roxb.) Schult.	X	X
	Eleocharis capillacea Kunth	X	
	Eleocharis liesneri S.González & Reznicek	X	X
	Eleocharis minima Kunth	X	X
	Eleocharis nudipes Palla	X	
	Eleocharis sellowiana Kunth		X
	Fuirena umbellata Rottb		X
	Lipocarpha humboldtiana Nees		X
	Rhynchospora corymbosa (L.) Britton	X	X
	Rhynchospora emaciata (Nees) Boeckeler	X	X
	Rhynchospora globosa (Kunth) Roem. & Schult.	X	
	Rhynchospora marisculus Lindl. ex Nees	X	X
	Scleria macrophylla J. Presl & C. Presl	X	
	Scleria microcarpa Nees ex Kunth	X	X
Dilleniaceae	*Davilla nitida* (Vahl) Kubitski	X	X
Droseraceae	*Drosera communis* A. St.-Hil.	X	
Ericaceae	*Gaylussacia brasiliensis* (Spreng.) Meisn.		X
Eriocaulaceae	*Eriocaulon elichrysoides* Bong.		X
	Eriocaulon macrobolax Mart.	X	X
	Syngonanthus caulescens (Poir.) Ruhland		X
	Syngonanthus gracilis (Bong.)		X
	Syngonanthus helminthorrhizus (Mart. ex Körn.) Ruhland	X	
Euphorbiaceae	*Acalypha* sp.		X
	Sapium hasslerianum Huber		X
Fabaceae	*Desmodium distortum* (Aubl.) J.F. Macbr	X	X
Gentianaceae	*Chelonanthus viridiflorus* (Mart.) Gilg		X
Lamiaceae	*Hyptis recurvata* Poit.		X
	Hyptis sinuata Pohl ex Benth.	X	
Lauraceae	*Nectandra gardneri* Meisn.		X
	Ocotea lancifolia (Schott) Mez	X	
Lentibulariaceae	*Utricularia gibba* A. Juss.	X	X
	Utricularia nana A.St.-Hil. & Girard	X	
	Utricularia nervosa Weber ex Benj.	X	X
	Utricularia tricolor A. St.-Hil.		X
Malpighiaceae	*Heteropterys eglandulosa* A. Juss.	X	X
	Heteropterys procoriacea Nied.	X	X

Appendix 1. Continued on next page...

Appendix 1. ...Continued

Family	Species	Dry season	Rainy season
Malvaceae	*Byttneria palustris* Cristóbal	X	X
	Peltaea obsita (Mart. ex Colla) Krapov. & Cristóbal	X	
Mayacaceae	*Mayaca sellowiana* Kunth	X	X
Melastomataceae	*Acisanthera alsinaefolia* (DC.) Triana	X	X
	Acisanthera variabilis (DC.) Triana	X	X
	Miconia chamissois Naudin	X	X
	Tibouchina gracilis (Bonpl.) Cogn.	X	X
	Tococa guianensis Aubl.	X	X
Menispermaceae	*Odontocarya tamoides* Miers		X
Myrtaceae	*Myrcia guianensis* (Aubl.) DC.		X
	Eugenia sp.	X	
Ochnaceae	*Sauvagesia racemosa* A. St.-Hil.	X	X
Onagraceae	*Ludwigia nervosa* (Poir.) H. Hara	X	X
	Ludwigia tomentosa (Cambess.) H. Hara	X	X
Phyllanthaceae	*Phyllanthus stipulatus* (Raf.) G.L. Webster	X	X
Piperaceae	*Piper aduncum* L.	X	
	Piper fuligineum Kunth	X	X
Plantaginaceae	*Bacopa arenaria* Loefgr. & Edwall		X
	Bacopa australis V.C. de Souza	X	
	Bacopa salzmannii (Benth.) Wettst. ex Edwall		X
Poaceae	*Andropogon hypogynus* Hack.	X	X
	Andropogon virgatus Desv.	X	X
	Anthaenantia lanata (Kunth) Benth.		X
	Anthaenantiopsis trachystachya (Nees) Mez ex Pilg.	X	
	Axonopus uninodis (Hack.) G.A. Black	X	
	Eriochrysis laxa Swallen	X	X
	Ichnanthus procurrens (Nees ex Trin.) Swallen		X
	Imperata tenuis Hack.	X	
	Loudetia flammida (Trin.) C.E. Hubb.		X
	Luziola bahiensis (Steud.) Hitchc.	X	X
	Panicum parvifolium Lam.	X	X
	Panicum pedersenii Zuloaga		X
	Paspalum dedeccae Quarin		X
	Paspalum glaucescens Hack.	X	
	Paspalum maculosum Trin.		X
	Rhytachne rottboellioides Desv.	X	X
	Saccharum asperum (Nees) Steud.	X	X
	Saccharum villosum Steud.	X	X
	Setaria paucifolia (Morong) Lindm.		X
	Steinchisma hians (Elliott) Nash		X

Appendix 1. Continued on next page...

Appendix 1. ...Continued

Family	Species	Dry season	Rainy season
Polygonaceae	*Polygonum acuminatum* Kunth	X	
	Polygonum stelligerum Cham.	X	
Pontederiaceae	*Pontederia parviflora* Alexander	X	
Rubiaceae	*Borreria pulchristipula* (Bremek.) Bacigalupo & E.L. Cabral	X	X
	Cephalanthus glabratus (Spreng.) K. Schum.	X	
	Coccocypselum hirsutum Bartl. ex DC.	X	
	Emmeorhiza umbellata (Spreng.) K. Schum.	X	
	Galium noxium (A. St.-Hil.) Dempster		X
	Hexasepalum radula (Willd.) Delprete & J.H. Kirkbr.	X	X
	Oldenlandia salzmannii (DC)Benth. & Hook. f. ex B. D. Jacks.	X	
	Psychotria tenerior (Cham.) Müll.Arg.		X
Santalaceae	*Phoradendron* sp.	X	
Sapindaceae	*Serjania marginata* Casar.	X	
Smilacaceae	*Smilax* sp.	X	X
Thelypteridaceae	*Meniscium serratum* Cav.	X	X
Thymelaeaceae	*Daphnopsis racemosa* Mart.	X	
Xyridaceae	*Xyris jupicai* Rich.	X	X
	Xyris laxifolia Mart.		X
	Xyris schizachne Mart.	X	