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FLORISTIC ELEMENTS AS BASIS FOR CONSERVATION OF WETLANDS AND PUBLIC POLICIES IN BRAZIL: THE CASE OF *VEREDAS* OF THE PRATA RIVER

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Abstract: *Vereda* is the wetland type of the *Cerrado*, often associated with the *buriti* palm *Mauritia flexuosa*. However, in Mato Grosso do Sul *veredas* may occur without *M. flexuosa*, generating legal misinterpretation and environmental damages, such as drainage for agriculture. As a case study, we inventoried the flora of natural and drained *veredas* of the Prata River, pointing out key-species for identification of *veredas* without *M. flexuosa*, providing subsidies for their characterization. We recorded 157 species (44 families), most being wet grassland plants and some aquatic macrophytes, 96 species being typical of the flora of *veredas*, plus woody and weedy species of drained ground. The macrophytes *Chara rusbyana*, *Echinodorus grisebachii*, *Leptostelma tweediei*, *Ludwigia major*, *Nymphaea gardneriana*, *Piper fuligineum*, *Sinningia elatior* and *Utricularia lloydii* are from the original flora of undisturbed *vereda*, the first being a macroalga typical of alkaline swamps. The sawgrass *Cladium mariscus* subsp. *jamaicense* occurs on organic soil, associated with filiform tussock grasses and sedges typical of *veredas*, characteristic in these wetlands, such as *Andropogon glaziovii*, *Anthaenantia lanata*, *Axonopus comans*, *Saccharum villosum*, *Setaria paucifolia*, *Scleria composita* and *Rhynchospora albiceps*. Our report adds to the scarce knowledge on these wetlands since we found two paludicolous orchids, *Cyrtopodium hatschbachii* (rare, endangered on the Brazilian redlist) and *Bletia catenulata*, plus the recent new species *Cyperus valiae* (*Cyperaceae*), a sedge endemic to this type of *vereda*. We present diagnostic indicator species of *veredas* without *M. flexuosa* (*e.g. Echinodorus grisebachii*, *Chara rusbyana*, *Ludwigia sericea*, *L. major*, *Lessingianthus bardanoides* etc.). As another novelty, we highlight plants indicating drained wetland. Our findings already support an improved law to preserve *Cerrado* wetlands.

Keywords: alkaline wetland; drained wetland; Neotropical swamp; sawgrass.

INTRODUCTION

Wetlands cover approximately 20% of South America and Brazil (Junk 1993). Due to the multiple functions, benefits and importance of wetlands, an international initiative regulated their use and protection, the RAMSAR Convention (1971). Brazil, as a signatory of this agreement in 1993, assumed the inventory and classification of its wetlands, and studies on management and protection (Diegues 1994). Yet, Brazil wetlands lack research and adequate characterizations, difficulting legal treatment to restrict use.

Despite the insertion of the term 'wetlands'

into the New Forest Code (Brasil 2012), there are conceptual controversies of the hydrological features of wetlands, presenting important juridical implications and, according to the Law 12,651/2012 (Brasil 2012), the marginal belts and surroundings of these natural assets are liable to protection. According to Maltchik *et al.* (2018), the term '*veredas*' is very local and it is not much used across the country. On the contrary, *vereda* is a well-established term in the *Cerrado* domain, the Brazilian second-largest phytogeographic province (Ribeiro & Walter 1998). Nevertheless, the legislation is still imprecise, leaving gaps for expansion of agriculture. This process was intensified in the last decades, in part due to the lack of clear law enforcement and of insufficient knowledge on the biota of Brazilian wetlands.

Among others, the Law n. 12.651, of 25th May 2012, upon the protection of native vegetation in Brazil, defines in its Art. 3rd incise II "*Permanent Preservation Area: protected area, covered or not of native vegetation, with the environmental function to preserve water resources, landscape, geological stability and biodiversity, to facilitate the gene flow of fauna and flora, to protect the soil and to assure the wellbeing of human populations*". And in Chapter II - On Permanent Preservation Areas - Section I, Art. 4th: *Are considered Permanent Preservation Areas, in rural or urban zones*, in its incise IV "*the areas around perennial springs and waterholes, in any topographic situation, within a minimum radius of 50 m";* also defining in its incise XI *"in veredas, the marginal belt, in horizontal projection, with minimum width of 50 m, after the permanent swampy and waterlogged space*". The National Committee on Wetlands (CNZU Recommendation No. 7 of June 11, 2015) approved at the 13th Meeting the definition for wetlands: "*Wetlands are ecosystems at the interface between terrestrial and aquatic environments, continental or coastal, natural or artificial, permanently or periodically flooded or with soggy soils. The waters can be fresh, brackish or salty, with communities of plants and animals adapted to their water dynamics*" (adapted from Junk *et al.* 2013).

Springs are water table outcrops with impounded or watercourses (Calheiros *et al.* 2004). Declared in Brazil as PPAs, headwaters exert numerous functions in nature, providing shelter to pollinators and contributing to maintaining biodiversity (Carvalho 2006). Furthermore, they reduce runoff and act as superficial and subsurface filter of water fluxes to the streams, fundamental for water quality and quantity (Carvalho 2006). The formation of a spring can be a waterhole, with concentrated aquifer discharge, or a diffuse outcrop, when the water table intercepts the surface, of spread outflow into small headwaters, originating *veredas* (Linsley & Franzini 1978). One of the most important wetlands in Brazil are the *veredas* and their conservation and definition also involve controversy under the technical and legal point of view because the limits to define springs, wetlands and *veredas* are often confusing.

Definitions of *vereda* are sometimes simplistic and do not contemplate all its characteristics: hydrological/morphological and physiognomical (Queiroz 2015). Among the factors that shape the communities of *veredas* are the topography, soil, water table depth, fire, latitude and climate (Crawley & Harral 2001, Guimarães *et al.* 2002, Bergamin *et al.* 2012, Araújo *et al.* 2013, Resende *et al.* 2013). Under geomorphology it is a depressed zone, within a structurally plane or flattened area, resulting from water table outcrop, which generally converges to a thalweg, marked by typical vegetation, characterized by palms, particularly *Mauritia flexuosa* (Arecales, Arecaceae), can contain peat, on plateaus of the basins and sedimentary cover, and in uplands with *Cerrado* savanna (Queiroz 2015). The soils are hydromorphic, rich in organic matter, wet, generally associated with water table outcrop and headwaters of small watercourses (Melo 2008). As a vegetation type, the *vereda* is part of the *Cerrado* domain (Araújo *et al.* 2002, Brandão *et al.* 1991, Ribeiro & Walter 1998), with indicator plants, such as *M. flexuosa* (IBGE 2007) and grasses of filiform (narrow or cylindric) leaves, characteristic of *veredas* and present in the wetlands of Bonito (Scremin-Dias *et al.* 2018) and in another 12 *veredas* studied by Moreira *et al.* (2015) in Mato Grosso do Sul. The vegetation of *veredas* is composed of hydrophilous plants generally surrounded by wet grassland, and often (Ribeiro & Walter 1998) or always associated with the *M. flexuosa* palm (Silva *et al.* 2018). However, in Mato Grosso do Sul state, *veredas* may occur without the palm (Moreira 2015, Moreira *et al.* 2015). Silva *et al.* (2018) considered these palmless *veredas* as moist (wet) grasslands, distinguishing *veredas* and moist grasslands, despite 53% floristic

similarity. However, in the Brazilian classification of wetlands proposed by Junk *et al.* (2014) and Cunha *et al.* (2014), *vereda* is any permanently wet area, with grassy-herbaceous vegetation.

Under CONAMA (National Council for Environment; Brasil 2002), *vereda* is a *"swampy or waterlogged space, which contains springs or headwaters, with hydromorphic soils, predominantly characterized by rows of the swamp palm buriti (M. flexuosa) and other forms of typical vegetation"*. However, in 2012 the new Brazilian Forest Code altered the definition of *vereda* (article 3rd, incise XII), replacing *"usually with the arboreal palm M. flexuosa"* for "*usually with palms*". So, the definition of *vereda* became wider, covering all types of palms, not just *M. flexuosa*, which usually does not mean obligatorily. Nonetheless, other forms of typical vegetation, such as grasses of waterlogged soil, were not specified, thus being necessary to get support from pertinent scientific literature (*e.g.*, Moreira 2015, Moreira *et al.* 2015).

Moreira *et al.* (2015) evaluated *veredas* with and without *M. flexuosa*, regarding occurrence, frequency, cover and species diversity, and concluded that both types are extremely similar, showing that there are no specific groups related to vegetation physiognomy, and in lack of a clear legal support there is misuse, what should be reconsidered for a correct interpretation of the CONAMA resolution (Brasil 2012). Due to legal misinterpretation of these *vereda* habitats, various environmental damages are caused, such as drainage, and the consequences are: diminished water supply, responsible for the perennation of streams and rivers; lowering of the water table, causing loss of the stored carbon to the atmosphere as CO_2, and the water storage sponge shrinking. *Veredas* have organosols (Jacomine 2013), they are liable to subsidence when oxidized (Santos & Zaroni 2006). Changes in the vegetation mean a loss of plant diversity and of habitats for the fauna, mainly fish, Anura, and aquatic and paludicolous birds and mammals.

The conservation of the wetlands that feed the Central Brazilian rivers is essential for the maintenance of the ecological integrity of the region. Wetlands are buffer zones and places of recharge of the aquifers, capturing, filtering and storing water, and have a primordial function in the maintenance of the superficial and underground water system (Junk *et al.* 2013). As a study case, we focused on the *veredas* of the Prata River (*Banhados do Rio da Prata*) because they are being drained, harming the rivers and the Pantanal floodplain downstream and the fish fauna, jeopardizing the viability of the touristic resorts, very dependent on crystalline waters. The Prata wetlands play such a role, as well as others of the region of Bonito and the Serra da Bodoquena. It is a karstic region, with crystalline rivers, sink-gullies, subterranean watercourses and springs, being considered a very fragile environment regarding human activities (Boggiani 1999). Limestone rocks predominate and the Aquifer is the Pre-Cambrian Limestone (SEMAC 2010), originating rivers with alkaline and transparent waters, which are the touristic attractions. The *veredas* of the Prata River belong to the Biodiversity Corridor Miranda-Serra da Bodoquena (Brambilla & Pellin 2006), a further reason to reinforce preservation.

The lack of knowledge and of characterization of the diversity of wetlands of Brazil has arisen problems for conservation. An example of a wetland under a conflict of use occurs in the neighbouring and buffering zone of the National Park Serra da Bodoquena, rich in springs, nowadays much threatened by drainage for crops. The swamps of sawgrass, *Cladium mariscus* subsp. *jamaicense* (Crantz) Kük. (Poales, Cyperaceae), with associated wet grasslands, all part of this *vereda* system, are important for the maintenance of the regional rich water resources. Recent studies on the local flora alerted that drainage is the main cause of alteration of the vegetation and of the integrity of that environment (Scremin-Dias *et al.* 2018). Unusual high turbidity has been claimed to be caused by drainage of the headwaters, jeopardizing the touristic activity, the main local economy. Mismanagement of the upper basin also affects the Pantanal floodplain, as already observed by Roque *et al.* (2016).

This study derived from an inventory we made for a legal expert report on the Prata River wetland undergoing unauthorized or unduly licenced drainage. Therefore, our objective was a qualitative inventory of the flora of the Prata River wetlands, to point out key species for the characterization of *veredas* without *M. flexuosa* and to provide subsidies for environmental agencies in decision making to avoid doubts about the classifications of these wetlands, independently on the presence of the *buriti* palm.

MATERIAL AND METHODS

Study areas

We sampled two wetlands of the Prata River (*Banhados do Rio da Prata*), or *veredas* without *M. flexuosa*, on two adjacent farms between the coordinates SAD69 (21°23'29.6" S, 56°36'39.1" W and 21°23'34.6" S, 56°36'04.8" W) and (21°22'43" S, 56°35'27.3" W and 21°23'02.3" S, 56°33'54.6" W), respectively located in the municipalities of Bonito and Jardim, Mato Grosso do Sul, Brazil (Figure 1). We had support from the State Justice and transport by the Environment Police to get access to the farms. Both farms present large wetland areas, with original vegetation and areas with drainage channels for mechanized crops of oat (sown first), soybean and corn.

The climate of the region is seasonal – Aw (Alvares *et al.* 2013), with the rainy season from October to March and the dry season from April to September, with an average annual rainfall from 1,400 to 1,600 mm. The average annual temperatures are between 22ºC and 26ºC.

Sampling

A preliminary overflight gave us a general view of the whole area to select original and drained spots, checked on satellite images and maps. The vegetation survey was done in May and October-November 2016, applying the wandering technique (Filgueiras *et al.* 1994), whereby we sampled 1.0 and 2.5 km long main lines at farm 1 and 2, respectively, proportional to the wetland areas and considering the different plant communities observed in both farms, encompassing the original undisturbed swamp and the drained and cultivated land. Along the main line, we sampled 50 and 100 m long zig-zag transversal belts at farm 1 and 10 at farm 2. We classified the plants according to the following habitats: (i) wet grassland, area of waterlogged organic soil (Critchley *et al.* 2002), where grasses and sedges should be more abundant (Janssens *et al.* 1998); (ii) riparian, area along drainage trenches and (iii) aquatic, area of water bodies, i.e., drainage trenches and puddles. Fertile plant specimens were collected, identified by the authors AP and VJP, and deposited in the Herbarium CGMS of

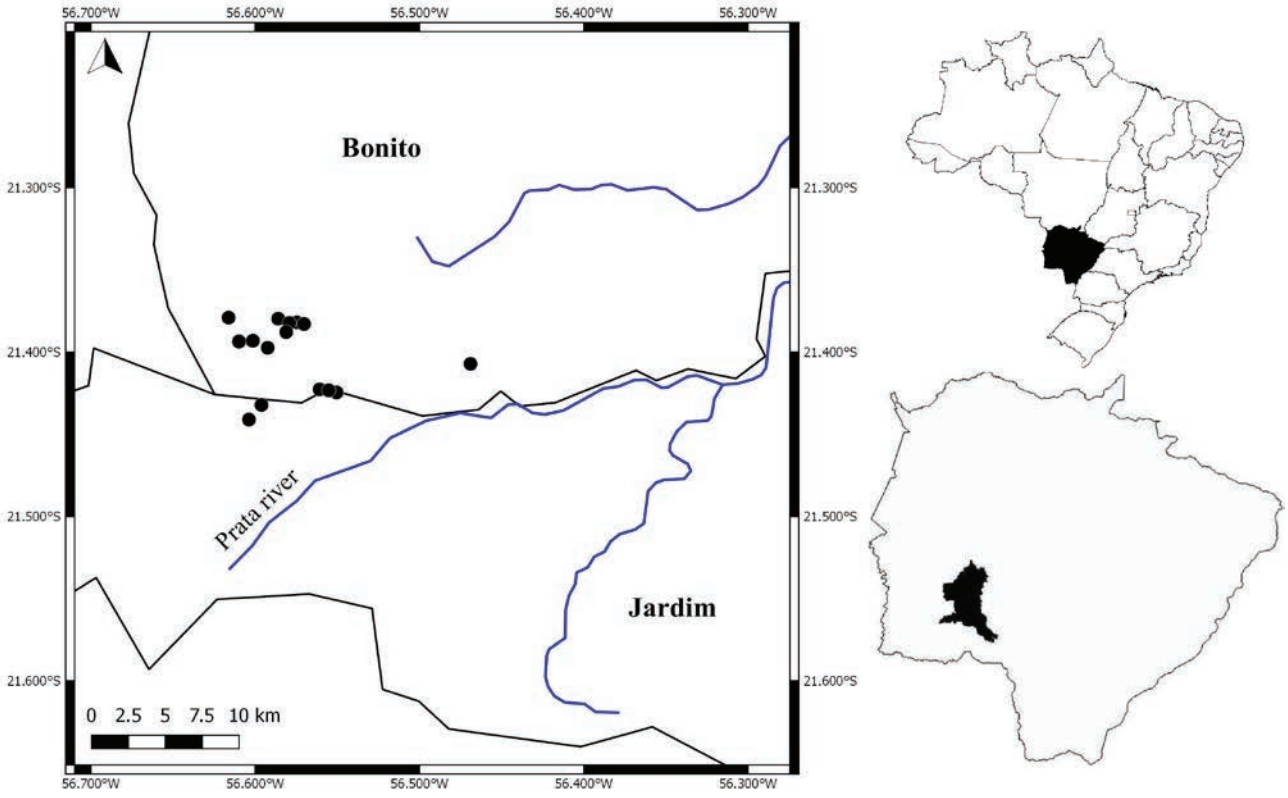

Figure 1. *Veredas* without *Mauritia flexuosa* of the Prata River ("Banhados do Rio da Prata") sampled in the municipalities of Bonito and Jardim, Mato Grosso do Sul, Brazil. The dots indicate the sampled areas on farms undergoing drainage.

the Universidade Federal de Mato Grosso do Sul (Appendix 1). The taxonomy for family and genus followed APG IV – Angiosperm Phylogeny Group (2016) and plant names were updated according to the Brazilian Flora database (Flora do Brasil 2020, under construction).

RESULTS

The recorded flora is listed in Appendix I, considering plants from wet grassland, riparian and aquatic habitats, pointing out the typical species of the *vereda* flora, as well as weeds and woody species of drained areas. We recorded a total of 157 plant species, being 91 of *vereda* and wet grassland, and 96 considered woody and weeds of drained soil. The richest families were Poaceae (31 species), Asteraceae (28) and Cyperaceae (17), and the most numerous genera were *Ludwigia* (Myrtales, Onagraceae) (7 species), *Rhynchospora* (Poales, Cyperaceae) (6) and *Andropogon* (Poales, Poaceae) (4). The species that occurred exclusively in the *veredas* without *M. flexuosa* are depicted in Table 1, pointing out those already mentioned by Moreira (2015).

In puddles of undisturbed *vereda* and in drainage canals, as well as in tracks of dredging tractors, we found aquatic macrophytes from the original local flora, *e.g.*, *Utricularia lloydii* (Lamiales, Lentibulariaceae) (Figure 2a-b), *Chara rusbyana* (Charales, Characeae) (Figure 2c), *Nymphaea gardneriana* (Nymphaeales,

Table 1. Species that occurred exclusively in the *veredas* without *Mauritia flexuosa* of the Prata River, collected plants or with observed presence (collection number: VP = Vali Joana Pott); farm (1 and 2); types of habitats within *veredas* (A = Aquatic, G = Wet grassland); indicator of flora of *vereda* (V), + mentioned by Moreira (2015).

Family / Species	Collection number	Farm	Habitat	Flora
ALISMATACEAE				
Echinodorus grisebachii Small	VP-12351	1, 2	V	A
APOCYNACEAE				
Asclepias mellodora A. St.-Hil.	VP-12262	1, 2		G+
ASTERACEAE				
Lessingianthus bardanoides (Less.) H. Rob.	VP-12247	1, 2	V+	G
CHARACEAE				
Chara rusbyana M.A. Howe	VP-12270	1, 2		A
CYPERACEAE				
Rhynchospora corymbosa (L.) Britt.	VP-12338	1, 2	V+	A, G
Rhynchospora rugosa (Vahl) Gale	VP-12328	1	V	
ONAGRACEAE				
Ludwigia major (Micheli) T.P. Ramamoorthy	VP-12307	1, 2	V	A, G
Ludwigia sericea (Cambess.) H. Hara	VP-12259	1, 2	V+	
PIPERACEAE				
Piper aduncum L.	VP-12343	1, 2	V+	
PLANTAGINACEAE				
Bacopa australis V.C. Souza	VP-12251	1, 2	V+	A, G
POACEAE				
Andropogon glaziovii Hack.	VP-12234	1	V+	
Andropogon macrothrix Trin.	VP-12329	1, 2	V+	G
Axonopus comans (Trin. ex Döll.) Kuhlm.	VP-12334	1, 2	V	
Paspalum cordatum Filg.		1, 2	V	

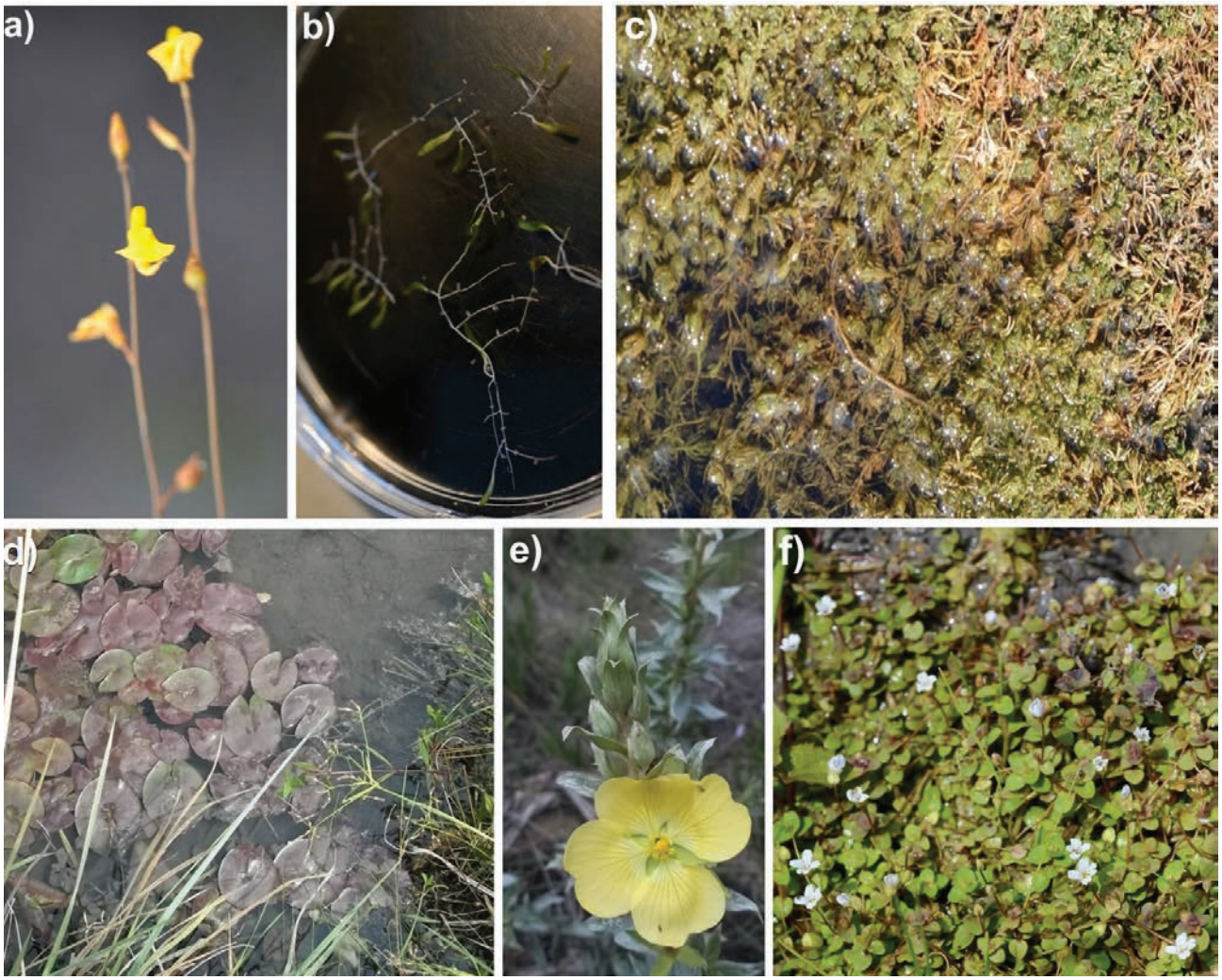

Figure 2. Aquatic macrophytes of the *vereda* native flora in the *vereda* of the Prata River in Bonito and Jardim, Mato Grosso do Sul: (a, b) *Utricularia lloydii*; (c) *Chara rusbyana*; (d) *Nymphaea gardneriana*; (e) *Ludwigia sericea* and (f) *Bacopa australis*.

Nymphaeaceae) (Figure 2d), *Ludwigia sericea* (Myrtales, Onagraceae) (Figure 2e), and *Bacopa australis* (Lamiales, Plantaginaceae) (Figure 2f).

Cladium mariscus subsp. *jamaicense* (Figure 3a) composes the monodominant sawgrass, on peaty soil, with organic material of undecomposed roots, soft, where a person sinks to the knee or more. In addition, there are various intermingled tussock filiform grasses typical of *vereda* in this type of wetland (Figures 3b-d), whose species identification is given next (Figures 4 and 6).

On drained areas (Figure 4a) and near old drainage canals (Figure 4b) we observed colonization of weeds (*e.g. Erechtites hieracifolius*, Asterales, Asteraceae, Figure 4a) and pioneer gallery forest (riparian) trees such as *Cecropia pachystachya* (Rosales, Urticaceae) (Figure 4a), *Myrsine parvifolia* (Caryophyllales, Primulaceae) (Figure 4c), *Sapium haematospermum* (Malpighiales, Euphorbiaceae) (Figure 4d) and *Tapirira guianensis* (Sapindales, Anacardiaceae). Weeds and riparian species are indicated in Appendix 1. Shrubs of the families Asteraceae (Asterales) (*Baccharis* sp., *Eupatorium* spp. *lato sensu*), Onagraceae (Myrtales) (*Ludwigia* spp.) etc. are some of the floodable grassland plants we recorded in these *veredas*.

Within the unspoilt sawgrass, we found two palustrine orchids, the rare *Cyrtopodium hatschbachii* (Asparagales, Orchidaceae) (Figure 5a), endangered on the Brazilian redlist (CNCFlora 2012), and another species, *Bletia catenulata* (Asparagales, Orchidaceae) (Figure 5b).

Furthermore, we sampled filiform grasses, typical of veredas (Figure 4a), *e.g.*, *Setaria paucifolia* (Poales, Poaceae) (Figure 6a), present and abundant in the veredas of the Prata River. Other typical

Figure 3. Predominance of filiform tussock grasses and sawgrass in *veredas* in Bonito and Jardim, Mato Grosso do Sul: (a) Transition of grasses (on the left)/sawgrass *Cladium mariscus* subsp. *jamaicense* (on the right); (b and c) *Vereda* filiform grasses; (d) Tussock of filiform grass on organic soil.

grasses (Poales, Poaceae) such as *Andropogon glaziovii* (Figure 6b), *Anthaenanthia lanata* (Figure 6c), *Axonopus comans* (Figure 6d) and *Saccharum villosum* were recorded. In addition, several sedges occurred (Poales, Cyperaceae): *Cyperus haspan* (Figure 6e), *C. valiae* Pereira-Silva, Hefler & R. Trevis. (recently described as a new species by Pereira-Silva *et al.* 2018) (Figure 6f), *Rhynchospora albiceps* (Figure 6g) and *Scleria composita* (Figure 6h).

DISCUSSION

The wandering technique of rapid inventory (Filgueiras *et al.* 1994) applied in this study considers the different types of vegetation present in the site to be sampled, and owing to its speed it helps to assess data to be utilized in decision making for the conservation of areas under possible environmental degradation. It is difficult to apply in this type of wetland because of the boggy soil, but we used the drain mounds as cross-sections wherefrom we walked into the swamp on both sides of the transect lines. The asystematic walk is a similar sampling procedure (Resende *et al.* 2013). The floristic inventory was not exhaustive and we assume that it was sufficient to infer upon the similarity with other *veredas*. For instance, the number of species (157) is comparable to 213 species recorded in five *vereda* sites by Silva *et al.* (2018).

The flora is very variable between *veredas*, as only six species were common to 13 areas. One of these is *M. flexuosa*, although this palm had already been assumed as the criterion to define a *vereda*, and another is *Anthaenanthia lanata* (Silva *et al.* 2018). This typical *vereda* grass is present in our study area. Poaceae, Asteraceae and Cyperaceae are commonly the main families in *veredas* (Munhoz

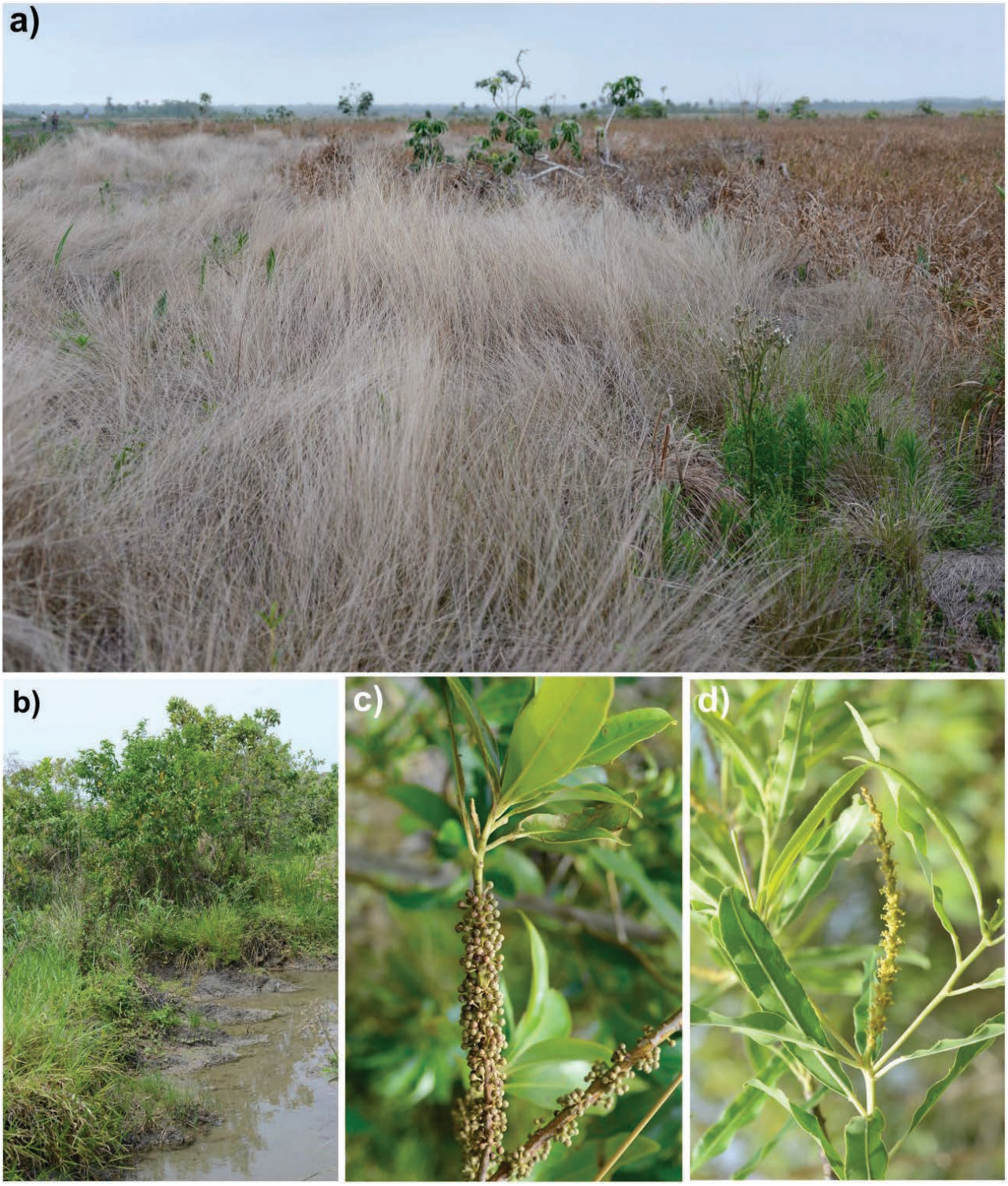

Figure 4. Woody species and weeds on drained *vereda* of the Prata River in Bonito and Jardim, Mato Grosso do Sul: (a) *Cecropia pachystachya* (top middle) and *Erechtites hieracifolius* (bottom right); (b) colonization of woody species and weeds along a drainage canal; c) *Myrsine parvifolia* and (d) *Sapium haematospermum*.

et al. 2011, Resende *et al.* 2013, Moreira *et al.* 2015, Silva *et al.* 2018). We observed grasses marked by Moreira *et al.* (2015) as typical of *veredas* without *M. flexuosa*, not being shared with *veredas* with this palm, such as *Rhynchospora corymbosa* (L.) Britt. and *R. rugosa* (Vahl) Gale (Poales, Cyperaceae), *Andropogon macrothrix* Trin., *A. glaziovii* Hack., *Axonopus comans* (Trin. ex Döll.) Kuhlm. and *Paspalum cordatum* Filg. (Poales, Poaceae). Araújo *et al.* (2002) also emphasize the predominance of

Figure 5. Orchids of *veredas* of the Prata River in Bonito and Jardim, Mato Grosso do Sul: (a) *Cyrtopodium hatschbachii* and (b) *Bletia catenulata*.

herbaceous-graminaceous forms. In contrast with the flora of acid soil *veredas*, we recorded just a single species of Melastomataceae, a remarkable scarcity already reported for alkaline wetlands in the region (Scremin-Dias *et al.* 2018), and absence of Eriocaulaceae and Xyridaceae, generally common in *veredas* with *M. flexuosa* (Munhoz *et al.* 2011, Resende *et al.* 2013, Silva *et al.* 2018).

Among the macrophytes found in puddles of undisturbed *vereda* and in drainage canals, the submerged *C. rusbyana* is a macroalga of alkaline waters and wetlands of Serra da Bodoquena, strictly aquatic (Pott 1999), forming whitish patches on the ground when dry (Scremin-Dias *et al.* 2018). It is typical of springs, streams and rivers of the Bonito region, as well as other aquatic species found in springs, such as *B. australis*, *Echinodorus grisebachii* Small, *Helanthium bolivianum* (Rusby) Lehtonen & Myllys (Alismatales, Alismataceae), *N. gardneriana* and *U. gibba*, illustrated by Pott (1999). According to Moreira *et al.* (2015), three species (*E. grisebachii*, *C. rusbyana* and *B. australis*) occur only in *veredas* without *M. flexuosa*. However, we also observed amphibious species that fit this group, such as *Ludwigia major* (Micheli) T.P. Ramamoorthy and *L. sericea* (Cambess.) H. Hara (Myrtales, Onagraceae). Nevertheless, such species so far considered exclusive to *veredas* without *M. flexuosa* may simply be a consequence of a yet small number of sampled areas. Further studies are necessary to elucidate if such pattern also applies to a wider geographical range.

The dense sawgrass formations of *C. mariscus* subsp. *jamaicense* occur on headwaters and wetlands of the rivers in Bonito region (Pott 1999), such as Perdido (Scremin-Dias *et al.* 2018), Prata and Formoso. This species of *Cladium* is the same sawgrass of the Everglades in Florida (Urban *et al.* 1993, Mossman 2009), covering 65-70% of those wetlands (Loveless 1959 *apud* Herndon *et al.* 1991), being sown to recover degraded marsh. The inflorescence of *C. mariscus* subsp. *jamaicense* contains

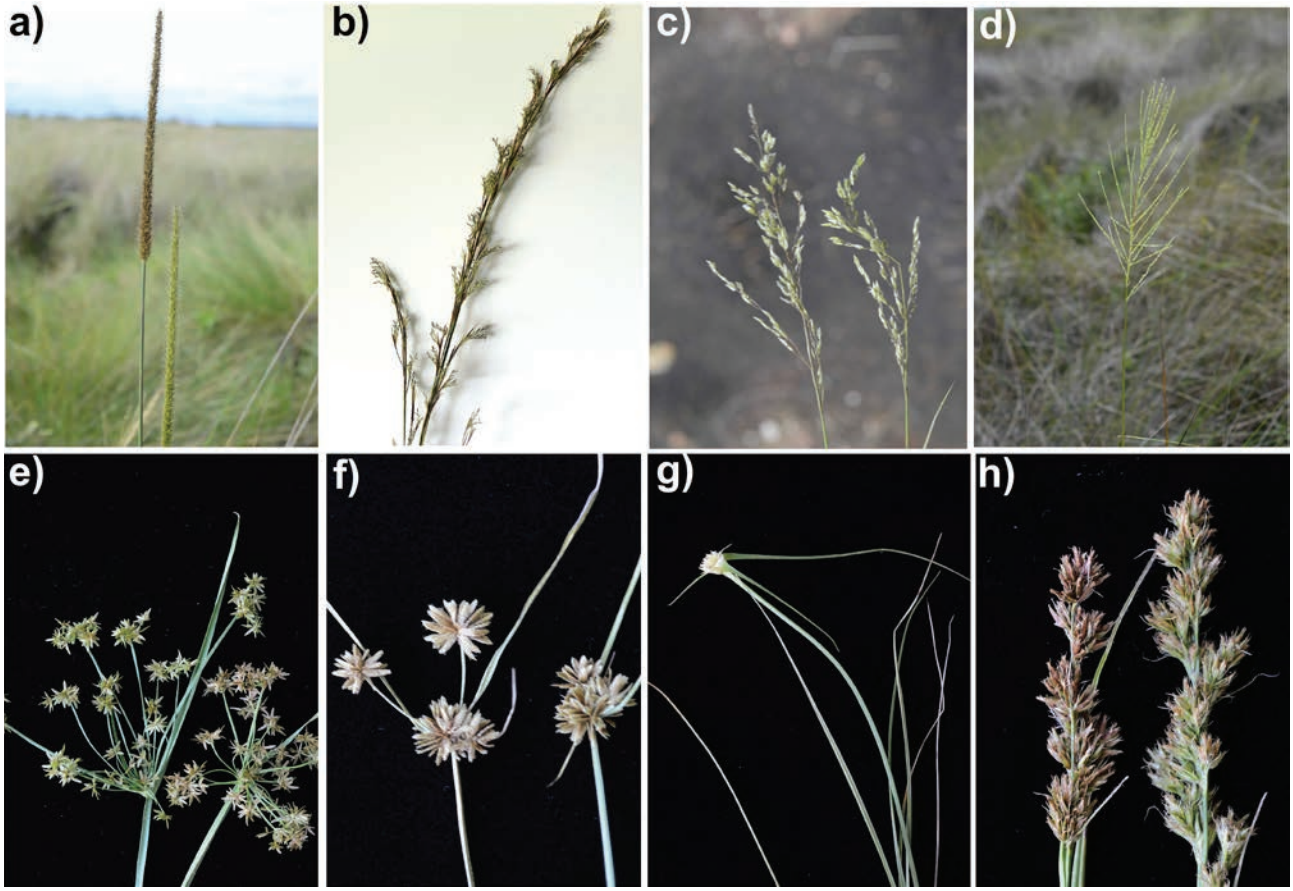

Figure 6. Filiform grasses and sedges typical of *veredas* of the Prata River in Bonito and Jardim, Mato Grosso do Sul, (a) *Setaria paucifolia*, (b) *Andropogon glaziovii*, (c) *Anthaenantia lanata*, (d) *Axonopus comans*, (e) *Cyperus haspan*, (f) *Cyperus valiae* (recently described as a new species), (g) *Rhynchospora albiceps*, (h) *Scleria composita*.

approximately 5000 seeds and the successful germination and establishment of this species depend on water-saturated sediments (Alexander 1971 *apud* Lorenzen *et al.* 2000). It occurs in peatland in Rio Grande do Sul (Costa *et al.* 2003), as it is also adapted to low nutrient environments (Newman *et al.* 1998).

The *veredas* are sensitive to disturbances, with little resilience, but maintain the original flora in areas with higher moisture (Guimarães *et al.* 2002). This means that drainage causes floristic changes, such as we detected. In addition, deepening of the water table is followed by the income of woody species in *veredas* (Meirelles *et al.* 2004), as we recorded. The species of gallery forest trees and shrubs of Asteraceae observed near old drains were already reported (Manço & Pivatto 2007), and are some of the plants we recorded in drained parts of the studied *veredas*. The pioneer tree *Cecropia pachystachya* Trécul (Rosales, Urticaceae), common in disturbed *vereda* (Munhoz *et al.* 2011) and in three veredas in Goiás (Resende *et al.* 2013), here colonizes earthmounds of drainage canals, spreading as the areas around become drained. Floodable and wet grasslands generally lack arboreal forms, being essentially composed of herbaceous and/or subshrubby species, mainly Poaceae and Cyperaceae (Ramos 2004, Ribeiro & Walter 2008, Silva *et al.* 2018). In the Prata River, the genera *Paspalum* and *Urochloa* (Poales, Poaceae) and *Cladium* and *Rhynchospora* (Poales, Cyperaceae) have been mentioned in a previous survey (Manço & Pivatto 2007). After drainage, further effects of soil preparation, herbicides and grain culture are even more harmful since there is the removal of the original vegetation that protects and maintains the *vereda*. Indeed, there was drying sawgrass near an area sprayed with a desiccant, probably glyphosate. The drained organic soil oxidizes, what favours the income of nitrophilous weeds such as *Erechtites hieracifolius* (L.) Raf. *ex* DC. (Asterales, Asteraceae).

In the buffer zone of the National Park Serra da

Bodoquena, the wetlands provide fundamental ecosystemic services for the species of flora and fauna, especially fish, and also the crystal-clear waters, that drive the ecotourism of the Bonito region. These wetlands, with *C. mariscus* subsp. *jamaicense* or without this indicator species, help to maintain the water regime, vital for the region, and any alteration interferes directly in economic, cultural and recreational activities.

Cunha *et al.* (2014) consider *veredas*, together with peatlands, as swampy areas with mixed herbaceous vegetation, not mentioning if the presence of *M. flexuosa* is required. We conclude that these areas of wetlands of the region of Serra da Bodoquena present diagnostic indicator species (Table 1) of headwaters and *veredas* without *M. flexuosa* and other palms, that can be utilized as key-species for the definition of such wetlands, extremely important for the conservation of the water resources of the region. Some of the main indicator species are aforementioned filiform tussock grasses and sedges.

Our report adds to the scarce knowledge on these wetlands, which can be highlighted by the presence of the recently described new species *Cyperus valiae* Pereira-Silva, Hefler & Trevis. (Poales, Poaceae) (Pereira-Silva *et al.* 2018), endemic to these marshes. Also, worth mentioning is the discovery of the two paludicolous orchids *Bletia catenulata* Ruiz & Pav. (Asparagales, Orchidaceae), and the rare *Cyrtopodium hatschbachii* Pabst. This latter is endangered on the Brazilian redlist (CNCFlora 2012) and here we record the seventh known collection location (Specieslink 2019), what reinforces the protection of these wetlands.

Our findings reinforce the need to intensify integrated studies on the biota of Brazilian wetlands, aiming to better characterize them to subsidize legal regulation of restrictions on their use. We highlight that the legal expert report of our study already helped to support the Law Ordinance 421, of 6th November 2017, signed by the Minister for Environment of Brazil, Art. 1st "*Indicates priority for the actions described in the MMA Ordinance n. 09/2007 and n. 223/2016, concerning the areas described in the Annex of this Law, aiming at the creation of mosaics of conservation units, restoration and implementation of ecological corridors for the conservation of the swamps and protection of species threatened by extinction*".

Adequate wetland management has great importance in mitigating climate changes since such areas play an important role in sequestration and storage of carbon (Wylynko 1999, Ramsar 2010). Drainage of peatlands is one of the foci of global emission of CO_2, however, we can reduce it with sustainable management of these ecosystems (Wylynko 1999, Ramsar 2010). Hereby, we seek to contribute to decision making and drafting of laws to protect the Brazilian wetlands, mainly those lacking legal descriptions, such as the diffuse springs and headwaters herein described, what would prevent the distortion of existing laws to clear or drain these areas, important for the maintenance of water bodies of public interest.

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REFERENCES

Alvares, C. A., Stape, J. L., Sentelhas, P. C., Gonçalves, J. L. M., & Sparovek, G. 2013. Köppen's climate classification map for Brazil. Meteorologische Zeitschrift, 22(6), 711–728. DOI: 10.1127/0941-2948/2013/0507

APG IV - Angiosperm Phylogeny Group. 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. The Botanical Journal of the Linnean Society, 181(1), 1–20. DOI: 10.1111/12385

Araújo, G. M., Barbosa, A. A. A., Arantes, A. A., & Amaral, A. F. 2002. Composição florística de veredas no município de Uberlândia, MG. Revista Brasileira de Botânica, 25(4), 475–493.

Araújo, G. M., Amaral, A. F., Bruna, E. M., & Vasconcelos, H. L. 2013. Fire drives the reproductive responses of herbaceous plants in a Neotropical swamp. Plant Ecology, 214, 1479–1484. DOI: 10.1007/11258-013-0268-9

Bergamin, R. S., Müller, S., & Mello, R. S. P. 2012.

Indicator species and floristic patterns in different forest formations in southern Atlantic rainforests of Brazil. Community Ecology, 13(2), 162–170. DOI: 10.1556/ComEc.13.2012.2.5

Boggiani, P. C. 1999. Geologia da Serra da Bodoquena, por que Bonito é bonito? In: E. Scremin-Dias, V. J. Pott, & P. R. Souza (Eds.), Nos jardins submersos da Bodoquena: um guia para identificação das plantas aquáticas de Bonito e região. pp. 1–23. Campo Grande: Ed. UFMS.

Brambilla, M., & Pellin, A. 2006. Projeto Corredor de Biodiversidade Miranda – Serra da Bodoquena: Ações prioritárias do Plano de Conservação e Implementação. Relatório técnico. Campo Grande: Fundação Neotrópica do Brasil e Conservação Internacional do Brasil: p. 434.

Brandão, M., Carvalho, P. G. S., & Baruqui, F. M. 1991. Veredas: uma abordagem integrada. Daphne, 1(3), 5–8.

Brasil - Ministério do Meio Ambiente. 2002. Conselho Nacional do Meio Ambiente. Resolução CONAMA nº 303, de 20 de março de 2002. Dispõe sobre parâmetros, definições e limites de Áreas de Preservação Permanente. (Retrieved on December 5th, 2016, from http://www.mma.gov.br/port/conama/res/res02/res30302.html).

Brasil. 2012. Lei nº 12.651, de 25 de maio de 2012. Dispõe sobre a proteção da vegetação nativa. Diário Oficial da União, Brasília, DF, 28 de maio de 2012. (Retrieved on December 5th, 2016, from http://www.planalto.gov.br/ccivil_03/_Ato2011-2014/2012/Lei/L12651.htm).

Calheiros, R. D. O., Tabai, F. C., Bosquilia, S.V., & Calamari, M. 2004. Preservação e recuperação das nascentes (de água e de vida). Comitê das Bacias Hidrográficas dos Rios PCJ-CTRN. Retrieved from https://www.sigam.ambiente.sp.gov.br/sigam3/Repositorio/222/Documentos/Cadernos_Mata_Ciliar_1_Preservacao_Nascentes.pdf

Carvalho, J. M. 2006. Prospecção e pesquisa de recursos hídricos subterrâneos no Maciço Antigo Português: linhas metodológicas. Doctoral thesis. Departamento de Geociências da Universidade de Aveiro. p. 296.

CNCFlora. *Cyrtopodium hatschbachii* in Lista Vermelha da flora brasileira versão 2012.2 Centro Nacional de Conservação da Flora. (Retrieved on December 17th, 2017, from http://cncflora.jbrj.gov.br/portal/pt-br/profile/Cyrtopodium hatschbachii).

Costa, C. S. B., Irgang, B. E., Peixoto, A. R., & Marangoni, J. C. 2003. Composição florística das formações vegetais sobre uma turfeira topotrófica da planície costeira do Rio Grande do Sul, Brasil. Acta Botanica Brasilica, 17(2), 203–212.

Crawley, M. J., & Harral, J. E. 2001. Scale dependence in plant biodiversity. Science, 291, 864–868. DOI: 10.1126/science.291.5505.864

Critchley, C. N. R., Chambers, B. J., Fowbert, J. A., Sanderson, R. A., Bhogal, A., & Rose, S. C. 2002. Association between lowland grassland plant communities and soil properties. Biology Conservation, 105(2), 199–215. DOI: 10.1016/S0006-3207(01)00183-5

Cunha, C. N., Piedade M. T. F., & Junk W. J. 2014. Classification e delineamento das áreas úmidas brasileiras. Cuiabá: EdUFMT.

Diegues, A. C. S. 1994. An inventory of Brazilian wetlands. Gland, Switzerland: IUCN.

Filgueiras, T. S., Nogueira, P. E., Brochado, A. L., & Guala, G. F. 1994. Caminhamento: um método expedito para levantamentos florísticos qualitativos. Cadernos de Geociências, 12, 39–43.

Flora do Brasil 2020 em construção. (Retrieved on December 17th, 2017, from http://www.floradobrasil.jbrj.gov.br).

Guimarães, A. J. M., Araújo, G. M., & Corrêa, G. F. 2002. Estrutura fitossociológica em área natural e antropizada de uma vereda em Uberlândia, MG. Acta Botanica Brasilica, 16(3), 317–329.

Herndon, A., Gunderson, L., & Stenberg, J. 1991. Sawgrass (*Cladium jamaicense*) survival in a regime of fire and flooding. Wetlands, 11(1), 17–28. DOI: 10.1007/bf03160838

IBGE. 2007. Manual Técnico de Pedologia. Manuais Técnicos em Geociências, Rio de Janeiro, 4, 316. Retrieved from https://biblioteca.ibge.gov.br/visualizacao/livros/liv37318.pdf

Jacomine, P. K. T. 2013. A nova classificação brasileira de solos. Anais da Academia Pernambucana de Ciências Agronômicas, 5, 161–179.

Janssens, F., Peters, A., Tallowin, J. R. B., Bakker, J. P., Bekker, R. M., Fillat, F., & Oomes, M. J. M. 1998. Relationship between soil chemical factors and grassland diversity. Plant Soil, 202, 69–78. DOI:

10.1023/A:1004389614865

Junk, W. J., Piedade, M. T. F., Lourival, R., Wittmann, F., Kandus, P., Lacerda, L. D., & Agostinho, A. A. 2014. Brazilian wetlands: their definition, delineation, and classification for research, sustainable management, and protection. Aquatic Conservation: Marine and Freshwater Ecosystems, 24(1), 5–22. DOI: 10.1002/aqc.2386

Linsley, R. K., & Franzini, J. B. 1978. Engenharia de recursos hídricos. McGraw-Hill do Brasil: p. 798.

Lorenzen, B., Brix, H., McKee, K. L., Mendelssohn, I. A., & Miao, S. 2000. Seed germination of two Everglades species, *Cladium jamaicense* and *Typha domingensis*. Aquatic Botany, 66(3), 169–180. DOI: 10.1016/S0304-3770(99)00076-5

Maltchik, L., Caleffi, V., Stenert, C., Batzer, D. P., Piedade, M. T. F., & Junk, W. J. 2018. Legislation for wetland conservation in Brazil: Are existing terms and definitions sufficient? Environmental Conservation, 45(3), 301–305. DOI: 10.1017/S0376892917000522

Manço, D. D. G., & Pivatto, M. A. C. 2007. Diagnóstico e plano de manejo da Reserva Particular do Patrimônio Natural Cabeceira do Prata, Jardim – MS. Retrieved from http://www.imasul.ms.gov.br/wp-content/uploads/sites/74/2015/06/3-planodemanejorppncabeceiradoprata.pdf

Meirelles, M. L., Guimarães, A. J. M., Oliveira, R. C., Araújo, G. M., & Ribeiro, J. F. 2004. Impactos sobre o estrato herbáceo de áreas úmidas do Cerrado. In: L. M. S. Aguiar, & A. J. A. Camargo (Eds.), Cerrado: ecologia e caracterização. Pp. 41–68. Planaltina: Embrapa Cerrados.

Melo ,D. R. 2008. Evolução das Veredas sob impactos ambientais nos geossistemas Planaltos de Buritizeiro/MG. Doctor thesis. Instituto de Geociências, Departamento de Geografia, Universidade Federal de Minas Gerais. p. 341.

MMA - Ministério do Meio Ambiente. 2014. Lista nacional das espécies da Flora Brasileira ameaçada de extinção. (Retrieved on December 5th, 2016, from http://www.mma.gov.br/biodiversidade/especies-ameacadas-de-extincao/flora-ameacada).

Moreira, S. N., Eisenlohr, P. V., Pott, A., Pott, V. J., & Oliveira-Filho, A. T. 2015. Similar vegetation structure in protected and non-protected wetlands in Central Brazil: Conservation significance. Environmental Conservation, 42(04), 356–362. DOI: 10.1017/S0376892915000107

Moreira, S. N. 2015. Flora, distribuição e estrutura da vegetação das áreas úmidas de uma região savânica brasileira: implicações para a conservação da biodiversidade. Doctor thesis. Programa de Pós-Graduação em Biologia Vegetal, Universidade Federal de Minas Gerais, Belo Horizonte. p. 131.

Mossman, R. E. 2009. Seed dispersal and reproduction patterns among everglades plants. Doctor thesis, Philosophy in Biology, Florida International University. ProQuest ETD Collection for FIU. p. 12.

Munhoz, C. B. R., Eugênio, C. U. O., & Oliveira, R. C. 2011. Vereda: guia de campo. Brasília: Rede de Sementes do Cerrado.

Newman, S., Schuette, J., Grace, J. B., Rutchey, K., Fontaine, T., Reddy, K. R., & Pietrucha, M. 1998. Factors influencing cattail abundance in the northern Everglades. Aquatic Botany, 60, 265–280. DOI: 10.1016/S0304-3770(97)00089-2

Pereira-Silva, L., Hefler, S. M., & Trevisan, R. 2018. *Cyperus longiculmis* and *C. valiae* (*Cyperaceae*), two new species from Brazil. Systematic Botany, 43(3), 741-746. DOI: 10.1600/036364418X697454

Pott, V. J. 1999. Riqueza verde em meio azul. In: E. Scremin-Dias, R. C. Hora, V. J. Pott, & P. R. Souza (Eds.), Nos jardins submersos da Bodoquena: um guia para identificação das plantas aquáticas de Bonito e região. pp. 59–93. Campo Grande: Ed. UFMS.

Queiroz, M. L. 2015. Nascentes, veredas, áreas úmidas: Revisão conceitual e metodologia de caracterização e determinação: Estudo de caso na Estação Ecológica de Águas Emendadas - Distrito Federal. Master thesis. Programa de Pós-Graduação em Geociências Aplicadas, Universidade de Brasília. p. 148.

Ramos, M. V. V. 2004. Caracterização dos solos, da estrutura fitossociológica e do estado nutricional da egetação de Veredas em diferentes superfícies geomorfológicas no Triângulo Mineiro. Doctoral thesis. Programa de Pósv-Graduação Ecologia, Universidade de Brasília. p. 140.

Ramsar. 2010. Convenção Ramsar sobre Zonas Úmidas. Cuidando das Áreas Úmidas: uma resposta às mudanças climáticas. (Retrieved on January 30, 2019, from http://www.ramsar.org).

Resende, I. L. M., Chaves L. J., & Rizzo, J. A. 2013. Floristic and phytosociological analysis of palm swamps in the central part of the Brazilian savanna. Acta Botanica Brasilica, 27(1), 205–225.

Ribeiro, J. F., & Walter, B. M. T. 1998. As principais fitofisionomias do bioma Cerrado. In: S. M. Sano, & S. P. Almeida (Eds.), Cerrado: ambiente e flora. pp. 89–166. Planaltina, DF: Embrapa/CPAC.

Ribeiro, J. F., & Walter, B. M. T. 2008. As principais fitofisionomias do bioma Cerrado. Cerrado: ecologia e flora, 1, 151–212.

Roque, F. O., Ochoa-Quintero, J., Ribeiro, D. B., Sugai, L. S., Costa-Pereira, R., Lourival, R., & Bino, G. 2016. Upland habitat loss as a threat to Pantanal wetlands. Conservation Biology, 30(5), 1131–1134. DOI: 10.1111/cobi.12713

Santos, H. G., & Zaroni, M. J. 2006. Organossolos. Agência Embrapa de Informação Tecnológica. Retrieved on December 5th, 2016, from http://www.agencia.cnptia.embrapa.br/gestor/solos_tropicais/arvore/CONTAG01_13_2212200611541.html.

Scremin-Dias, E., Pott, V. J., Damasceno-Junior, G. A., Cristaldo, A. C. M., Dias, F. A., & Pott, A. 2018. Flora de campos úmidos calcários da Serra da Bodoquena. Iheringia, 73(1), 80–92. DOI: 10.21826/2446-8231201873s80

Semac - Secretaria de Estado de Meio Ambiente, do Planejamento, da Ciência e Tecnologia e Instituto de Meio Ambiente de Mato Grosso do Sul. 2010. Plano Estadual de Recursos Hídricos de Mato Grosso do Sul, MS. Campo Grande: Editora UEMS: p. 194. Retrieved from: http://www.servicos.ms.gov.br/imasuldownloads/PERH-MS.pdf

Specieslink. 2019. *Cyrtopodium hatschbachii* Pabst. (Retrieved on May 10, 2019, from: http://www.species.link.org).

Silva, D. P., Amaral, A. G., Bijos, N. R., & Munhoz, C. B. R. 2018. Is the herb-shrub composition of *veredas* (Brazilian palm swamps) distinguishable? Acta Botanica Brasilica, 32(1), 47-54. DOI: 10.1590/010233062017abb0209

Urban, N. H., Davis, S. M., & Aumen, N. G. 1993. Fluctuations in sawgrass and cattail densities in Everglades water conservation area 2A under varying nutrient, hydrologic and fire regimes. Aquatic Botany, 46, 203–223. DOI: 10.1016/0304-3770(93)90002-E

Wylynko, D. 1999. Prairie wetlands and carbon sequestration - Assessing sinks under Kyoto Protocol. Canada: International Institute for Sustainable Development, Wetlands International, and Ducks Unlimited Inc.: p. 52.

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Appendix 1. Flora of the swamps of the Prata River, collected plants or with observed presence (*exotic; collection number: AP = Arnildo Pott, VP = Vali Joana Pott); farm (1 and 2); typical habitats of species (A = Aquatic, G = Wet grassland, D = drained, R = Riparian) and type of flora (V = *Vereda*, W = Weed). **Recently described as a new species. [e] = Endemic species.

Family / Scientific name	Collection number	Farm	Habitat	Flora
ACANTHACEAE				
Justicia laevilinguis (Nees) Lind.	VP-12258	1, 2	A	V
Justicia sp.	VP-12268	1, 2	G	
Ruellia simplex C. Wright		1, 2	G	V
ALISMATACEAE				
Echinodorus grisebachii Small	VP-12351	1, 2	A	V
Helanthium bolivianum (Rusby) Lehtonen & Myllys	VP-12267	1, 2	A	V
AMARANTHACEAE				
Alternanthera pungens Kunth		1, 2	D	W
ANACARDIACEAE				
Tapirira guianensis Aubl.		1, 2	R	V
APIACEAE				
Cyclospermum leptophyllum (Pers.) Sprague		1, 2	D	W
Eryngium ebracteatum Lam.	VP-12271	1, 2	G	V
Eryngium pandanifolium Cham. & Schltdl.		1, 2	G	V
APOCYNACEAE				
Asclepias mellodora A. St.-Hil.	VP-12262	1, 2	G	
Funastrum clausum (Jacq.) Schltdl.		1, 2	G	
Oxypetalum cf. *alpinum* (Vell.) Fontella & E.A. Schwartz	AP-17403	1, 2	G	
Rhabdadenia madida (Vell.) Miers	VP-12281	1, 2	G	V
ARACEAE				
Xanthosoma striatipes (Kunth & Bouche) Mad.		1, 2	A	V
ASTERACEAE				
Acmella leptophylla (Sm.) R.K. Jansen	VP-12246	1, 2	G	
**Ambrosia elatior* L.		1, 2	D	W
Aspilia foliacea (Spreng.) Baker	VP-12349	1, 2	G	
Baccharis dracunculifolia DC.		1, 2	D	W
Baccharis sp.		2	G	
Barrosoa candolleana (Hook. & Arn.) R.M. King & H.Rob.	VP-12319	1, 2	G	V
Calea sp.	VP-12248	1	G	
Campovassouria cruciata (Vell.) R.M. King & H. Rob.	VP-12331	1, 2		V
Campuloclinium macrocephalum (Less.) R.M. King & H. Rob.	VP-12250	1, 2	D, G	V
Chromolaena christeana (Baker) R.M. King & H. Rob.	VP-12249	1, 2	G	V
Chromolaena laevigata (Lam.) R.M. King & H. Rob.		1, 2	D, G	W, V
**Conyza bonariensis* (L.) Cronq.		1, 2	D	W
Emilia sagittata (Vahl) DC.		1, 2	D	W

Appendix 1. Continued on next page...

Appendix 1. ...Continued

Family / Scientific name	Collection number	Farm	Habitat	Flora
Erechtites hieracifolius (L.) Raf. ex DC.		1, 2	D	W, V
Gamochaeta americana (L.) Wedd.		1, 2	D	W
Lepidaploa remotiflora (L.C. Rich.) H. Rob.	VP-12287	1, 2	D	W
Leptostelma tweediei (Hook. & Arn.) D.J.N. Hind & G.L. Nesom.	VP-12332	1, 2		V
Lessingianthus bardanoides (Less.) H. Rob.	VP-12247	1, 2	G	V
Lessingianthus aff. *bardanoides* Less.) H. Rob.	VP-12288	2	G	V
Lessingianthus rubricaulis (Humb. & Bonpl.) H. Rob.		1, 2	G	V
Mikania cordifolia (L.) Willd.		1, 2	G	V
Picrosia longifolia G. Don	VP-12323	1, 2		V
Porophyllum sp.	VP-12291	1, 2	D, G	
Raulinoreitzia crenulata (Spreng.) R.M. King & H. Rob.		1, 2		V
Sphagneticola sp.	VP-12352	1, 2	G	
**Tridax procumbens* L.		1, 2	D	W
Vernonanthura brasiliana (L.) H. Rob.		1, 2	D	W
Indetermined		1, 2	G	
BORAGINACEAE				
Euploca procumbens (Mill.) Diane & Hilgert		1, 2	D, G	
CHARACEAE				
Chara rusbyana M.A. Howe	VP-12270	1, 2	A	
CONVOLVULACEAE				
**Ipomoea aristolochiaefolia* Kunth) Don.		1, 2	D	W
CUCURBITACEAE				
Melothria sp.		1, 2	G	W, V
CYPERACEAE				
Cladium mariscus subsp. *jamaicense* (Crantz) Kük.	VP-12327	1, 2	A	
Cyperus haspan L.	VP-12347	1, 2	A, G	V
Cyperus unioloides R. Br.	VP-12241	1, 2	A, G	V
*** Cyperus valiae* Pereira-Silva, Hefler & R. Trevis	VP-12242	1, 2	G	V
Eleocharis elegans (Kunth) Roem. & Schult.	VP-12243	1, 2	A, G	V
Eleocharis geniculata (L.) Roem. & Schult.	VP-12244	1, 2	A, G	V
Eleocharis minima Kunth		1, 2	A, G	V
Eleocharis sellowiana Kunth		1	A, G	V
Fimbristylis complanata (Retz.) Link	VP-12239	1, 2	D, A, G	V
Fuirena incompleta Nees	VP-12240	1, 2	A, G	V
Rhynchospora albiceps Kunth	VP-12335	1, 2	A, G	V
Rhynchospora corymbosa (L.) Britt.	VP-12338	1, 2	A, G	V
Rhynchospora emaciata (Nees) Boeckeler		1, 2		V
Rhynchospora marisculus Lindl. & Nees		1, 2		V
Rhynchospora robusta (Kunth) Boeckeler	VP-12337	1, 2		V

Appendix 1. Continued on next page...

Appendix 1. ...Continued

Family / Scientific name	Collection number	Farm	Habitat	Flora
Rhynchospora rugosa (Vahl) Gale	VP-12328	1		V
Scleria composita (Nees) Boeckeler	VP-12348	1, 2	A, G	V
EQUISETACEAE				
Equisetum giganteum L.		1, 2	A, G	V
EUPHORBIACEAE		1, 2		
Acalypha communis Muell. Arg.		1, 2	G	
Caperonia castaneifolia (L.) A. St.-Hil.	VP-12255	1, 2	A, G	V
Croton argenteus L.	AP-17409	1, 2	G	
Croton cinerellus Müll.Arg.	AP-17339	1	G	
Croton didrichsenii G.L. Webster	AP-17345	2	D	V
Sapium haematospermum Muell. Arg.	AP-17401	1, 2	R	W
Sapium hasslerianum Huber		1, 2		V
FABACEAE				
Ancistrotropis peduncularis (Kunth) A. Delgado	AP-17407	1, 2	G	
Arachis glabrata Benth.	VP-12272	1, 2	G	
Clitoria cf. *densiflora* Benth.	AP-17408	1, 2	G	
Desmodium cajanifolium (Kunth) DC.		1, 2		V
**Glycine max* (L.) Merr.		1		W
Indigofera bongardiana (Kuntze) Burkart	VP-12285	1, 2	G	
Mimosa polycarpa Kunth		1, 2	G	W
GESNERIACEAE				
Sinningia elatior (Kunth) Chautems	VP-12325	1, 2		V
IRIDACEAE				
Sisyrinchium fasciculatum Klatt	VP-12266	1, 2	G	
LAMIACEAE				
Hyptis pachyarthra Briq.	VP-12253	1, 2	G	V
LENTIBULARIACEAE				
Utricularia gibba L.		1, 2	A, G	V
Utricularia lloydii Merl ex Lloyd	VP-12277	1, 2	A, G	V
Utricularia praelonga A. St.-Hil. & Girard		1, 2	A	V
LOGANIACEAE				
Spigelia breviflora (Chodat & Hassl.) H.H. Hurley	VP-12333	1, 2	A, G	V
LUNULARIACEAE				
Lunularia sp.	VP-12275	1, 2	A	
LYTHRACEAE				
Adenaria floribunda Kunth	AP-17402	1, 2	G	V
Cuphea pterosperma Koehne	VP-12257	1, 2	A, G	V
MALVACEAE				
Byttneria palustris Cristóbal	VP-12344	1, 2	G	V
**Sida* sp.		2		W

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Appendix 1. ...Continued

Family / Scientific name	Collection number	Farm	Habitat	Flora
MELASTOMATACEAE				
Acisanthera limnobios (Schrank & Mart. ex DC.) Triana	VP-12256	1, 2	A, G	V
PRIMULACEAE				
Myrsine parvifolia A. DC.	AP-17400	1, 2	R	V
MYRTACEAE				
Psidium guineense Sw.		1, 2	G	V
NYMPHAEACEAE				
Nymphaea gardneriana Planch.	VP-12252	1, 2	A	V
ONAGRACEAE				
Ludwigia bullata (Hassl.) H. Hara	VP-12261	2	A	V
Ludwigia leptocarpa (Nutt.) H. Hara	VP-12260	1, 2	A, G	V
Ludwigia major (Micheli) T.P. Ramamoorthy	VP-12307	1, 2	A, G	V
Ludwigia octovalvis (Jacq.) Raven	VP-12309	1, 2	A, G	
Ludwigia sericea (Cambess.) H. Hara	VP-12259	1, 2		V
Ludwigia peruviana (L.) H. Hara	VP-12261	1, 2	A, G	V
Ludwigia sp.	VP-12339	1	A, G	V
ORCHIDACEAE				
Bletia catenulata Ruiz & Pav.	VP-12340	1, 2	A	V
Cyrtopodium hatschbachii Pabst	VP-12280	1, 2		V
OROBANCHACEAE				
Buchnera longifolia Kunth	VP-12330	1, 2	G	V
PASSIFLORACEAE				
Passiflora foetida L.	AP-17404	1	G	
PHYLLANTHACEAE				
Phyllanthus stipulatus (Raf.) G.L. Webster	VP-12265	1, 2	A, G	V
PIPERACEAE				
Piper aduncum L.	VP-12343	1, 2	R	V
Piper fuligineum Kunth	VP-12301	1, 2		V
PLANTAGINACEAE				
Bacopa australis V.C. Souza	VP-12251	1, 2	A, G	V
Stemodia hassleriana Chodat	VP-12264	1, 2	A, G	
Stemodia hyptoides Cham. & Schltdl.	VP-12295	1, 2	G	
POACEAE				
Andropogon bicornis L.		1, 2	G	W
Andropogon glaziovii Hack.	VP-12234	1		V
Andropogon macrothrix Trin.	VP-12329	1, 2	G	V
Andropogon virgatus Desv.	VP-12233	2		
Anthaenantia lanata (Kunth) Benth.	VP-12238	1, 2	G	V
**Avena sativa* L.		1, 2		W

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Family / Scientific name	Collection number	Farm	Habitat	Flora
Arundinella hispida (Humb. & Bonpl. ex Willd.) Kuntze		1		V
Axonopus comans (Trin. ex Döll.) Kuhlm.	VP-12334	1, 2		V
Axonopus uninodis (Hack.) G.A. Black		1, 2		V
**Chloris canterae* Arech.		1, 2		W
**Eleusine indica* (L.) Gaertn.		1, 2		W
Hemarthria altissima (Poir.) Stapf & C.B. Huber	VP-12236	1	G	V
Hyparrehnia bracteata (Humb. & Bonpl. ex Willd.) Stapf		1		V
Imperata tenuis Hack.		1	G	V
Leersia hexandra Sw.		1	A, G	V
Leptochloa virgata (L.) Beauv.	AP-17336	1, 2	G	
**Melinis repens* (W.) Zizka		1, 2		W
Mnesithea aurita (Steud.) de Koning & Sosef		1	G	V
Panicum sp.	VP-12237	1, 2	G	
Paspalum cordatum Filg.		1, 2		V
Paspalum intermedium Munro	VP-12346	1, 2	G	V
Paspalum urvillei Steud.	VP-12345	1, 2	G, W	
Saccharum asperum (Nees) Steud.		1, 2		V
Saccharum villosum Steud.	VP-12232	1, 2		V
Schizachyrium condensatum (Kunth) Nees	VP-12235	1, 2	G	V
Setaria parviflora (Poir.) Kerguélen		1, 2	A, G	W, V
Setaria paucifolia (Morong) Lindm.	VP-12230	1, 2		V
**Sorghum bicolor* subsp. *arundinaceum* (Desv.) de Wit & J.R. Harlan		1, 2		W
Stephostachys mertensii (Roth) Zuloaga & Morrone		1, 2	G	
**Urochloa brizantha* (Hochst. ex A. Rich.) R.D. Webster		1, 2		W
* *Urochloa decumbens* (Stapf) R.D. Webster		1, 2		W
POLYGALACEAE				
Polygala appendiculata Vell.	VP-12254	1, 2	G	V
POLYGONACEAE				
Polygonum punctatum Elliot		1, 2	A, G	V
PTERIDACEAE				
Pityrogramma calomelanos (L.) Link	VP-12336	1, 2	G	V
Pteris vittata L.	VP-12306	1, 2	G	
RUBIACEAE				
Richardia brasiliensis Gomez		1, 2		W
RICCIACEAE				
Riccia sp.		2	A	
SOLANACEAE				
Cestrum laevigatum Schltdl.		1, 2	G, R	V

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Family / Scientific name	Collection number	Farm	Habitat	Flora
Physalis angulata L.	AP-17406	1	G	W
Solanum nigrescens M. Martens & Galeotti		1, 2	G	W
THELYPTERACEAE				
Amauropelta rivularioides (Fée) Salino & T.E. Almeida	VP-12350	1, 2	G	V
URTICACEAE				
Cecropia pachystachya Trécul		1, 2	G, R	V
VERBENACEAE				
Glandularia hassleriana (Briq.) Tronc.	VP-12296	1, 2	G	
Lantana trifolia L.	VP-12342	1	G	
Lippia recolletae Morong	VP-12263	1, 2	G	
Phyla nodiflora (L.) Greene	VP-12269	1, 2	G	
Verbena litoralis Kunth	VP-12341	1, 2	G	W