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Vegetation pyramids applied to the analysis of dense forest units in the Pantanal of *Abobral*

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Abstract

The Pantanal of *Abobral* consists of units of heterogeneous landscapes, in which some dense vegetation, popularly known as *cordilheiras* and *capões*, stand out and survive amidst the floodplain. Such formations are of great importance for local biodiversity, but are continually exploited by livestock without adequate management. The aim of this study is to graphically demonstrate the process by which a *cordilheira* has been going through and discuss the possible causes of environment degradation related to the composition of each vegetal stratum. Biogeographic data sheets were filled with information from the herbaceous, shrubby and arboreal strata, collected in three plots, two at the edges and one at the center of the *cordilheira*. Strata information were graphically compiled in three vegetation pyramids, visually demonstrating the dynamics of the strata, providing a comparative analysis of the plots from aspects related to dynamics and sociability. Nineteen species, of various strata, were recorded in the central plot, compared to 13 and 15 species in the edges. The most frequent species in all plots was *Attalea phalerata*. The species composition of the *cordilheira*, indicated the occurrence of adaptive processes in response to biotic, abiotic and anthropic factors such as laminar erosion, burnings and presence of cattle. An analysis of the vegetation pyramids corroborated the field observations, due to the progression of the arboreal stratum and low representativeness of the other strata.
Keywords: Biogeography; Landscape; *Cordilheira*; Anthropic Impacts

Resumo

O Pantanal do Abobral é composto por unidades de paisagens heterogenias, no qual algumas densas vegetações, conhecidas popularmente como cordilheiras e capões, se destacam e sobrevivem em meio às planícies alagáveis. Possuem grande importância para a biodiversidade local. Tais unidades de vegetação são exploradas pela pecuária sem que haja o manejo adequado. O objetivo deste trabalho é demonstrar graficamente o processo pelo qual uma cordilheira vem passando e identificar as possíveis causas de degradação a partir da composição de cada estrato vegetal. As análises partiram do preenchimento fichas biogeográficas com as informações dos estratos herbáceo, arbustivo e arbóreo, coletadas em três parcelas, duas nas bordas e uma ao centro da Cordilheira. As informações dos estrados foram compiladas graficamente em três pirâmides de vegetação, demonstrando visualmente a dinâmica dos estratos e proporcionaram uma análise comparativa das parcelas a partir de aspectos referentes à dinâmica e sociabilidade. Foram

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contabilizadas 19 espécies na parcela central, comparadas com 13 e 15 espécies nas parcelas das bordas. A espécie de maior ocorrência em todas as parcelas foi *Attalea phalerata*. A composição das espécies na cordilheira, indica a ocorrência de processos adaptativos em resposta a favores bióticos e abióticos como erosão laminar, queimadas e presença de gado. A análise das pirâmides de vegetação corrobora as observações de campo, por causa da progressão do estrato arbóreo e a baixa representatividade dos demais estratos.
Palavras-chave: Biogeografia; Paisagem; Cordilheira; Impactos Antrópicos

I. INTRODUCTION

The Pantanal, located in the Upper Paraguay River Basin, is a seasonally floodable plain with 152,389km² (PARANHOS FILHO et al., 2014, p.73). Pantanal has a hydrological cycle that provides a rapid cycling of nutrients, promoting support for the biodiversity in the region (ALHO, 2008, p.958). Additionally, seasonal flows promote the development of a heterogeneous landscape that is capable of interact with the flood and dry regime (ANDRADE, 2017, p. 54), forming a mosaic of ecosystems.

In the middle of the floodplains, there are forest formations known as *cordilheiras* and *capões*, which stand out due to the subtle positive relief and remain non-flooded during the seasonal flow (SILVA et al., 2000, p.143). These vegetations are described by Pott (1994) and Andrade (2017, p.29): cordilleras are elevations of the plain forming elongated cords; and *capões* are also formed from elevations of the plain, but of elliptical or circular shape and variable diameter.

Cordilheiras and *capões* are essential for the survival of wildlife, being used as a refuge during the flood season and extremely relevant to the biological balance (ANDRADE, 2017, p. 55). These vegetation units are also important for animal nutrition, local temperature regulation, nutrient cycling and litter formation (JUNK et al., 1989, p.112). Despite of its proven importance, these forest units are suffering with anthropic effects. The main local economic activity in Pantanal is cattle raising, which has negative impacts, such as deforestation and environmental degradation (ALHO and GONÇALVES, 2005, p.25).

Biogeographic techniques that enables the graphic analysis of the vegetation cover, such as the vegetation pyramid, were developed by Bertrand (1966, p.138) and Braun-Blanquet (1979, p.65). To assess the current state of phytophysiognomies, the sociability, dominance, and number of individuals in each stratum are important parameters in order to identify the degradation level and how the environment is reacting to it (BRAUN-BLANQUET, 1979, p.29). Different studies have used these techniques in order to access the current

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cover situation of different Brazilian phytophysiognomies (*e.g.* PASSOS and UGIDOS, 1996; PASSOS, 2003; BERTRAND, 1966), including some in the Pantanal (*e.g.* CUNHA et al., 2009; ANDRADE, 2017).

The aim of this study was to characterize the structure of the vegetative strata of a *cordilheira* in the Pantanal of Abobral, discussing the natural and anthropic processes influencing the dynamics of the center and edges of this phytophysiognomy.

II. MATERIAL E METHODS

The study was carried out in the Pantanal of Abobral (Figure 1), a sub-region of the Pantanal from the Brazilian state of Mato Grosso do Sul, located in the municipalities of Aquidauana and Corumbá (aprox. 19°46'13.5"S, 56°04'23.1"W Gr., 19°14'50.7"S, 57°14'01.7''W Gr.) (SILVA and ABDON, 1998, p.1740).

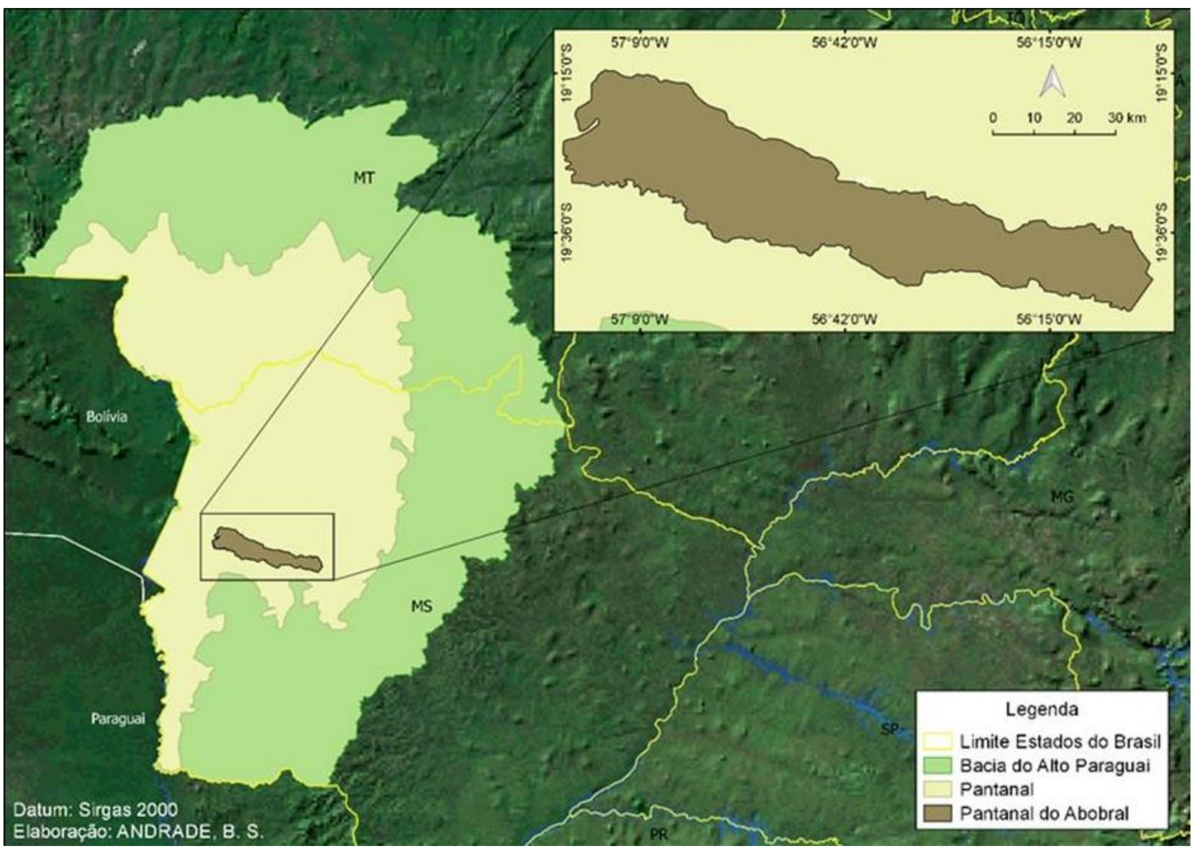

Figure 1 – Pantanal of Abobral location. Source: Andrade (2017, p.26).

Two field trips were carried out for data collection. In the first one (December 02 to 03, 2016) a *cordilheira* was selected (Figure 2) and its perimeter, as well as its area were measured. In the center of the *cordilheira* the first sample plot was established (P1 at 19º26'08.09"S, 57º03'47.5"W; Figure 2). In the second

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field trip (October 28 to 29, 2017), two plots were established (P2 at 19º26'10.34" S, 57º03'46.26" W; and P3 at 19º26'07.1" S, 57º03'49.2" W; Figure 2), one in each of the ends of the *cordilheira*. Each marked plot (*e.g.*, Figures 2 and 3a) had 20m × 20m (400 m²), all of which were geo-referenced by a GPS (Garmin Etrex 30x).

Figure 2 - Geolocation of the studied cordillera in Pantanal of Abobral. Source: Google Earth.

For the development of the study, we used biogeographic data sheets (tables 2, 3 and 4) adapted from Bertrand (1966, p.138). Each data sheet was filled with information such as name of the species; number of individuals; approximate height of the collected plants (Figure 3c) in each stratum (arboreal, shrubby and herbaceous); and the phytosociological parameters proposed by Braun-Blanquet (1979, p.29; Table 1), abundance-dominance (an estimate of the relative surface covered by the different plant species) and sociability (reflecting the grouping between them).

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Table 1 – Classification criteria of the phytosociological parameters, abundance/dominance and sociability, used to describe the vegetal strata of the plots and construct vegetation pyramids.

Class	Abundance/Dominance	Class	Sociability
5	75–100% of canopy coverage	5	Continuous population, dense spots
4	50–75% of canopy coverage	4	Small colonies, dense spots, not extensive
3	25–50% of canopy coverage	3	Growth in groups
2	10–25% of canopy coverage	2	Groups of 2 or 3 individuals
1	Less than 10% of canopy coverage	1	Isolated Individuals
+	Some rare, isolated, normally small individuals	+	Rare or isolated plant

Source: Braun-Blanquet (1979)

Definition of the different plant habits (that name the strata) were based on Harris and Harris (1994, p.141), and Gonçalves and Lorenzi (2007, p.97): trees (composing the arboreal stratum) are woody plants, with a visible, normally single, trunk is visible in its base; shrubs are woody plants, with stems that branch close to the ground; finally, herbs are non-woody plants.

Field collections and herborization of vegetal material were carried out according to the usual techniques of botany (FIDALGO and BONONI, 1984; MORI et al., 1989). Specimens were collected preferably fertile, an than pressed and dried (Figure 3b). For the species identification, all collected material was taken to the Herbarium of the Federal University of Mato Grosso do Sul - Três Lagoas.

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Figure 3 – Collection methods. a) Plot establishment. b) Plant presses drying. c) Collection of tree species.

Data from the biogeographic sheets were graphically represented through the construction of vegetation pyramids (BERTRAND, 1966, p.143; BRAUN-BLANQUET 1979, p.70; PASSOS, 2003, p.255). Vegetation pyramids visually show the dynamics of each stratum, classified as in progression, regression or equilibrium. Strata marked as in progression, tend to have a large amount of young individuals and / or seedlings; on the other hand, strata in regression usually present low abundance of each species and / or several dead individuals; finally, the equilibrium does not exhibit any of the above characteristics or intermediate characteristics. The three constructed vegetation pyramids were analyzed and compared in order to identify differences between them.

Vegetation pyramids constitute a methodological contribution of great importance to Biogeography, especially for the analysis, understanding and graphic representation of the vertical structure of plant units; the dynamics established between the individuals that comprise each stratum; the dynamics between strata; and the dynamics related to the ecobiotic factors (SILVA, 2016, p. 76).

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III. Results and discussion

Measurements of the *cordilheira* indicated an area of ca. 13,750m² and a perimeter of ca. 500m. In the plot located in the center of the *cordilheira* (P1; Figure 4a-h), 19 species were recorded, with predominance of the arboreal stratum, followed by the shrubby and herbaceous strata (Table 2).

Table 2 – Plot 1 biogeographic data sheet. N – Number of individuals; H – Height; A/D – Abundance/Dominance; S – Sociability; ** – Not included in vegetation pyramids.

Stratum	Species	N	H	A/D	S
Arboreal	*Attalea phalerata* (Mart. ex Spreng.) Burret	167	1–10m	5	5
	Anadenanthera colubrina (Vell.) Brenan	17	25m	2	1
	Rhamnidium elaeocarpum Reissek	15	2.5m	1	2
	Handroanthus impetiginosus (Mart. ex DC.) Mattos	6	0.6–2m	+	1
	Trema micranta (L.) Blume	4	5m	1	1
	Unidentified 1	4	15m	2	3
	Unidentified 2	3	0.60–8m	+	1
	Enterolobium contortisiliquum (Vell.) Morong	3	18m	2	2
Shrubby	*Phyllanthus* sp.	7	0.12m	+	1
	Clavija sp.	3	0.10m	+	3
	Cnidoscolus sp.	2	0.60m	+	3
	Serjania sp.	2	0.05m	+	+
	Unidentified 3	1	1.2m	+	+
	Melloa quadrivalvis (Jacq.) A.H.Gentry	1	-	+	+
Herbaceous	*Marantha* sp.	1	0.05m	+	3
Lianas **	*Dioscorea* sp.	5	-	2	1
	Smilax spinosa Mill	1	-	+	+

Abundance/Dominance classes = 5) 75–100% of canopy coverage; 4) 50–75%; 3) 25–50%; 2) 10–25%; 1) less than 10%; +) Some rare, isolated, normally small individuals. Sociability classes = 5) Continuous population, dense spots; 4) small colonies, dense spots not extensive; 3) Growth in groups; 2) Groups of 2 or 3 individuals; 1) isolated Individuals; +) Rare or isolated plant.

There are nine tree species in the P1 plot, the most abundant was *Attalea phalerata*, followed by *Anadenanthera colubrina* and *Rhaminidium elaecarpum*. Other tree species had only a few specimens within the P1 plot, but most of them were seedlings, suggesting that they were recent in the locality and could indicate a progression of the arboreal stratum.

The palm species, *Attalea phalerata*, regionally known as acuri (Figure 4f-g), makes up 75% of the abundance-dominance of the arboreal stratum, been aggregately distributed in dense spots. Evidences of the presence of cattle, indicate the importance of acuri fruits for the cattle and wild fauna diet, since the species

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has a high energetic potential for these animals (TERBORGH, 1986, p.33). Acuri is a heliophile pioneer, that is quite resistant to fires, characteristics that make it very common in the *cordilheiras* (POTT et al., 2011, p.266). The high frequency of acuri individuals causes the species to be frequently considered as a plague (LORENZI, 1992, p.274) or superdominant species (MATOS and PIVELLO, 2009, p.29), and different studies carried out in the Pantanal showed the high abundance of *A. phalerata* (e.g., SEPÚLVEDA, 2016; ANDRADE, 2017). Acuri abundance may be related to cattle raising, since cattle potentially act on intense seed dispersal (Tomas et al., 2009, p.58).

Anadenanthera colubrina had several individuals in the P1 plot, however had abundance-dominance of only 20%, due to the presence of a single mature individual (25m tall), and 16 seedlings or young specimens. This heliophilous species may be colonizing the center of the *cordilheira* due to the appearance of open areas in the canopy (LORENZI, 1992, p.172).

Rhaminidium elaecarpum (Figure 4d-e) is regionally known as cabriteiro, and composes less than 10% of the abundance-dominance of the arboreal stratum in the P1 plot. This species is better adapted to open and humid formations, have fruits that are consumed by cattle and birds, and has great potential for regrowth, been relatively common in deforested areas (LORENZI, 1992, p. 298; POTT, 1994).

Only six shrub species occur in the P1 plot, been *Phyllanthus* sp. (Figure 4c) the most abundant, followed by *Clavija* sp., *Serjania* sp. and *Cnidoculis acileatissimus*. *Phyllantus* sp. had mostly young individuals, suggesting a progression of the shrub stratum. The occurrence of this species is normally related to movement of livestock (POTT, 1994), indicating an anthropogenic effect in the *cordilheira*. *Cnidosculus aculeatissumus* occurred only as a few mature individuals, this species is a bioindicator of environments affected by fires or seasons of drought (POTT, 1994).

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Figure 4 – Plot 1 characterization. a) Geolocation. b–h) Plant species. b) *Maranta* sp. c) *Phyllanthus* sp. d–e) *Rhamnidium elaeocarpum* Reissek. d) Habit. e) Leaf. f–g) *Attalea phalerata* (Mart. ex Spreng.) Burret. f. Habit. g) Inflorescence. h) *Smilax spinosa* Mill. Images source: a) Google Earth. b–h) First author.

The herbaceous stratum was characterized only by *Maranta* sp. (Figure 4b), which is a quite resilient species, adapted to environments with occasional fires. However, only a few individuals were found, suggesting a strong regression, probably related to the progression of the other strata and the presence of cattle in the area.

The P2 plot (Figure 5a-f), located in one of the edges of the *cordilheira* (Figure 5a), had evidences of recent floods (Figure 5d), such as water marks in the tree trunks and exposed roots at the base of the trees. Claw marks were also found in one of the trees (Figure 5e), evidencing the presence of wild animals in the area,

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probably felines, as mentioned by Andrade (2017, p.6) in her study in the region. The presence of wild life in the area emphasizes the ecological importance of this environment as a refuge for wildlife. A total of 14 species were recorded in the P2 plot, which also had predominance of arboreal stratum (Table 3).

Table 3 – Plot 2 biogeographic data sheet. N – Number of individuals; H – Height; A/D – Abundance/Dominance; S – Sociability; * – Limitrophe species.

Stratum	Species	N	H	A/D	S
Arboreal	*Attalea phalerata* (Mart. ex Spreng.) Burret	316	0.60–3m	5	5
	Rhamnidium elaeocarpum Reissek	29	0.60–1.5m	3	3
	Croton urucurana Baill	15	0.30m	+	+
	Inga vera Willd	10	1m	+	1
	Aspidosperma cylindrocarpon Müll.Arg.	9	1.70m	2	2
	Trema micranta (L.) Blume	7	3–5m	3	2
	Unidentified 1	3	0.30–1.5m	+	+
	Unidentified 2	3	2m	+	1
	Handroanthus impetiginosus (Mart. ex DC.) Mattos	2	2m	2	2
	Unidentified 3	1	1.5m	+	+
	Unidentified 4	1	20m	1	1
Shrubby	*Serjania sp.*	30	0.30m	1	3
	Unidentified 5	12	0.30m	1	1
	Randia armata (Sw.) DC	1	1.8m	+	+
Herbaceous	*Bromelia balaense* Mez*				

Abundance/Dominance classes = 5) 75–100% of canopy coverage; 4) 50–75%; 3) 25–50%; 2) 10–25%; 1) less than 10%; +) Some rare, isolated, normally small individuals. Sociability classes = 5) Continuous population, dense spots; 4) small colonies, dense spots not extensive; 3) Growth in groups; 2) Groups of 2 or 3 individuals; 1) isolated Individuals; +) Rare or isolated plant.

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Figure 5 – Plot 2 Characterization. a. Geolocation. b–-c) Plant species. b) *Trema micranta* (L.) Blume. c) *Bromelia balaense* Mez. d) floodmark in the tree. e) Wild animal scratch. f) Fallen tree and clearing. Images source: a) Google Earth. b–f) First author.

There are 11 tree species in the P2 plot, the most common was *A. phalerata*, followed by *R. elaecarpum*, *Croton urucurana*, *Inga* cf. *urugensis*, *Aspidosperma cylindrocarpe* and *Trema micranta*. Despite the large number of individuals of *A. phalerata*, the abundance/dominance of the species in the P2 plot (45%) was not as great as in the P1, due to the higher proportion of seedlings to mature individuals. The sociability of this palm species indicated groups of four to six individuals sparsely distributed throughout the plot. Another important

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tree species in the P2 plot was *T. Micrantha* (Figure 5b), with individuals 3-5m tall. *Trema micranta* is a pioneer species of deforested or burned areas (POTT, 1994), which may indicate that the area is undergoing a local restoration process. The large number of seedlings and young individuals in this plot can indicate the progression of the arboreal stratum, even though the absolute coverage of the plot canopy is only 50%, with a large clearing left after the fall of some trees (Figure 5e). Degradation of the upper stratum has negative impacts on the fauna, especially for frugivorous species, pollinators, and species that nests on the trees (TOMAS et al., 2009).

The shrubby stratum in the P2 plot is composed by four species, in which *Serjania* sp. stands out in numbers of individuals, but all at a young age. This species easily regrowth after burnings (POTT, 1994), and the size and number of the individuals can indicate a recent fire, hypothesis corroborated by the burn marks on the bark of trees in the plot. Other shrub species in the P2 plot were found in a low number of individuals and at young age, characterizing a stratum regression.

No herb was collected within P2 plot, clearly showing a regression of the stratum, probably due to fires and cattle. However, it is important to highlight the presence of *Bromelia balaense*, the caraguatá (Figure 5c), as a large patch composed of several young and adult individuals in areas adjacent to the plot. The fire regime has a close relation with the caraguatá, promoting the increase of the number of individuals, through the rhizomes that survive the heat and regrow occupying the recently formed clearings. This species was graphically represented in the vegetation pyramid of the P2 plot, as a progressive limitrophic species in the *cordilheira*.

In the P3 plot (Figure 6a-d), located in the opposite edge of the *cordilheira* (Figure 6a), 16 species were recorded. This plot also had the predominance of tree species (Table 4), and the arboreal stratum was the only one in progression. There are 11 tree species in the P3 plot, the most abundant was *Attalea phalerata*, followed by *Copernicia alba*. As in the other plots, *A. phalerata*, was the most numerous species. Its sociability was represented by small colonies composing dense spots within the plot, and its abundance/dominance represented a coverage of ca. 50% of the canopy.

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Table 4 – Plot 3 biogeographic data sheet. N – Number of individuals; H – Height; A/D – Abundance/Dominance; S – Sociability; * – Limitrophe species; ** – Not included in vegetation pyramids.

Stratum	Species	N	H	A/D	S
Arboreal	*Attalea phalerata* (Mart. ex Spreng.) Burret	232	0.30–4m	5	4
	Copernicia alba Morong	6	10m	2	1
	Unidentified 1	4	3m	+	+
	Albizia niopoides (Benth.) Burkart	2	3–30m	2	+
	Unidentified 2	2	12m	2	+
	Inga vera Willd	2	0.2m	+	+
	Psidium guineense Sw.	2	5m	+	+
	Croton urucurana Baill	1	1m	+	+
	Curatella americana L.	1	0.2m	+	+
	Unidentified 3	1	4m	+	+
	Unidentified 4	1	1.5m	+	+
Shrubby	Unidentified 5	6	1m	+	+
	Unidentified 6	1	0.2m	+	+
	Randia armata (Sw.) DC	1	2m	+	+
Herbaceous	*Bromelia balaense* Mez *	-	-	1	5
Lianas**	*Dioscorea alata* L.	-	-	+	+

Abundance/Dominance classes = 5) 75–100% of canopy coverage; 4) 50–75%; 3) 25–50%; 2) 10–25%; 1) less than 10%; +) Some rare, isolated, normally small individuals. Sociability classes = 5) Continuous population, dense spots; 4) small colonies, dense spots not extensive; 3) Growth in groups; 2) Groups of 2 or 3 individuals; 1) isolated Individuals; +) Rare or isolated plant.

Copernicia alba (Figura 6e), popularly known as caranda, was another important tree species in the P3 plot. This species is relatively common in the Pantanal, however its occurrence was not registered in the other plots. Some specimens of caranda had exposed roots up to 1m above the ground (Figure 6e), indicating the occurrence of laminar erosion (i.e., removal of layers from the soil along with the water flow), which can only be noticed through the gradual exposure of the tree roots, indicating the depth of the soil layers that were dragged (BERTONI and NETO, 2012) Laminar erosion can be aggravated by the presence of livestock, a process already observed in *cordilheiras* of the Pantanal of Nhecolandia (Silva et al. 2013). The caranda is a fire-resistant species, pioneer of succession, with excellent interaction with the water dynamics, tolerating up to 5m of flood (POTT, 1994).

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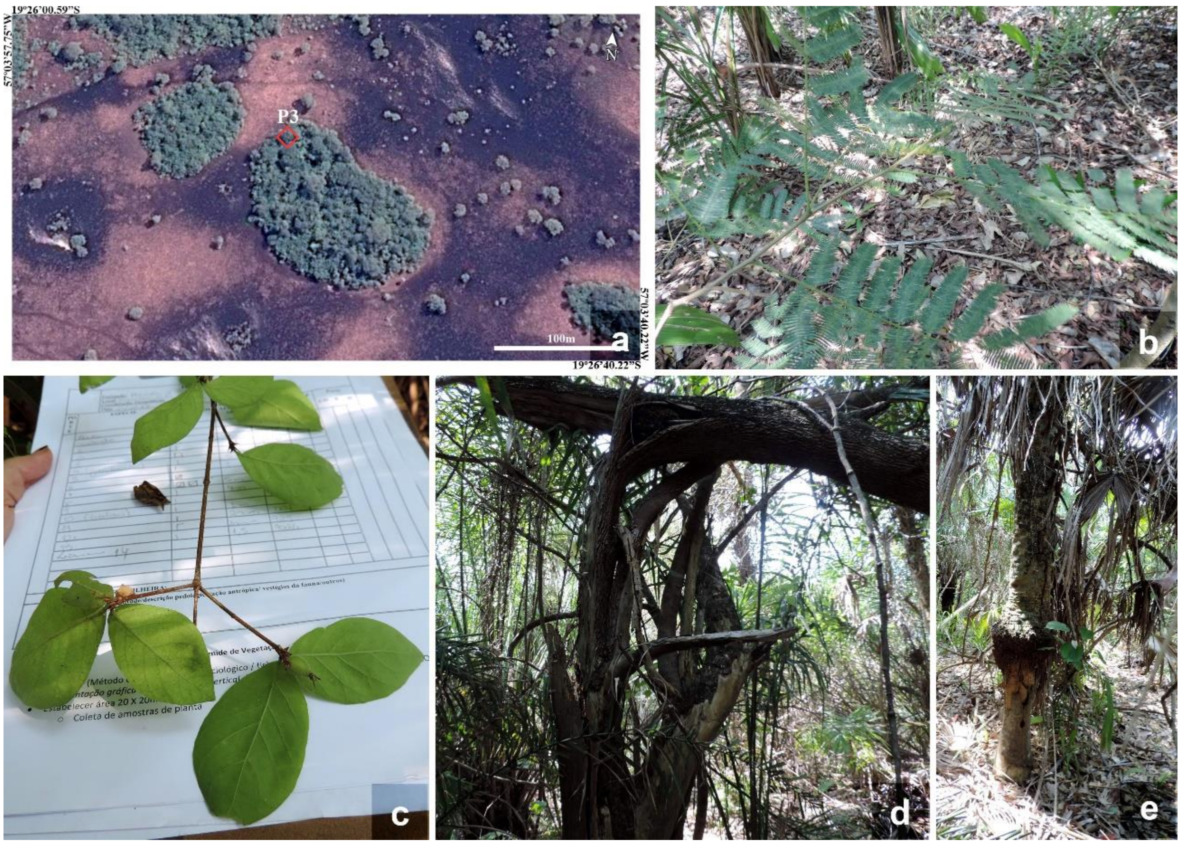

Figure 6 – Plot 3 Characterization. a. Geolocation. b–-c) Plant species. b) *Albizia niopoides* (Benth.) Burkart. c) *Randia armata* (Sw.) DC. d) Burned trees. e) Evidence of laminar erosion in *Copernicia alba* Morong. Images source: a) Google Earth. b–e) First author.

A last tree species that should be highlighted is *Albiza niopoides* (Figure 6b), bioindicator of degraded areas and very suitable for its recovery, sheltering native bird nests, such as the blue macaw and *tuiuiú* (POTT, 1994). Other tree species had only a few specimens within the P3 plot.

The shrubby stratum, was represented by four species in the P3 plot. However, only one was collected fertile and could be identified, *Randia armata* (Figure 6c). The low number of shrub individuals indicated that the stratum is in regression (Figure 7). The herbaceous stratum had no specimens collected, but as in the P2 plot, the caraguata, was present around the plot.

The information collected in the plots demonstrates the dynamics of each vegetative stratum and the process by which the *cordilheira* is going through. An analysis of the vegetation pyramids (Figure 7), suggests that in all three plots the arboreal stratum is going through progression. Biologically, this is corroborated mainly by the massive presence of *A. phalerata* and other pioneer species, which have rapid growth and colonize altered areas (LORENZI, 2002) collaborating for the process of ecological succession. Our results corroborate

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what was reported by Andrade (2017, p.72), in which *A. phalerata* was the species with the highest number of individuals in other *cordilheiras* in the Abobral region of Pantanal.

The arboreal stratum differs between the plots mainly in terms of sociability, in which the plot in center of the *cordilheira* (P1), process a very dense spot, with a near total coverage of the canopy from a larger number of species and individuals. P2 and P3 plots have canopy coverages close to 50%, and dominance of individuals of *A. phalerata* aggregated in dense spots. The abundance of *acurí* has correlation with cattle and fires, and its monodominance evidences the process of degradation, reducing or preventing the recruitment of tree species (TOMAS et al., 2009, p. 58).

In plots 2 and 3, it is possible to verify the change in the structure and floristic composition due to its proximity to the border that is influenced by natural flood events of the Pantanal (PRADO et al., 1994), evidenced by palm species such as *C. alba* and *A. phalerata*, that are adapted to flooded environments.

The pattern of sociability in the last two plots reflected the agglutination of specimens and the presence of large clearings in the area. These forest glades increase the incidence of light and consequentially modify the forest structure and species dynamics, increasing the establishment of sun tolerant and fast-growing species (e.g., pioneer, herbaceous and liana species) (LIMA, 2005, p.653; ANDRADE, 2017, p.80).

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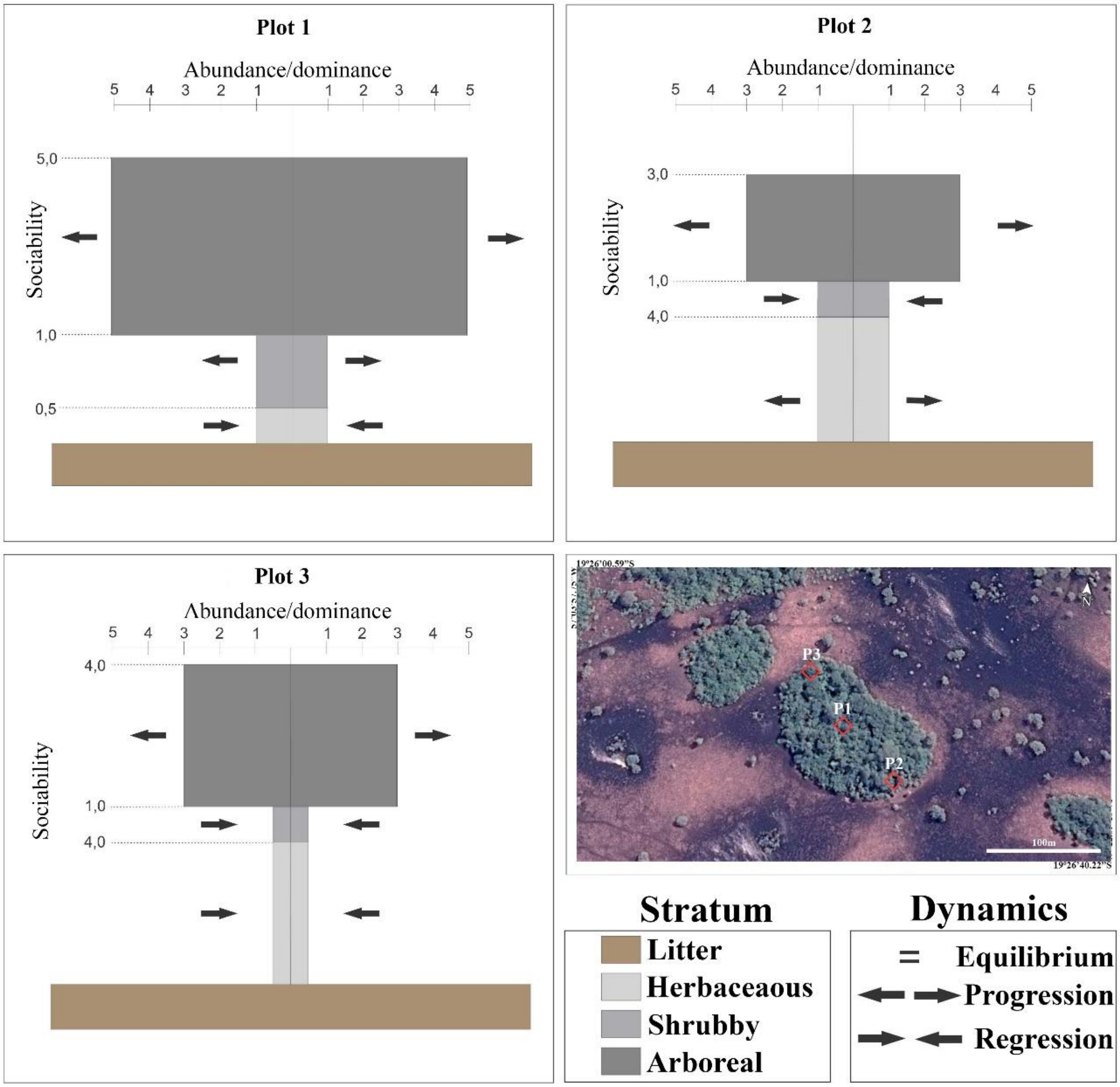

Figure 7 – Vegetation pyramids. Abundance/Dominance classes = 5) 75–100% of canopy coverage; 4) 50–75%; 3) 25–50%; 2) 10–25%; 1) less than 10%; +) Some rare, isolated, normally small individuals. Sociability classes = 5) Continuous population, dense spots; 4) small colonies, dense spots not extensive; 3) Growth in groups; 2) Groups of 2 or 3 individuals; 1) isolated Individuals; +) Rare or isolated plant.

Clearings in some forest formations can contribute to floristic diversity and in some cases to the regeneration of the plant community, since photoblastic seeds may take advantage of the light incidence to develop (BROKAW, 1982, p.102; DENSLOW & HARTSHORN, 1994, p. 144; TABARELLI, 1994, p. 142). In the studied *cordilheira*, the presence of clearings played an important role in the establishment of liana species, which are also favored by the dry period (SCHNITZER, 2005, p. 267) and the occurrence of fires (DAMASCENO-JUNIOR et al., 1999, p. 206; POTT 2000, p. 175).

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Heliophilous liana species, such as *Dioscorea alata* and *Smilax fluminenceses* (Figure 4h), were found in plots 1 and 3. Both species are well adapted and generally related to the presence of humans in the area (POTT, 1994). Lianas are woody plants that grows climbing on other plants (HARRIS and HARRIS, 1994; GONÇALVES and LORENZI, 2007). Because of this, species of lianas were not included in the vegetation pyramids, as they did not conform to any of the habits established by Passos and Ungido (1996) and Bertrand (1966, p. 143). Nevertheless, it is important to note that lianas are bioindicators of anthropic processes or natural disturbances due to their affinity for open environments such as edges or clearings in forestall formations (PUTZ, 1984).

Lianas are also associated with habitat degradation, as they affect the natural regeneration of trees and the development of herbaceous species due to the excessive shading, mechanical effect and smothering caused by their occupation.

The P1 plot was the only one that have the shrubby stratum in progression, with the occurrence of a greater number of individuals. The herbaceous stratum was the least represented, with none individuals collected in the plots of the edges. Different factors may explain the low representativeness of the herbaceous and shrubby strata: natural prevalence of tree species in forest formations, such as of the *cordilheiras*; monodominance of some species overshadowing the lower strata; occurrence of recent fires (Figura 6d) that clared the understory of the formation; consumption by cattle of the low vegetation; reduction of the strata caused by the flood and consequent laminar erosion (Figura 6e).

IV. CONCLUSION

Vegetation pyramids contributed to the observation of the environmental pressures in the studied area, since, the dynamics between the strata and the ecology of the species, indicate environmental degradation. Progression of the arboreal stratum indicates a recent instability in the *cordilheira*, specially because of the prevalence of pioneer species, bioindicators of degradation. Such instability is also proved by the small variability of species, regression of the shrubby stratum and the lack of herbaceous individuals in most plots, which may be related to anthropic processes, such as livestock activity. In contrast, we observed the environmental struggle for the recovery of the ecosystem, but that occurs at a slower rate than the degradation. The study of the landscape of this *cordilheira*, provide an insight into the processes that are occurring in a small part of a large biome, which may reflect on larger scales. Therefore, there is great importance in the study of

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cordilheiras, seeking to understand the biogeographic phenomena of this important physiognomy from Pantanal.

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