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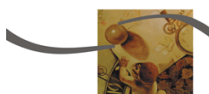
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Analysis of floristic similarity between forest remnants from the upper Paraná river floodplain, Brazil

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ABSTRACT. The vegetation from the upper Paraná river floodplain is a fragment of Seasonal Semideciduous Forest (SSF) that presents fields, lowlands and extensive areas of pasture along with forest formations. Aiming to accomplish analyses of floristic similarity between riparian forests remnants in this floodplain, an analysis using nine surveys was performed, four on the right bank, two on the left bank and three at an island, including tree species. Sørensen's (ISs) and Jaccard's (ISj) similarity coefficients were calculated, and a Correspondence Analysis (CA) was applied to a matrix of presence and absence of species. Thirty-seven families, 80 genera and 110 species were recorded. Among the species, 5.5% were generalist, while 29.1% were exclusive to one survey. The values of ISs and ISj ranged from 31 to 78.4%, and 31 to 64.5%, respectively. The CA grouped the surveys in the right and left banks and the island; the species with the highest positive correlation on axis 1 were the most common in the surveys on the left bank. The obtained results evidenced that floristic surveys constitute important indicatives for evaluations of the vegetation distribution in the floodplain.

Keywords: coefficients of similarity, multivariate analysis, seasonal semideciduous forest, riparian vegetation.

Análise da similaridade florística entre remanescentes florestais da planície de inundação do alto rio Paraná, Brasil

RESUMO. A vegetação da planície de inundação do alto rio Paraná encontra-se nos domínios da Floresta Estacional Semidecidual (FES) e, além das formações florestais, apresenta campos, várzeas e extensas áreas de pastagem. Com o objetivo de elaborar análises da similaridade florística entre remanescentes florestais ripários dessa planície, foi realizada uma análise entre nove levantamentos, sendo quatro na margem direita, dois na esquerda e três em uma ilha, para as espécies arbóreas. Foram calculados os índices de similaridade de Sørensen (ISs) e de Jaccard (ISj) e elaborada Análise de Correspondência (CA), a partir de uma matriz de presença e ausência para espécies. Foram listadas 37 famílias, 80 gêneros e 110 espécies. Dentre as espécies, 5,5% foram generalistas enquanto que, 29,1% foram exclusivas de apenas um levantamento. Os valores de ISs variaram de 31 a 78,4% e os de ISj de 31 a 64,5%. A CA agrupou os levantamentos nas margens direita e esquerda e a ilha, as espécies com maior correlação positiva no eixo 1 foram as comuns aos levantamentos da margem esquerda. Os resultados alcançados demonstraram que levantamentos florísticos constituem importantes indicativos para avaliações da distribuição da vegetação nessa planície.

Palavras-chave: índices de similaridade, análises multivariadas, floresta estacional semidecidual, floresta ripária.

Introduction

Wetlands are aquatic ecosystems found in all climate types, from the tropics to the tundra, and on all continents, except Antarctica (MITSCH; GOSELINK, 1993). These environments include water bodies, temporary or not, as lakes, rivers and streams, besides marsh, floodplains and marine ecosystems, among others (GOPAL; JUNK, 2000; NEIFF, 2001).

Occupy about 6% from the Earth surface, or 8.6 million km², of which about 56% are in tropical and subtropical regions (MITSCH; GOSELINK, 1993). These areas provide one of the major ecological traits to South America, due to the large extent of

occurrence, encompassing approximately 20% of its territory (JUNK, 1993); and for Brazil, were estimated 1,082,466 km² (NEIFF, 2001). Most wetlands belong to the category of floodplain, which are those periodically flooded (JUNK et al., 1989).

The forest in the surroundings of water bodies, known as riparian or streamside vegetation among others, present differences mainly regarding the floristic composition and structure. In general, low values of similarity indexes and high species diversity, due to environmental heterogeneity have been registered to Brazilian riparian forests (BERNACCI et al., 1998; LACERDA et al., 2005; MEYER et al.,

2004; RODRIGUES; NAVE, 2004; ROLIM et al., 2006; TEIXEIRA; RODRIGUES, 2006).

Several factors may influence the (dis) similarity between riparian forests, such as the hydrological characteristics from the watershed, the different influence degrees of flooding, the forest remnant width, the matrix and domain of vegetation, successional stage, climate, topography, soil types, geographical distance, altitude and latitude (ARAÚJO et al., 2005; BERNACCI et al., 1998; COSTA; MANTOVANI, 1995; DURIGAN et al., 2008; KINOSHITA et al., 2006; LACERDA et al., 2005; MACHADO et al., 2004; MARANGON et al., 2003; MEYER et al., 2004; METZGER et al., 1997; RODRIGUES; NAVE, 2004; ROLIM et al., 2006; SANTOS; KINOSHITA, 2003; SILVA et al., 2007; STRANGHETTI; RANGA, 1998; TEIXEIRA; RODRIGUES, 2006).

For the upper Paraná river floodplain, the floristic similarity was low and the factors related was the vegetation heterogeneity that comprised the Seasonal Semideciduous Forest (SSF), the typical formations of riparian forests, the Cerrado and the Pantanal; the water availability, the soil type and anthropogenic disturbances (SOUZA; MONTEIRO, 2005; SOUZA et al., 1997; SOUZA et al., 2004a; ROMAGNOLO; SOUZA, 2000). Concerning these assessments, Souza et al. (2004b) divided didactically the superior stretch of this plain into three systems, known as left bank, right bank and central (islands).

In this way, the present study aimed to analyze the floristic similarity, including tree component, between riparian forest remnants from the upper Paraná river

floodplain, considering the hypothesis that the floristic composition is an useful indicative to distinguish the three compartments, i.e., left bank, right bank and island.

Material and methods

The study area comprised riparian forest remnants located at upper Paraná river floodplain, in the Mato Grosso do Sul and Paraná States, of which nine were selected to accomplish surveys of tree species (Figure 1; Table 1).

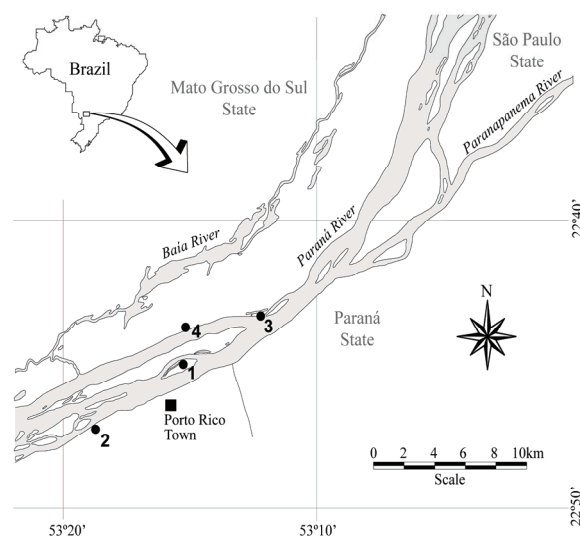


Figure 1. Location of the study area and surveys employed in the analysis of floristic similarity of upper Paraná river floodplain (Mato Grosso do Sul and Paraná States, Brazil) (1 = A1, A2, A3; 2 = A4, A9; 3 = A5 and 4 = A6, A7, A8) (A1 to A9 = study areas according to Table 1) (Modified from Nupélia/UEM, 2012).

Table 1. Surveys accomplished in riparian forests from the upper Paraná river floodplain (Mato Grosso do Sul and Paraná States, Brazil) and employed in the analysis of floristic similarity (SSF = Seasonal Semideciduous Forest; DBH = diameter at breast height; Ne = number of species).

Source	Code	Municipality	State	Altitude (m)	Vegetal formation	Soil type	Location	Site	Sampling method	Sampled area (ha)	Inclusion criteria	Ne
Campos and Souza (2003)	A1	Porto Rico	PR	230	Alluvial SSF	Hydromorphic alluvial	Porto Rico Island	Forest 1	Parcels	0.41	DBH \geq 4.8 cm	33
Campos and Souza (2003)	A2	Porto Rico	PR	230	Alluvial SSF	Non-hydromorphic alluvial	Porto Rico Island	Forest 2	Parcels	0.45	DBH \geq 4.8 cm	18
Campos and Souza (2003)	A3	Porto Rico	PR	230	Alluvial SSF	Non-hydromorphic alluvial	Porto Rico Island	Forest 3	Parcels	0.13	DBH \geq 4.8 cm	23
Slusarski; Souza, unpublished data	A4	Porto Rico	PR	250	Submontane SSF	-	Left bank	Araldo Forest	Floristic	\approx 10.0	Trees	68
Campos et. al. (2000)	A5		MS	250	Alluvial SSF	Non-hydromorphic alluvial (levee) and Hydromorphic alluvial (lake)	Right bank	-	Parcels	0.54	DBH \geq 4.8 cm	43
Romagnolo and Souza (2000)	A6	Taquaruçu	MS	200-300	Alluvial SSF	Non-hydromorphic alluvial	Right bank	Downstream	Parcels	0.31	DBH \geq 4.8 cm	40
Romagnolo and Souza (2000)	A7	Taquaruçu	MS	200-300	Alluvial SSF	Non-hydromorphic alluvial	Right bank	Intermediate	Parcels	0.31	DBH \geq 4.8 cm	29
Romagnolo and Souza (2000)	A8	Taquaruçu	MS	200-300	Alluvial SSF	Non-hydromorphic alluvial	Right bank	Upstream	Parcels	0.31	DBH \geq 4.8 cm	36
Romagnolo and Souza (2005)	A9	Porto Rico	PR	250	Submontane SSF	-	Left bank	Araldo Forest	Floristic	\approx 2.5	Trees	85

The Paraná river is the tenth in the world in discharge, and one of the main constituents of the second largest drainage basin from South America, the La Plata Basin. Since its headwater, in the confluence of Grande and Paranaíba rivers, until its mouth, at the estuary of Prata river, near Buenos Aires, the Paraná river runs about 3,800 km, draining an area of 2,800,000 km² (STEVAUX et al., 1997).

At its upper stretch, the river forms a floodplain, composed by a main channel, islands and sandy bars (STEVAUX, 1994). The left bank is formed by Caiuá Sandstone Formation and is differentially exposed to the floods, which is determined by altitude and topographic variations, mostly forming speets up to 15 m height and more rarely low-lying areas subjected to flooding. The right bank is composed by alluvial sediments and alluvial colluvium unconsolidated and associated to Paraná river and tributaries, form an extensive fluvial plain with a complex of tributaries, secondary channels, marshes, lakes and marginal levees (SOUZA FILHO; STEVAUX, 1997).

Among human disturbances that the Paraná river is exposed, the main one is the dams, present both in the main channel and in most tributaries, totaling about 130 reservoirs. Therefore, the floodplain that presented 480 km extension and more than 20 km width, was reduced for 230 km extension with the construction of Porto Primavera dam in 1998 (AGOSTINHO et al., 2004).

The climate, according to Köppen classification system, is Cfa or tropical-subtropical climate with hot summer. The annual mean temperature is higher than 22°C and the annual mean precipitation ranges from 1,200 to 1,500 mm (CAMPOS; SOUZA, 2003; CAMPOS et al., 2000; SOUZA; MONTEIRO, 2005).

The vegetation is inserted in the SSF domain (IBGE, 1992) and is represented by two formations: the Alluvial and the Submontane (VELOSO; GÓES FILHO, 1982), besides the non-forest vegetation

and the areas of ecological tension (CAMPOS; SOUZA, 1997). The forests, beyond the species from SSF, present typical areas of riparian areas, of Cerrado and of Pantanal (SOUZA; MONTEIRO, 2005) and are influenced by the availability of water, soil type, adjacent vegetation and anthropogenic disturbances (SOUZA et al., 2004a).

From this list of species gathered by these surveys, we elaborated a matrix of presence and absence, employed in the floristic comparison and in the similarity analyses between the areas. We conferred the synonyms and excluded the unknown taxa at any taxonomic level. The angiosperm species were grouped in families according to the APG III system (APG III, 2009). The writing of scientific names, abbreviations of names of the species authors and synonymy of the species were checked in the Index Kewensis, by consulting the *site* from Missouri Botanical Garden, St. Louis (MOBOT, 2010) or Lista de Espécies da Flora do Brasil 2012 (FLORA DO BRASIL, 2012).

The floristic similarity between the surveys was assessed through the Sørensen's (ISs) and Jaccard's (ISj) similarity coefficients (MÜELLER-DOMBOIS; ELLENBERG, 1974). The first allowed comparisons with three previous studies accomplished in the upper Paraná river floodplain, and the second, with other studies developed in areas of riparian SSF. In order to ordinate the data, we applied the Correspondence Analysis (CA) (MCCUNE; GRACE, 2002), by using the PC-ORD software version 4, and the graphs were made using Statistica 7 software.

Results and discussion

The floristic list, compiled from nine surveys, resulted in a total of 110 species that were grouped in 80 genera and 37 families (Table 2). The number of sampled species, by survey, ranged from 18 to 85, with mean value of 12.22.

Table 2. Floristic list of tree species with respective occurrences in nine surveys accomplished in the upper Paraná river floodplain (Mato Grosso do Sul and Paraná States, Brazil) (A1 to A9 = study areas according to Tab. 1; 1 = presence; 0 = absence; T = total number of surveys in which the species occurred; *exotic species).

Family/Species	A1	A2	A3	A4	A5	A6	A7	A8	A9	T
ANACARDIACEAE										
3- <i>Astronium graveolens</i> Jacq.	0	0	0	0	0	0	0	0	1	1
4- <i>Spondias mombin</i> L.	0	0	0	1	1	1	1	1	0	5
ANNONACEAE										
5- <i>Annona emarginata</i> (Schltdl.) H. Rainer	1	1	0	1	1	1	1	1	0	7
6- <i>Annona sylvatica</i> A.St.-Hil.	1	0	0	0	0	0	0	0	0	1
7- <i>Unonopsis guatterioides</i> (A.DC.) R.E.Fr.	1	0	1	1	1	1	1	1	1	8
APOCYNACEAE										
8- <i>Tabernaemontana catharinensis</i> A.DC.	1	1	1	1	1	1	1	1	1	9
ARECACEAE										
1- <i>Acrocomia aculeata</i> (Jacq.) Lodd. ex Mart.	0	0	0	1	0	0	0	0	1	2

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Family/Species	A1	A2	A3	A4	A5	A6	A7	A8	A9	T
BIGNONIACEAE										
9- <i>Handroanthus heptaphyllus</i> Mattos	0	0	0	0	0	0	0	0	1	1
10- <i>Tabebuia rosealba</i> (Ridl.) Sandwith	0	0	0	0	0	0	0	0	1	1
BORAGINACEAE										
11- <i>Cordia ecalyculata</i> Vell.	0	0	0	0	0	0	0	0	1	1
12- <i>Cordia sellowiana</i> Cham.	0	0	0	0	1	1	0	1	0	3
BURSERACEAE										
13- <i>Protium heptaphyllum</i> (Aubl.) Marchand	0	0	1	0	1	1	0	0	0	3
CALOPHYLLACEAE										
16- <i>Calophyllum brasiliense</i> Cambess.	0	0	0	0	1	1	0	1	1	4
CANNABACEAE										
107- <i>Celtis iguanaea</i> (Jacq.) Sarg.	1	1	0	1	1	0	0	1	1	6
108- <i>Trema micrantha</i> (L.) Blume	0	0	0	1	0	1	0	0	1	3
CELASTRACEAE										
32- <i>Salacia grandiflora</i> Peyr.	0	0	0	0	0	1	1	0	0	2
CHRYSOBALANACEAE										
15- <i>Licania octandra</i> (Hoffmanns. ex Roem. & Schult.) Kuntze	0	0	0	0	0	0	0	0	1	1
CLUSIACEAE										
17- <i>Garcinia brasiliensis</i> Mart.	0	0	0	0	0	1	0	1	0	2
18- <i>Garcinia gardneriana</i> (Planch. & Triana) Zappi	0	0	0	1	0	0	0	0	0	1
ELAEocarpaceae										
19- <i>Sloanea garckeana</i> K.Schum.	1	1	1	1	1	0	0	1	1	7
20- <i>Sloanea guianensis</i> (Aubl.) Benth.	0	0	0	1	1	1	1	1	1	6
ERYTHROXYLACEAE										
21- <i>Erythroxylum anguifugum</i> Mart.	1	0	0	1	0	0	0	0	1	3
22- <i>Erythroxylum pelleterianum</i> A.St.-Hil.	0	0	0	0	0	0	0	0	1	1
EUPHORBIACEAE										
23- <i>Actinostemon conceptionis</i> (Chodat & Hassl.) Hochr.	0	0	0	1	0	0	0	0	1	2
24- <i>Alchornea glandulosa</i> Poepp. & Endl.	0	0	0	1	0	1	0	0	1	3
25- <i>Croton urucurana</i> Baill.	1	1	0	1	1	0	1	1	1	7
LAMIACEAE										
109- <i>Vitex megapotamica</i> (Spreng.) Moldenke	0	1	0	1	0	1	1	0	1	5
LAURACEAE										
35- <i>Nectandra angustifolia</i> (Schrad.) Ness	1	1	0	1	1	0	1	1	1	7
33- <i>Nectandra cissiflora</i> Ness	0	0	0	0	1	1	0	1	0	3
34- <i>Nectandra cuspidata</i> Nees	0	0	0	0	0	0	0	1	0	1
36- <i>Nectandra leucantha</i> Nees	0	0	0	1	0	0	0	0	1	2
37- <i>Nectandra reticulata</i> (Ruiz & Pav.) Mez	0	0	0	0	1	0	0	1	0	2
38- <i>Ocotea diospyrifolia</i> (Meisn.) Mez	1	1	1	1	1	1	1	1	1	9
39- <i>Ocotea puberula</i> (Rich.) Nees	0	0	0	0	0	0	0	0	1	1
LECYTIDACEAE										
40- <i>Cariniana estrellensis</i> (Raddi) Kuntze	0	0	0	1	0	0	0	0	1	2
LEGUMINOSAE										
Caesalpinioideae										
41- <i>Apuleia leiocarpa</i> (Vogel) J.F.Macbr.	0	0	0	1	1	0	0	0	0	2
42- <i>Copaifera langsdorffii</i> Desf.	0	0	0	0	1	0	0	0	0	1
43- <i>Peltophorum dubium</i> (Spreng.) Taub.	0	0	1	1	1	1	1	1	1	7
44- <i>Pterogyne nitens</i> Tul.	0	0	0	1	0	0	0	0	0	1
Faboideae										
45- <i>Andira fraxinifolia</i> Benth.	1	0	0	1	0	0	0	0	1	3
46- <i>Dalbergia frutescens</i> (Vell.) Britton	0	0	0	1	0	0	0	0	1	2
47- <i>Lonchocarpus cultratus</i> (Vell.) A.M.G.Azevedo & H.C.Lima	0	0	0	1	0	0	0	0	1	2
48- <i>Machaerium stipitatum</i> Vogel	0	0	0	0	0	0	0	0	1	1
49- <i>Machaerium villosum</i> Vogel	0	0	0	0	0	0	0	0	1	1
50- <i>Myroxylon perufiferum</i> L.f.	0	0	0	0	0	0	0	0	1	1
51- <i>Pterocarpus rohrii</i> Vahl	0	0	0	1	0	1	0	0	1	3
52- <i>Sweetia fruticosa</i> Spreng.	0	0	0	0	0	0	0	0	1	1
Mimosoideae										
53- <i>Albizia niopoides</i> (Spruce ex Benth.) Burkart	1	1	1	1	1	1	1	1	1	9
54- <i>Anadenanthera colubrina</i> var. <i>cebil</i> (Griseb.) Altschul	0	0	0	1	0	0	0	0	1	2
55- <i>Calliandra foliolosa</i> Benth.	0	0	0	1	0	0	0	0	1	2
56- <i>Enterolobium contortisiliquum</i> (Vell.) Morong	0	0	0	0	0	0	0	0	1	1
57- <i>Inga laurina</i> (Sw.) Willd.	0	0	0	1	0	1	1	0	1	4
58- <i>Inga marginata</i> Willd.	0	0	0	1	0	0	0	0	0	1
59- <i>Inga vera</i> Willd.	1	1	1	1	1	1	1	1	1	9
60- <i>Parapiptadenia rigida</i> (Benth.) Brenan	0	0	0	1	1	0	0	0	1	3
61- <i>Zygia latifolia</i> (L.) Fawc. & Rendle	1	0	1	1	1	1	1	1	1	8
MALVACEAE										
105- <i>Guazuma ulmifolia</i> Lam.	0	0	0	0	1	1	1	1	0	4
106- <i>Luehea divaricata</i> Mart. & Zucc.	0	0	0	1	0	0	0	0	0	1
MELASTOMATACEAE										
62- <i>Miconia jucunda</i> (DC.) Triana	0	0	0	0	0	0	0	0	1	1
MELIACEAE										
63- <i>Guarea guidonia</i> (L.) Sleumer	0	0	0	1	1	1	0	1	1	5
64- <i>Guarea kunthiana</i> A.Juss.	0	0	0	0	0	0	0	0	1	1
65- <i>Guarea macrophylla</i> Vahl	1	0	1	1	0	0	0	0	1	4

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Family/Species	A1	A2	A3	A4	A5	A6	A7	A8	A9	T
MELIACEAE										
66- <i>Trichilia catigua</i> A.Juss.	0	0	0	1	0	0	0	0	1	2
67- <i>Trichilia pallida</i> Sw.	1	0	1	1	1	1	0	1	1	7
MORACEAE										
68- <i>Ficus guianensis</i> Desv.	0	0	0	0	0	0	0	0	1	1
69- <i>Ficus gomelleira</i> Kunth	1	0	1	0	0	0	0	0	0	2
70- <i>Ficus obtusiuscula</i> Miq. (Miq.)	1	1	0	1	0	0	0	1	1	5
71- <i>Madura tinctoria</i> (L.) D.Don ex Steud.	0	0	0	1	0	0	1	1	1	4
MYRTACEAE										
73- <i>Campomanesia xanthocarpa</i> (Mart.) O.Berg	0	0	0	0	0	0	0	0	1	1
72- <i>Eugenia subterminalis</i> DC.	0	0	0	0	0	0	0	0	1	1
74- <i>Eugenia egensis</i> DC.	0	0	0	1	0	1	0	0	0	2
75- <i>Eugenia florida</i> DC.	1	0	1	1	1	1	1	1	1	8
77- <i>Eugenia handroi</i> (Mattos) Mattos	0	0	0	0	1	0	1	0	0	2
76- <i>Eugenia moraviana</i> O.Berg	0	0	0	1	0	0	0	0	1	2
78- <i>Plinia rivularis</i> (Cambess.) Rotman	0	0	0	0	0	0	0	0	1	1
79- <i>Psidium guajava</i> L.	0	0	0	1	1	1	1	0	1	5
80- <i>Psidium</i> cf. <i>guineense</i> Sw.	0	0	0	0	0	1	0	0	0	1
NYCTAGINACEAE										
81- <i>Guapira opposita</i> (Vell.) Reitz	0	0	0	1	0	0	0	0	1	2
PHYTOLACCACEAE										
82- <i>Gallesia integrifolia</i> (Spreng.) Harms	0	0	0	1	1	1	0	1	1	5
PICRAMNIACEAE										
103- <i>Picramnia sellowii</i> Planch.	1	1	1	1	0	0	0	0	1	5
PIPERACEAE										
83- <i>Piper tuberculatum</i> Jacq.	1	1	0	1	1	1	0	1	1	7
POACEAE										
2- <i>Chusquea sellowii</i> Rupr.	0	0	0	0	1	1	1	0	1	4
POLYGONACEAE										
84- <i>Ruprechtia laxiflora</i> Meisn.	0	0	0	1	1	1	0	0	1	4
85- <i>Triplaris americana</i> L.	1	1	1	1	1	1	1	1	1	9
RHAMNACEAE										
86- <i>Colubrina retusa</i> (Pittier) Cowan	1	0	0	0	0	0	1	1	1	4
RUBIACEAE										
87- <i>Coussarea platyphylla</i> Müll.Arg.	1	0	1	1	1	1	0	1	1	7
88- <i>Genipa americana</i> L.	1	0	1	1	0	0	0	0	1	4
89- <i>Machaonia brasiliensis</i> (Humb.) Cham. & Schltdl.	0	0	0	1	1	0	1	0	1	4
90- <i>Psychotria carthagenensis</i> Jacq.	1	1	0	1	0	0	0	1	1	5
91- <i>Rosenbergiodendron longiflorum</i> (Ruiz & Pav.) Fargertl.	0	0	0	0	0	0	0	0	1	1
RUTACEAE										
92- <i>Citrus X aurantium</i> L.*	0	0	0	1	0	1	0	0	1	3
93- <i>Citrus X limon</i> (L.) Osbeck*	0	0	0	1	1	0	0	0	1	3
94- <i>Metrodorea nigra</i> A.St.-Hil.	0	0	0	0	0	0	0	0	1	1
95- <i>Pilocarpus pennatifolius</i> Lem.	0	0	0	0	0	0	0	0	1	1
96- <i>Zanthoxylum caribaeum</i> Lam.	0	0	0	1	0	0	0	0	1	2
SALICACEAE										
26- <i>Casearia aculeata</i> Jacq.	0	0	0	1	0	0	0	0	1	2
27- <i>Casearia decandra</i> Jacq.	0	0	0	0	0	0	0	0	1	1
28- <i>Casearia gossypiosperma</i> Briq.	0	0	0	1	1	1	0	1	1	5
29- <i>Casearia lasiophylla</i> Eichler	1	1	0	1	0	0	0	0	1	4
110- <i>Casearia sylvestris</i> Sw.	0	0	0	1	0	0	0	0	0	1
30- <i>Xylosma glaberrimum</i> Sleumer	1	1	1	0	0	0	0	0	0	3
31- <i>Xylosma venosa</i> N.E.Br.	1	0	0	0	0	0	1	0	0	2
SAPINDACEAE										
97- <i>Allophylus edulis</i> (A.St.-Hil. et al.) Hieron. ex Niederl.	1	0	1	1	1	1	1	1	1	8
98- <i>Sapindus saponaria</i> L.	1	0	1	1	1	1	1	1	1	8
SAPOTACEAE										
99- <i>Chrysophyllum gonocarpum</i> (Mart. & Eichler ex Miq.) Engl.	0	0	0	1	0	0	0	0	1	2
100- <i>Chrysophyllum marginatum</i> (Hook. & Arn.) Radlk.	0	0	0	1	0	0	0	0	1	2
101- <i>Pouteria glomerata</i> (Miq.) Radlk.	1	0	1	1	1	1	1	0	1	7
102- <i>Pouteria torta</i> (Mart.) Radlk.	0	0	1	1	1	1	0	1	1	6
SOLANACEAE										
104- <i>Solanum granulosoleprosum</i> Dunal	0	0	0	0	1	0	0	0	0	1
URTICACEAE										
14- <i>Cecropia pachystachya</i> Trécul	1	1	1	1	1	1	1	1	1	9
Total	33	18	23	68	43	40	29	36	85	

The surveys that presented greater number of species were the A9 and A4, both located in the left bank, whereas those with lower richness were situated on the right bank and in the island (Table 2). The environmental heterogeneity of the, in the locations where the surveys were undertaken, with a marginal

zone subjected to frequent flooding, one intermediate and subjected to sporadic flooding, besides one third, more internal zone not exposed to flooding (SOUZA, unpublished data), may be related to higher floristic richness. Moreover, in the right bank and islands, the surveyed areas presented higher topographical

homogeneity and thus greater exposure to flooding that tend to be frequent (CAMPOS; SOUZA, 2003; CAMPOS et al., 2000; ROMAGNOLO; SOUZA, 2000; SOUZA; MONTEIRO, 2005).

High species diversity in riparian forests, due to environmental heterogeneity, was verified by Van den Berg and Oliveira-Filho (2000) and by Rodrigues and Nave (2004). On the other hand, Bernacci et al. (1998), Metzger et al. (1997, 1998), Silva et al. (2007) and Teixeira and Rodrigues (2006), considered that areas exposed to frequent flooding tend to present lower species richness.

These considerations must be examined with some caution since anthropic disturbances reported for the areas and different sampling methods constitute some parameters that could affect on the obtained results. According to Magurram (1988), the number of species is directly correlated to the size of the samples. Stranghetti and Ranga (1998) compared four remnants of SSF in São Paulo State and three in Minas Gerais State and verified that the size of the samples influenced on the species diversity. In accordance to Teixeira and Rodrigues (2006), the number of species sampled in riparian forests from different Brazilian regions is quite varied due to diverse environmental conditions, the matrix of surrounding vegetation, the dynamics of natural clearings, human interference and also the different sampling methods.

In relation to species distribution, we registered the occurrence of two groups, the generalists and the exclusive. The first was constituted by species that occurred in nine surveys (*Tabernaemontana catharinensis*, *Cecropia pachystachya*, *Ocotea diospyrifolia*, *Albizia niopoides*, *Inga vera* and *Triplaris americana*), which grouped 5.5% of the species (Table 2; Figure 2) and in eight surveys (*Unonopsis guatterioides*, *Zygia latifolia*, *Eugenia florida*, *Allophylus edulis* and *Sapindus saponaria*), grouped 10% of the species. This relationship of species had already been stated as generalist for the upper Paraná river floodplain (SOUZA et al., 2004a). The group of exclusive, broader, grouped 29.1% of the species that presented exclusive occurrence in one of the surveys, among them, the most expressive were the A9, with 20% of these species and the A4, with 4.5% (Table 2; Figure 2).

In general, the riparian forests presented a reduced number of generalist species and a high number of exclusive ones. For the upper Paraná river floodplain, in an analysis among six (SOUZA et al., 1997), and posteriorly, among nine surveys (SOUZA et al., 2004a), about 3% of generalist and 60% of exclusive species were found.

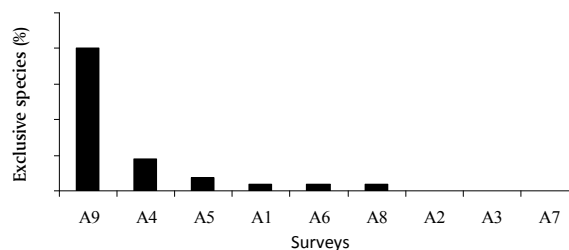


Figure 2. Percentage of tree species with exclusive occurrence for each one of the surveys analyzed of the upper Paraná river floodplain (Mato Grosso do Sul and Paraná States, Brazil).

For the wetland forests from South and Southeastern Brazil (SILVA et al., 2007), about 37% of the species were exclusive to one of 35 analyzed areas, and 8% occurred in eight, without species common to all areas. For the riparian forests of Jacaré-Pepira river, São Paulo State (METZGER et al., 1997; BERNACCI et al., 1998), 27% of the species were exclusive to one of 15 studied remnants and 0.5% were generalist, i.e., were present in all surveys.

Among the species listed in the present study, the most frequent to riparian forests from extra-Amazonian regions (RODRIGUES; NAVE, 2004; TEIXEIRA; RODRIGUES, 2006) and to wetland forests from South and Southeastern Brazil (SILVA et al., 2007), were: *Callophylum brasiliensis*, *Casearia sylvestris*, *Cecropia pachystachya*, *Copaifera langsdorffii*, *Trichilia pallida* and *Luehea divaricata*. With exception of *Cecropia pachystachya*, *Trichilia pallida* and *Callophylum brasiliensis* the others were exclusive to only one of the surveys analyzed of the upper Paraná river floodplain.

Regarding the floristic similarity between the surveys, the values of Sørensen index (ISs) ranged from 31 to 78.4%, in 61.1% of analyses, the values were equal or higher than 50%. The most similar surveys were the A5 and A8, both located in the right bank, followed by A4 and A9, in the left bank (Table 3).

Table 3. Sørensen's (ISs) and Jaccard's (ISj) similarity coefficients between nine surveys of tree species from the upper Paraná river floodplain (Mato Grosso do Sul and Paraná States, Brazil).

ISs	A2	A3	A4	A5	A6	A7	A8	A9
A1	66.7	67.9	55.4	52.6	43.8	54.8	63.8	47.5
A2	-	43.9	39.5	39.3	31.0	42.5	51.9	31.1
A3	-	-	43.9	54.5	53.9	50.0	54.2	37.0
A4	-	-	-	59.5	57.4	47.4	55.8	78.4
A5	-	-	-	-	74.7	63.9	78.5	50.0
A6	-	-	-	-	-	63.8	71.1	49.6
A7	-	-	-	-	-	-	61.5	40.4
A8	-	-	-	-	-	-	-	47.9
A9	-	-	-	-	-	-	-	-
ISj	A2	A3	A4	A5	A6	A7	A8	A9
A1	39.1	55.6	31.0	31.0	31.0	31.0	31.0	31.0
A2	-	39.1	31.0	31.0	31.0	31.0	31.0	31.0
A3	-	-	31.0	31.0	31.0	31.0	31.0	31.0
A4	-	-	-	34.4	34.4	34.4	34.4	64.5
A5	-	-	-	-	55.7	45.4	63.3	34.4
A6	-	-	-	-	-	45.4	55.7	34.4
A7	-	-	-	-	-	-	45.4	34.4
A8	-	-	-	-	-	-	-	34.4
A9	-	-	-	-	-	-	-	-

For the upper Paraná river floodplain, Souza et al. (1997), Romagnolo and Souza (2000) and Souza et al. (2004a), found mean values between 13 and 72.7%. The dominance of values considered low was associated to environmental heterogeneity and anthropic disturbances. The first mainly due to the diversity of environments that are influenced by water availability, soil type, location between the forest domain of the Paraná State and the Cerrado of Mato Grosso do Sul State (SOUZA et al., 2004a). Values considered low, in remnants of SSF, were reported by Silva and Soares (2003), Meira Neto and Martins (2002), Marangon et al. (2003), Meyer et al. (2004) and Teixeira and Rodrigues (2006).

The values of Jaccard index (ISj) varied between 31 and 64.5%, and in 13.9% of the analyses the values were superior to 50% (Table 3). The most similar surveys were the A4 and A9, both located in the left bank, followed by the A5 and A8 in the right bank. In areas of SSF, the values were also considered low (ARAÚJO et al., 2005; BERNACCI et al., 1998; COSTA; MANTOVANI, 1995; KINOSHITA et al., 2006; SANTOS; KINOSHITA, 2003).

In the present study, the values from the Sørensen index were higher than those from Jaccard, and with changes between the most similar surveys, so that for the first index were those of right bank, and for the second, of left bank. Comparisons between these two indexes were performed by Pifano et al. (2007), in an area of Submontane SSF in Minas Gerais State, which also found higher values for ISs. The authors considered that this difference was due to own formulation of the indexes.

The Correspondence Analysis (CA), for the surveys, evidenced the distinction into three groups: left bank, right bank and island. In this analysis, the first two axes were retained for interpretation, the first with eigenvalue of 0.3, and the second of 0.2; the first one distinguished the left bank (A4 and A9), and the second axis separated the island (A1, A2 and A3) (Figure 3). The surveys of left bank (A4 and A9) were carried out in the same remnant under the domain of Submontane SSF under different exposure to floods and both presented the floristic as sampling method, whereas the surveys of right bank (A5, A6, A7 and A8) and island (A1, A2 and A3) were under the domain of Alluvial SSF in similar conditions of flood and were sampled through phytosociological methods.

Silva et al. (2007) also applied an ordination analysis between 35 areas of wetland forests from South and Southeast regions of Brazil and verified that areas with similar flood regime were closer amongst themselves in the ordination axes.

For the species (Figure 4), the CA evidenced that for the axis 1, 15 species presented a higher positive

correlation ($r = 0.9$) and were common between the surveys of left bank (Table 4).

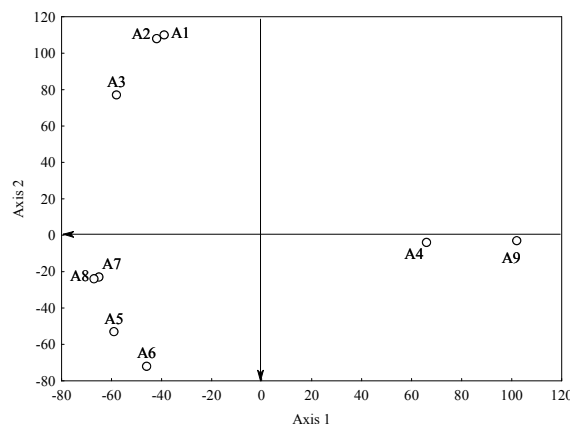


Figure 3. Ordination of nine forest surveys of upper Paraná river floodplain (Mato Grosso do Sul and Paraná States, Brazil).

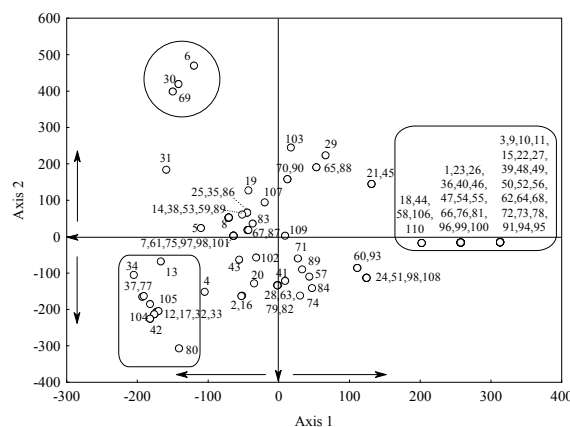


Figure 4. Ordination of tree species from nine forest surveys at upper Paraná river floodplain (Mato Grosso do Sul and Paraná States, Brazil) (the numbers refer to species listed in table 2; the species exclusive for each system were circled; the species 1, 23, 26, 36, 40, 46, 47, 54, 55, 66, 76, 81, 96, 99, 100 presenting higher correlation).

Table 4. Species of tree that presented higher correlation (r) in the Correspondence Analysis (CA) in nine forest surveys at Upper Paraná river floodplain (Mato Grosso do Sul and Paraná States, Brazil).

Species	Axis 1	Axis 2
1-Acromia aculeata	0.9	-
20-Sloanea guianensis	-	-0.9
23-Actinostemon conceptiones	0.9	-
26-Casearia aculeata	0.9	-
30-Xylosma glaberrimum	-	0.9
36-Nectandra leucantha	0.9	-
40-Cariniana estrellensis	0.9	-
46-Dalbergia frutescens	0.9	-
47-Lonchocarpus cultratus	0.9	-
54-Anadenanthera colubrina var. cebil	0.9	-
55-Calliandra foliolosa	0.9	-
66-Trichilia catigua	0.9	-
76-Eugenia moraviana	0.9	-
81-Guapira opposita	0.9	-
96-Zanthoxylum caribaeum	0.9	-
99-Chrysophyllum gonocarpum	0.9	-
100-Chrysophyllum marginatum	0.9	-
105-Guazuma ulmifolia	-0.6	-

On the other hand, *Guazuma ulmifolia* with the highest negative correlation ($r = -0.6$) occurred only in the surveys of right bank. For the axis 2, *Xylosma glaberrimum* with the greatest positive correlation ($r = 0.9$) occurred only on the island, while *Sloanea guianensis* with the highest negative correlation ($r = -0.9$) occurred in the left bank and right bank (Table 4).

Conclusion

The results indicated that floristic surveys are important indicative for evaluations of vegetation distribution and for characterization of the left bank, right bank and island in the upper Paraná river floodplain.

The species common to the banks and island, although representing less than one quarter of the species listed here and the high occurrence of species exclusive to one survey constitute important subsidies for projects of revegetation in this region. The first species, more frequent, would be indicated for early stages of revegetation of the environments in general, and the other species, exclusive to some locations, would be suitable for enrichment of a particular area.

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