FLORISTIC COMPOSITION IN TWO SUB-AREAS OF A WETLAND (VEREDA) IN AUSTRAL CENTRAL BRAZIL

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ABSTRACT

Wetlands are globally threatened ecosystems and in the Cerrado savanna are known as *veredas*, which is included in the world's list of regions considered as a priority for conservation. The study was carried out in two sub-areas of a *vereda*, being named "upper part and lower part of *vereda*", in the municipality of Terenos, State of Mato Grosso do Sul. The method used in the fieldwork was the walkover survey. We identified 46 families, 108 genera and 165 species. On the upper part, we found 70 species and on the lower part, 109 species. The Jaccard diversity index for the sub-areas was 0.08, demonstrating that they are different. The most species-rich family was Cyperaceae (27). Predominate the herbs (124), emergent and amphibious. We recorded *Cyperus longiculmis*, a new species described and found in *veredas*.
Key words: Aquatic vegetation, Macrophytes, Wetland.

RESUMO

As áreas úmidas são ecossistemas ameaçados globalmente e no bioma Cerrado, são conhecidas como veredas, incluídas na lista mundial de regiões consideradas prioridades para a conservação. O estudo foi realizado em duas sub-áreas de uma vereda, sendo denominadas parte alta e parte baixa da vereda, município de Terenos, Mato Grosso do Sul. O método utilizado no trabalho de campo foi o caminhamento. Foram identificadas 46 famílias, 108 gêneros e 165 espécies. Na área denominada superior, 70 espécies foram identificadas e na parte inferior, 109 espécies. O índice de diversidade de Jaccard para as sub-areas foi de 0,08, demonstrando que elas são diferentes. A família mais rica em espécies foi Cyperaceae (27). Predominam as ervas (124), emergentes e anfíbias. Também foi registrada *Cyperus longiculmis*, uma nova espécie descrita para áreas de veredas.
Palavras-chave: Vegetação aquática, Macrófitas, Áreas úmidas.

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INTRODUCTION

Wetlands are ecosystems globally threatened by human action and they are internationally protected by the Ramsar Convention, which recognizes their relevance. They have important ecosystem functions, such as the purification and recharge of groundwater, microclimate regulation and the supply of drinking water to human and provision of water to wildlife, what originated the term “water infrastructure” (Irigaray, 2015). Furthermore, they have a high richness of species endemism, considered as centres of speciation (Wittmann *et al*., 2013). Wetlands occur in different Brazilian biomes and cover about 20% of the territory, predominantly in the Amazonian forest (Junk *et al*., 2012). They are also common in the Cerrado savanna, which is included in the world’s list of priority for nature conservation (Hotspots), taking into account its great diversity and number of endemic species, along with the high degree of threat and destruction (Klink and Machado, 2005; Scariot *et al*., 2005).

In the Cerrado, some wetlands are called *veredas*, they are marshy areas with mixed vegetation (Cunha *et al*., 2015), near springs and in saturated soils throughout the year (hydromorphic and poorly drained), with abundant organic matter and superficial water table. It is a hydrophilic community, formed by a continuous grassy herbaceous stratum, which occupies most of its area, and another shrubby-arboreal, with coverage between 5 and 10% (Meirelles *et al*., 2004). Cunha *et al*. (2015) characterize the *vereda* by different stages of development, where the spring area is occupied by dense herbaceous vegetation, followed by shrubs, subshrubs and pteridophytes, then vines and some tree species, turning into a riparian forest where the drainage channel becomes deeper.

According to Araújo *et al*. (2002) and Fagundes and Ferreira (2016), several factors, such as humidity and water table depth, influence the floristic composition and structure of the *veredas*. However, most of these communities are occupied by dense vegetation of herbs and grasses, mainly by species from the Asteraceae, Cyperaceae, Eriocaulaceae and Poaceae families, in addition to a shrub and sub-shrub stratum composed of Melastomataceae and Rubiaceae, with a great diversity of species and forms of life.

Despite its great diversity of species, in addition to its importance as a water source, research carried out in areas of *veredas* is still considered insufficient, considering the rapid environmental changes related to anthropic actions, mainly in the South, Southeast and Midwest of Brazil (Junk *et al*., 1989; Pott and Pott, 2003; Pivari *et al*., 2011). Moreira *et al*. (2011) and Moreira *et al.* (2015) described *veredas* with and without the palm *Mauritia flexuosa* L.f., both common landscapes in the Cerrado, yet lacking studies on the aquatic vegetation, despite their environmental importance.

Thus, the objective of this study was to identify plant species and their life forms and habits in two sub-areas of a wetland (*Vereda*) of the Cerrado savanna, in Terenos, State of Mato Grosso do Sul, Brazil.

MATERIALS AND METHODS

Study site

The work was carried out in two sub-areas (sites) of a wetland (*Vereda*), being named “upper part and lower part of vereda”, with the presence of water accumulation and clay soil (gleysol), over an impermeable laterite layer. The upper part (T) is an outcrop of groundwater, headwater of a *vereda*, forming a streamlet, dammed as an artificial pond, up to 2 m deep, fenced up, being considered the most preserved. The lower part (B) is located *c.* 450 m downstream of the upper part, at the lower end of the *vereda*, and also

contains a small constructed pond, up to 0.8 m deep, with access to livestock. The ponds were not sampled. The lower part of *vereda* drains into a small creek with riparian forest, running to the Anhanduí river, affluent of the Pardo river, of the Paraná basin. The palm *Mauritia flexuosa* L.f., though present elsewhere in this *vereda*, does not occur within the sampled areas.

The study area is located at Fazenda Modelo (3,081 ha), farm of the Brazilian Research Agency Embrapa Beef Cattle, municipality of Terenos, in the middle of the State of Mato Grosso do Sul, at the coordinates 20°33'03.2"S, 54°48'52.5"W and 20°33'28.5"S, 54°49'08.3"W, at a mean altitude of 550 m (Figure 1). The upper part (T) has an area of circa 250 m x 80 m (20.000 m²); the lower part (B) measures circa 150 m x 80 m (12.000 m²).

The biogeographic domain of the area is the Cerrado, with the presence of different vegetation types, such as savanna *s. s.*, woodland (*cerradão*), wetlands (*veredas*) and riparian formations. This *vereda* is surrounded by agricultural and pastoral areas, as usual in the region. The regional climate, according to the classification of Köppen-Geiger, is a transition zone between the humid mesothermic subtype (Cfa) without drought or short drought, and the humid tropic subtype (Aw) with summer rainfall and dry winter. The average annual rainfall is around 1,400 mm, with a monthly average above 150 mm from October to March and below this between April and September. The annual average temperature ranges from 22 to 23 ºC, with the mean maxima exceeding 30 ºC (October to March) and the mean minima reaching 14.5 ºC (June and July) (CPTEC-INPE 2014).

Data collection

The method used in the field work was the walkover survey, that consists of recognition of vegetation types, preparation of the list of species found during exploratory walks along an imaginary zig-zag lines and analysis of the results (Filgueiras *et al.*, 1994). In two-month intervals, during 18 months, three researchers took the walks, approximately 1-2 m apart, on both sites. The observation time was 4 h per sampling in each site, sufficient to collect all fertile species.

The sampling was performed out between Oct. 2015 and Jun. 2017, in alternate months (Oct. and Dec. – 2015, Feb., Apr., Jun., Aug., Oct. and Dec. - 2016, Feb., Apr. and Jun. - 2017). 252 collections were made, deposited in the extinct Herbário HMS of Embrapa Gado de Corte, incorporated into the CGMS Herbarium of the Federal University of Mato Grosso do Sul in Campo Grande. The botanical nomenclature was updated according to Reflora (2018), within the phylogenetic classification system based on APG IV (2016).

The classification of species habits was done according to Sando and Almeida (1998) and Ribeiro *et al.* (2001), being divided into trees (woody plants without basal branches and height above ± 2 m), shrubs (woody plants, with or without basal ramifications and height ± 1 to 2 m), subshrubs (± 0.50 to 1 m), herbs (<1 m tall, including grasses, sedges and non-graminoids) and climbing plants (long stems needing support). In addition to these groups, macroalgae and mosses (taxonomic classification) were also identified.

According to Irgang *et al*. (1984), species were classified in life forms according to habit and position in relation to water surface (amphibious, emergent, rooted floating, rooted submersed and free submersed).

RESULTS

We recorded 165 species, belonging to 106 genera and 46 botanical families (Table 1). On the upper part of *Vereda*, we found 70 species (42.4%) and on the lower part of *Vereda*, 109 species (66.1%). Only 14 species (8.5%) were common to both areas. The Jaccard diversity index obtained was 0.08.

Table 1 - Plant families and species recorded on the upper (U) and lower (L) part of *Vereda* at Embrapa Beef Cattle, Terenos, Mato Grosso do Sul, Brazil (Hbt [habitats]: alg=algae; climb=climbers; herb=herbs; moss=mosses; sub=subshrubs; shr=shrubs; tree; e=exotic; Life forms (LF): Am=amphibious; Em=emergent; RF=rooted floating; RS=rooted submerged; FS=free submerged. Voucher Pina=collection number of Talita C. Pina)

Families – Species	Hbt	U	L	LF	Voucher Pina
Alismataceae					
Echinodorus longipetalus Micheli	Herb		X	Em	16
Helanthium bolivianum (Rusby) Lehtonen & Myllys	Herb		X	Em	215
Helanthium tenellum (Martius) Britton	Herb	X		Em	222
Sagittaria rhombifolia Cham.	Herb		X	RF	38
Apiaceae					
Eryngium ebracteatum Lam.	Herb	X		Em	51
Eryngium floribundum Cham. & Schltdl.	Herb		X	Em	33, 210
Eryngium pandanifolium Cham. & Schltdl.	Herb	X		Em	109
Apocynaceae					
Mandevilla rugosa (Benth.) R.E. Woodson	Climb		X	Em	14
Rhabdadenia madida (Vell.) Miers	Herb	X		Em	54
Aquifoliaceae					
Ilex affinis Gardner	Shr	X		Am	103
Araliaceae					
Hydrocotyle pusilla A. Rich.	Herb		X	Em	174
Hydrocotyle ranunculoides L. f.	Herb	X		Em	149
Asteraceae					
Acilepidopsis echitifolia (Mart. ex DC.) H. Rob.	Sub	X	X	Em	119
Adenostemma suffruticosum Gardner	Herb		X	Em	70
Chaptalia integerrima (Vell.) Burkart	Herb		X	Am	84
Clibadium armanii (Balb.) Sch.Bip. ex O.E. Schulz	Shr		X	Em	39
Chromolaena cf. *callilepis* (Sch.Bip. ex Baker) R.M. King & H.Rob.	Sub		X	Am	117, 186
Elephantopus palustris Gardner	Herb		X	Em	219
Leptostelma tweediei (Hook. & Arn.) D.J.N. Hind & G.L. Nesom	Herb	X	X	Em	67
Lessingianthus cf. *grandiflorus* (Less.) H. Rob.	Herb	X		Em	106
Mikania stenophylla W.C. Holmes	Climb	X	X	Am	27
Picrosia longifolia D. Don	Herb	X		Em	229
Pterocaulon alopecuroides (Lam.) DC.	Herb		X	Am	136, 169
Pterocaulon lanatum Kuntze	Herb		X	Am	112
Raulinoreitzia crenulata (Spreng.) R.M. King & H.Rob.	Sub	X		Em	147
Symphyotrichum squamatum (Spreng.) G.L. Nesom	Sub		X	Em	64
Vernonanthura brasiliana (L.) H. Rob.	Sub		X	Am	180

Vernonanthura cuneifolia (Gardner) H. Rob.	Sub	X		Am	232
Begoniaceae					
Begonia cucullata Willd.	Herb		X	Em	66
Boraginaceae					
Varronia polycephala Lam.	Sub		X	Am	250
Bryophyta, Hypnaceae					
Isopterygium tenerifolium Mitt.	Moss		X	Em	205
Burmanniaceae					
Burmannia flava Mart.	Herb	X		Em	199
Campanulaceae					
Lobelia camporum Pohl	Herb		X	Em	19
Characeae					
Chara guairensis R. Bicudo	Alg	X		RS	152
Convolvulaceae					
Jacquemontia tamnifolia (L.) Griseb.	Climb		X	Em	134
Cyperaceae					
Cyperus brasiliensis (Kunth) Bauters	Herb	X		Em	45
Cyperus brevifolius (Rottb.) Endl. ex Hasslk.	Herb		X	Am	10
Cyperus haspan L.	Herb		X	Am	17
Cyperus lanceolatus Poir.	Herb		X	Am	32
Cyperus sellowianus (Kunth) T. Koyama	Herb		X	Em	7
Cyperus longiculmis Pereira-Silva, Hefler, R. Trevis.	Herb	X		Em	101, 236
Cyperus luzulae (L.) Retz.	Herb		X	Am	29
Cyperus niederleinianus Boeckeler	Herb	X		Em	46
Cyperus odoratus L.	Herb		X	Am	6
Cyperus surinamensis Rottb.	Herb		X	Am	8
Cyperus unioloides R. Br.	Herb	X		Em	238
Cyperus virens Michx.	Herb		X	Am	77
Eleocharis acutangula (Roxb.) Schult.	Herb		X	Em	26
Eleocharis contracta Maury ex Micheli	Herb		X	Em	3
Eleocharis plicarhachis (Griseb.) Svenson	Herb	X	X	Em	157
Fimbristylis autumnalis (L.) Roem. & Schult.	Herb	X	X	Am	6,62,115, 217,235
Fuirena incompleta Nees	Herb		X	Em	29
Fuirena umbellata Rottb.	Herb		X	Am	35
Rhynchospora emaciata (Nees) Boeckeler	Herb	X		Em	111
Rhynchospora loefgreni Boeckeler & Schult.	Herb	X		Am	42
Rhynchospora marisculus Lindl. & Nees	Herb	X	X	Em	50, 220
Rhynchospora rugosa (Vahl) Gale	Herb	X	X	Em	162
Rhynchospora trispicata (Nees) Schrad. ex Steud.	Herb	X		Am	159
Rhynchospora velutina (Kunth) Boeckeler	Herb		X	Em	13
Scleria hirtella Sw.	Herb	X		Am	95
Scleria microcarpa Nees ex Kunth	Herb		X	Am	11
Scleria macrophylla J. Presl & C. Presl	Herb		X	Am	207
Eriocaulaceae					
Eriocaulon aquatile Körn	Herb	X		Em	193
Eriocaulon macrobolax Mart.	Herb		X	Em	214

Eriocaulon modestum Kunth	Herb	X		Em	139, 192, 255
Syngonanthus caulescens (Poir.) Ruhland	Herb	X		Am	142, 202
Syngonanthus gracilis (Bong.) Ruhland	Herb		X	Am	124
Syngonanthus helminthorrhizus (Mart. ex Körn.) Ruhland	Herb	X		Em	228
Euphorbiaceae					
Euphorbia hyssopifolia L.	Herb		X	Am	31, 190, 249
Sapium obovatum (Klotzsch) Müll. Arg.	Sub		X	Am	12
Fabaceae					
Calopogonium mucunoides Desv.	Climb		X	Am	170
Chamaecrista nictitans (L.) Moench.	Shr		X	Am	80
Crotalaria lanceolata E. Mey.	E-shr		X	Am	86
Desmodium barbatum (L.) Benth.	E-sub		X	Am	75
Desmodium incanum DC.	Sub		X	Am	89
Desmodium scorpiurus (Sw.) Desv.	Herb		X	Am	173
Indigofera hirsuta L.	Sub		X	Am	133
Macroptilium lathyroides (L.) Urb.	Climb		X	Am	5
Mimosa nuda Benth.	Sub		X	Am	85, 82
Stylosanthes scabra Vog.	Shr		X	Am	88, 89
Gentianaceae					
Chelonanthus viridiflorus (Mart.) Gilg	Sub	X		Em	107
Schultesia gracilis Mart.	Herb	X		Em	158
Schultesia heterophylla Miq.	Herb	X	X	Em	176
Iridaceae					
Cipura paludosa Aubl.	Herb		X	Am	78
Lamiaceae					
Hyptis balansae Briq.	Herb		X	Am	118, 178, 247
Hyptis microphylla Pohl ex Benth.	Herb	X		Em	108
Hyptis recurvata Poit.	Herb		X	Am	171, 209
Salvia scabrida Pohl	Sub		X	Am	113
Lentibulariaceae					
Utricularia gibba L.	Herb	X		FS	151
Utricularia hydrocarpa Vahl	Herb	X		FS	154
Utricularia laxa A. St.-Hil. & F. Girard	Herb	X		Em	233
Utricularia myriocista A. St.-Hil. & F. Girard	Herb	X		FS	104
Utricularia nervosa G. Weber ex Benj.	Herb	X		Em	105
Utricularia olivacea Wright ex Griseb.	Herb	X		FS	150
Utricularia praelonga A. St.-Hil. & F. Girard	Herb	X		Em	44
Utricularia trichophylla Spruce ex Oliver	Herb	X		Em	137
Lythraceae					
Ammannia auriculata Willd.	Herb		X	Am	187
Cuphea carthagenensis (Jacq.) J.F. Macbr.	Herb		X	Am	21
Cuphea cf. *pterosperma* Koehne	Herb	X	X	Am	52
Rotala mexicana Cham. & Schltdl.	Herb		X	Em	191
Malpighiaceae					
Heteropterys procoriacea Nied.	Climb	X		Am	97, 165,

					230
Malvaceae					
Melochia pyramidata L.	Herb	X		Am	110
Peltaea obsita (Colla) Krapov. & Cristóbal	Sub		X	Am	69
Sida linifolia Cav.	Herb		X	Am	79
Sida rhombifolia L.	Herb		X	Am	74
Sidastrum paniculatum (L.) P.A. Fryxell	Sub		X	Am	135
Mayacaceae					
Mayaca sellowiana Kunth	Herb	X		Em	102
Melastomataceae					
Acisanthera variabilis (Mart. & Schrank) Triana	Herb	X		Em	223
Miconia chamissois Naudin	Shr		X	Am	72
Menyanthaceae					
Nymphoides indica (L.) Kuntze	Herb	X		RF	160
Myrtaceae					
Blepharocalyx salicifolius (Kunth) O. Berg	Shr		X	Am	243
Myrcia palustris DC.	Shr	X		Am	164
Onagraceae					
Ludwigia bullata (Hassl.) H. Hara	Sub	X	X	Em	116, 195
Ludwigia elegans (Cambess.) H. Hara	Herb		X	Am	4
Ludwigia irwinii T.P. Ramamoorthy	Herb		X	Am	127
Ludwigia nervosa (Poir.) H. Hara	Sub		X	Am	125, 183
Ludwigia octovalvis (Jacq.) P.H. Raven	Herb		X	Am	23, 188
Ludwigia rigida (Miq.) Sandwith	Sub		X	Am	248
Orchidaceae					
Habenaria amambayensis Schltr.	Herb	X		Em	224
Platythelys debilis (Lindl.) Garay	Herb		X	Em	221
Orobanchaceae					
Melasma melampyroides (Rich.) Pennell	Herb		X	Am	184
Phyllanthaceae					
Phyllanthus stipulatus (Raf.) G.L. Webster	Herb		X	Em	30
Piperaceae					
Piper fuligineum Kunth	Sub	X		Am	41
Piper macedoi Yunck.	Sub		X	Am	36
Plantaginaceae					
Bacopa australis V.C. Souza	Herb	X		Em	194
Bacopa caroliniana (Walter) B.L. Rob.	Herb		X	Em	60
Bacopa congesta Chodat & Hassl.	Herb		X	Em	213
Scoparia dulcis L.	Herb		X	Am	22
Poaceae					
Andropogon bicornis L.	Herb		X	Am	81
Andropogon glaziovii Hack.	Herb		X	Em	242
Andropogon virgatus Desv. ex Ham.	Herb		X	Am	93, 153
Anthaenantia lanata (Kunth) Nees	Herb	X		Em	241
Arundinella hispida (Humb. & Bonpl. ex. Willd.) Kuntze	Herb		X	Am	182, 204
Eriochrysis laxa Swallen	Herb	X	X	Em	49, 94, 71, 203

Hyparrhenia rufa (Nees) Stapf	Herb		X	Am	172
Loudetia flammida (Trin.) C.E. Hubb.	Herb	X		Am	161
Luziola bahiensis (Steud) Hitchc.	Herb	X		Em	155
Mnesithea aurita (Steud.) de Koning & Sosef	Herb		X	Em	73
Paspalum virgatum L.	Herb		X	Am	122
Rhytachne rottboellioides Desv. ex Ham.	Herb	X		Em	55
Saccharum asperum (Nees) Steud.	Herb	X	X	Am	83, 226
Sacciolepis vilvoides (Trin.) Chase	Herb	X		Em	58, 90, 231
Steinchisma laxum (Sw.) Zuloaga	Herb		X	Am	61
Trichanthecium cyanescens (Nees ex Trin.) Zuloaga & Morrone	Herb	X	X	Em	99, 132
Polygalaceae					
Polygala campestris Gardner	Herb		X	Am	130
Polygonaceae					
Polygonum meisnerianum Cham.	Herb	X		Em	166
Pontederiaceae					
Pontederia cordata L.	Herb	X		Em	218, 240
Primulaceae					
Lysimachia minima (L.) U. Manns & Anderb.	Herb		X	Am	245
Myrsine umbellata Mart.	Tree		X	Am	208
Pteridaceae					
Pityrogramma calomelanos (L.) Link	Herb		X	Am	181
Pityrogramma trifoliata (L.) R.M. Tryon	Herb		X	Em	37
Thelypteridaceae					
Thelypteris serrata (Cav.) Alston	Herb		X	Am	63
Rubiaceae					
Borreria pulchristipula (Bremek.) Bacigalupo & E.L.Cabral	Herb		X	Em	25, 128
Emmeorhiza umbellata (Spreng.) K.Schum.	Herb		X	Am	244
Hexasepalum radula (Willd.) Delprete & J.H. Kirkbr.	Herb	X		Am	53
Oldenlandia salzmannii (DC.) Benth. & Hook.f. ex B.D. Jacks.	Herb		X	Em	237
Psychotria carthagenensis Jacq.	Shr	X		Am	146
Solanaceae					
Solanum americanum Mill.	Herb		X	Am	34
Verbenaceae					
Lantana trifolia L.	Sub		X	Am	129
Lippia alba (Mill.) N.E. Br. ex P. Wilson	Sub		X	Am	24
Stachytarpheta cayennensis (Rich.) Vahl	Herb		X	Am	87
Xyridaceae					
Xyris jupicai Rich.	Herb	X	X	Em	18, 91, 196
Xyris savanensis Miq.	Herb	X		Em	43, 143
Xyris schizachne Mart.	Herb	X		Em	56, 148
Xyris tortula Mart.	Herb	X		Em	140

Live forms and habitats

The herbs (124 spp.) totaled 75.1% of the species, with the predominance of emergent (76 species, 46.1%) and amphibious (82 species, 49.7%). The greatest number of species occurred in the genera *Andropogon*, *Cyperus*, *Hyptis*, *Ludwigia*, *Rhynchospora*, *Utricularia* and *Xyris* (Table 1).

The second largest number of species was found for subshrubs (23 species, 13.9%), followed by climbers (6 species, 3.6%), shrubs (9 species, 5.4%) and tree (1 species, 0.6%). On site were also identified (taxonomic classification), algae (1 species, 0.6%) and mosses (1 species, 0.6%). The woody species *Ilex affinis*, *Sapium obovatum*, *Stylosanthes scabra*, *Varronia polycephala*, *Vernonanthura chamaedrys* and *Miconia chamissois* were found forming groupings.

We found herbaceous species with filiform leaves, belonging to Cyperaceae, Poaceae and Xyridaceae. *Rhynchospora* spp. form dense clumps, consisting of entangled living and dead leaves. In the gaps between the tussocks, we sampled Eriocaulaceae, such as *Eriocaulon* spp., plus Lentibulariaceae.

The most abundant life form (Figure 2a) is amphibious plants, 17 species (10.3%) occurring on the upper part of *Vereda* and 69 (41.8%) on the lower part of *Vereda*, followed by emergent, being 47 species (28.5%) on the upper part and 39 (23.6%) on the lower part. The smallest number of species was found for rooted floating (2 species), rooted submerged (1 species) and free submerged (4 species).

Regarding plant habits (Figure 2b), herbs comprised 124 species (75.1%), 58 (35.1%) occurred on the upper part of *Vereda*, compared with 77 species (46.7%) on the lower part of *Vereda* and both had 11 (6.7%) in common. Twenty three species of subshrubs, 6 species (3.6%) on the upper part, while 19 species (11.5%) occurred on the lower part, one being exotic and 2 species (1.2%) in common; shrubs, 9 species (5.4%); climbers, 6 species (3.64%); and 1 species of algae, mosses and trees (0.6% each).

Genera and Families

Altogether, on upper and lower part of *Vereda*, we identified 106 genera and most of them (82 genera, 77,4%) had a single species. Among the recorded genera, *Cyperus* presented the largest number of species (12), followed by *Utricularia* (8), *Rhynchospora* and *Ludwigia* (6 each) and *Xyris* (4), totalling 36 species (21.8%). Among the eight recorded species of *Utricularia*, *U. laxa* and *U. olivacea* were new occurrences for the State of Mato Grosso do Sul at the time of the survey. We recorded *Cyperus longiculmis*, a new species just described from *veredas* (Pereira-Silva *et al.* 2018).

In the study site, we identified 46 families, being that 9 families (19.6%) were exclusive to the upper part of *Vereda* and 17 (36.9%) to the lower part of *Vereda*, and 20 (43.5%) common to both areas. The 10 families richest were Cyperaceae (27 species), Asteraceae and Poaceae (16 each), Fabaceae (10) and Lentibulariaceae (8). These 77 species encompassed 46.7% of all species found. On the other hand, 29 families (63.0%) were represented by only one or two species (Figure 3).

DISCUSSION

Species, live forms and habitats

According to Mendonça *et al.* (2008), 770 species have been catalogued in *veredas* in the Brazilian Cerrado. We recorded more that 20% of those species cited by Mendonça *et al.* (2008), at the place of study (Fazenda Modelo), that demonstrates the high richness, despite the small size of our evaluated site. On the other hand, 82 species found in this

work are not listed by Mendonça *et al*. (2008). This result could demonstrate that there are still many species not cataloged for the *veredas*. However, the list can be considered old (2008), as new species have been described for this environment. In addition, changes occur in relation to the names of species, genera and families, which does not allow a precise comparison with the original listing.

Tannus and Assis (2004), working in various areas of shrubby and wet Cerrado grassland in Itirapina, SP, listed 18% of the total of species compiled by Mendonça *et al.* (2008) and they considered that as a considerable richness. Thus, despite the list by Mendonça *et al*. (2008) be considered outdated, the species richness of the Fazenda Modelo can be considered high.

The highest herb species richness we found is related to the predominance of Poaceae, Lentibulariaceae, Cyperaceae and Asteraceae, the same main families reported for wet grasslands and *veredas* by Araújo *et al*. (2002), Guimarães *et al*. (2002), Meirelles *et al*. (2004), Tannus and Assis (2004), Moreira *et al*. (2011), Araújo *et al*. (2012) and Moreira *et al*. (2015). Thus, despite the differences between species, only a small group of families predominates in humid areas, such as *veredas*, indicating their ability to adapt to flooded environments. These families probably have adaptations, such as the ability to withstand certain periods of anoxia and/or hypoxia.

The proportion of the total number of species we recorded for Asteraceae, Cyperaceae, Fabaceae and Poaceae, about 41.8%, were relatively superior to 38.8% presented by Araújo *et al.* (2002), working in four *veredas* in good condition in Uberlândia, MG. On the other hand, Guimarães *et al.* (2002), in the same region, in a preserved and another disturbed *vereda*, found a greater number of species per family, 59.4%, in relation to the total we collected. However, it is important to point out that they worked in a different region, hence different results, demonstrating that the *veredas* because they are dispersed over central Brazil, can present regional floristic peculiarities, although with a predominance of certain groups. Araújo *et al.* (2002) point out that several species found in *veredas* are not restricted to their phytocoenosis, due to influence of the surrounding vegetation.

In this way, the surroundings of the *vereda* is an important factor to be considered. In the case of the studied area (Fazenda Modelo), as it is a research center, there is a higher level of environmental preservation of the place, which provides greater floristic diversity, possibly positively influencing the *vereda*. The difference in species richness may be influenced by several factors. For example, the increase in the population of some species that benefit from environmental changes and the intenser their competition, the greater the probability that some species will be reduced or eliminated (Silva and Durigan, 2006). But according to Fagundes and Ferreira (2016), water table depth is the main factor that influence the floristic composition and structure of the *veredas*.

Despite the diversity of species, according to Araújo *et al.* (2002), Guimarães *et al.* (2002), Meirelles *et al.* (2004), Tannus and Assis (2004), Moreira *et al.* (2011) and Araújo *et al.* (2012), species of Poaceae, Cyperaceae and Asteraceae are dominant in this type of environment, a result confirmed by our data, demonstrating a pattern of occupation of these wetlands, despite possible anthropic actions. This group of heliophilic representatives is favoured by open treeless environments (Coutinho, 1978).

The higher species richness of the lower part of *vereda* can be partially attributed to disturbance by cows and horses. In accordance, Pandey and Singh (1991) and Belsky (1992) report that protected areas tend to have lower species richness than corresponding grazed sites. Guimarães *et al.* (2002) mention that the increased richness in anthropized areas would result from greater environmental heterogeneity due to disturbances in the

vegetation structure. According to Meirelles *et al.* (2004), bovine cattle through grazing and trampling, often followed by soil erosion, may lead to a change in species richness of wet grasslands. However, depending on grazing intensity, the diversity of species may increase or decrease, since, under moderate use, the richness can increase or with excessive grazing, decline (Guimarães *et al.*, 2002). As already mentioned, the study site is an agricultural research center. In this way, certain rules are followed, avoiding excessive grazing and environmental degradation, occurring a greater floristic diversity.

In relation to arboreal and climbing species, the results obtained confirmed the pattern found in other *veredas*, with few species in this group, factor related to the constraints of the edaphic environment. Araújo *et al.* (2002), indicated that this group is less representative in *veredas* in Uberlândia. On the other hand, algae, mosses and epiphytes are groups not normally cited, demonstrating that the *veredas* have specific environmental conditions, which allow certain groups to be dominant, while others, more rare.

In studies with *veredas*, usually a species of palm (*Mauritia flexuosa* L.f.), is always mentioned, popularly known as 'buriti' and a symbol of this type of environment. However, in this study it was not found. In relation to the presence or absence of the palm, according to Moreira *et al*. (2011) and Moreira *et al*. (2015), absence is not an indication that a wetland in Cerrado is not a *vereda*, since other species may be indicative of this type of environment. However, this issue is yet controversial, because some authors differentiate the *vereda* from other wetlands mainly by the presence of *M. flexuosa*, formed basically by two strata, a herbaceous grassland, occupying most of the area, and another shrubby-arboreal stratum with presence of *M. flexuosa*, with 5 to 10% cover (Sano *et al.* 2008). Nonetheless, the latest forest code considers both *veredas* with and without *M. flexuosa*, but the interpretation of the law still fails to protect wetlands without the iconic palm (Moreira *et al*. 2015).

A common feature of *veredas* is the presence of species that form dense clumps, with filiform leaves which were also found in abundance at the study site. In relation to the tussock species, Munhoz and Felfili (2007) point out that they are the great majority of the representatives of Poaceae and Cyperaceae and this group tends to present greater vegetative cover than small herbs, interfering with their diversity and abundance. Araújo *et al.* (2002) also report that dense clumps of filiform species may hinder the establishment of other species.

In relation to life forms, Moreira *et al.* (2011), in a *vereda* pond *c.* 1 km from our study area, have also identified the amphibious plants as the most abundant, with 64.5%, but only 9.2% of emergent plants, results different from our findings, demonstrating that the wetlands differ within short distances in the same region. On the other hand, Pott and Pott (2003), in surveys conducted in ponds of the Pantanal, found as the most expressive life forms the emergent (39 species, 51.4%) and amphibious plants (20 species, 28%), similarly to our results. According to Moreira *et al.* (2011), the high richness of amphibious plants could be explained by their ability to survive in either flooded or dry ground.

The most frequent plant habits encountered were herbs, with 75.1%, which predominated on both upper part and lower part of *vereda*. On the other hand, the second most abundant group, the subshrubs (13.9%) presented most species on the lower part (11.5%), with species of families more common in disturbed and dry areas, such as Asteraceae and Fabaceae, for example. The greater presence of herbs would be expected, due to the edaphic environment limiting the establishment of other larger forms of life.

Genera and Families

The species richest families we recorded, Poaceae, Cyperaceae and Asteraceae, are also reported as such for *veredas* elsewhere (Araújo *et al*., 2002; Meirelles *et al*., 2004; Tannus and Assis, 2004; Moreira *et al*., 2011; Moreira *et al*., 2015). Accordingly, the species richest genera we found are also common to other wet grasslands and *veredas*, as reported by Araújo *et al.* (2002), Guimarães *et al.* (2002), Meirelles *et al.* (2004), Tannus and Assis (2004) and Moreira *et al.* (2011), demonstrating a pattern of occupation of these wetlands, despite possible anthropogenic disturbance.

The species richest genus was *Cyperus* and *Rhynchospora*, representing nearly 9.7% of the flora of this *vereda*, plus other Cyperaceae genera such as *Eleocharis*, *Fimbristylis*, *Fuirena* and *Scleria*. Cyperaceae are characteristic of *veredas* (Araújo *et al*., 2002), very frequent in anthropized wet grasslands (Moreira and Bragança, 2011) and according to Pivari *et al*. (2008), sedges may suggest recent changes. Although built decades ago, the impoundments in both areas certainly continue to favour emergent species of the above-mentioned genera. We highlight the occurrence of *Cyperus longiculmis*, a new species just described from *veredas* of Mato Grosso do Sul and Minas Gerais (Pereira-Silva *et al.*, 2018), what reveals the importance of floristic surveys in such areas and reinforces their relevance for conservation of plant diversity.

The genus with the second highest number of species, *Utricularia* (Lentibulariaceae), are herbaceous species, submerged aquatic or in swampy soil, found in lakes, ponds and dams (Joly, 2005), an adaptation that allows colonization of the impounded upper part. Until recently, two of these eight species were new occurrences for the State of Mato Grosso do Sul: *U. laxa* and *U. olivacea* (Taylor, 1989; Dubs, 1998; Miranda and Rivadavia, 2010).

The second family with the largest number of species, Asteraceae, is one of the most numerous in nature (Souza and Lorenzi, 2005). According to Moreira and Bragança (2011), the morphological characteristics of their propagules allow dispersion by wind and animals, thus cattle circulating to graze and drink water create microhabitats and may help to spread *Pterocaulon* and *Vernonanthura* on the lower part.

Poaceae also stood out and Guimarães *et al*. (2002) highlight this family as being one of the most important and frequent in *veredas*. Among the main genera, *Panicum l.s.*, *Paspalum* and *Andropogon* occupy mainly places with higher humidity in pastures in initial stages of degradation (Moreira and Bragança, 2011).

In relation to Fabaceae, also with a large number of species, we recorded *Calopogonium, Chamaecrista*, *Crotalaria* (one exotic species), *Desmodium*, *Indigofera* and *Mimosa*, common in grasslands. Araújo *et al*. (2002) state that legumes are known for their large number of shrub and tree species in the Cerrados; but the collected species were mostly subshrubs, indicating that the environment is limiting to the establishment of larger plants. Another observed result is that all legumes, mostly non-aquatic, were exclusive to the lower part, not as wet and more disturbed than the upper part, demonstrating their adaptation to sites with a higher level of environmental impact. This may be related to their ability to fix nitrogen.

Regarding the number of species per family, our results differ from those reported by Oliveira *et al*. (2009) on six *veredas* in Triângulo Mineiro, with 8.5% of families with just one or two species. On the other hand, Moreira *et al*. (2011), in a nearby *vereda* pond, cited 51.6% of families with a single species, while Tannus and Assis (2004) mentioned 41% in wetland sites, indicating high richness and diversity of genera, similarly to our finding.

In regard to Lentibulariaceae, considered true aquatic, they only occur on the upper part, wetter and more preserved than the lower part. A similar situation was observed for Eriocaulaceae, Mayacaceae and Xyridaceae, most species considered true aquatic also occur mostly on the upper part. Other recorded families, such as Piperaceae, Aquifoliaceae, Begoniaceae and Burmanniaceae, are common in wet soils (Joly, 2005).

Malvaceae congregate numerous weeds of degraded habitats, either native, such as *Sida* spp., or exotic, such as *Sidastrum paniculatum*, exclusive to the lower part of *vereda*. Lamiaceae are represented throughout the country by genera with native and introduced species, whose habit extends from the herbaceous, shrubby to arboreal, including species of *Hyptis* considered weedy, normally abundant in anthropized areas (Moreira and Bragança, 2011), present on the upper part and lower part of *vereda*.

In accordance with our observation, Oliveira *et al*. (2009) state that the works on *vereda* demonstrate the existence of a complex vegetation, with great richness of associated species. Despite the impact of livestock, the environment still presents a great diversity of species, demonstrating some resilience under moderate grazing. However, these wetlands are rapidly changing due to agricultural activities. We did not survey the transversal floristic variation, of edge, middle and core zones, as has been described by Araújo *et al*. (2002) and Resende *et al*. (2013), however, we demonstrated the longitudinal plant diversity of the *vereda* and highlight its similar relevance to be taken into consideration for conservation. In conclusion: the upper part and the lower part of *vereda* are floristically different. Therefore, more studies on their flora would be important to provide subsidies for the creation of conservation units and for the correct management or recovery of *veredas*.

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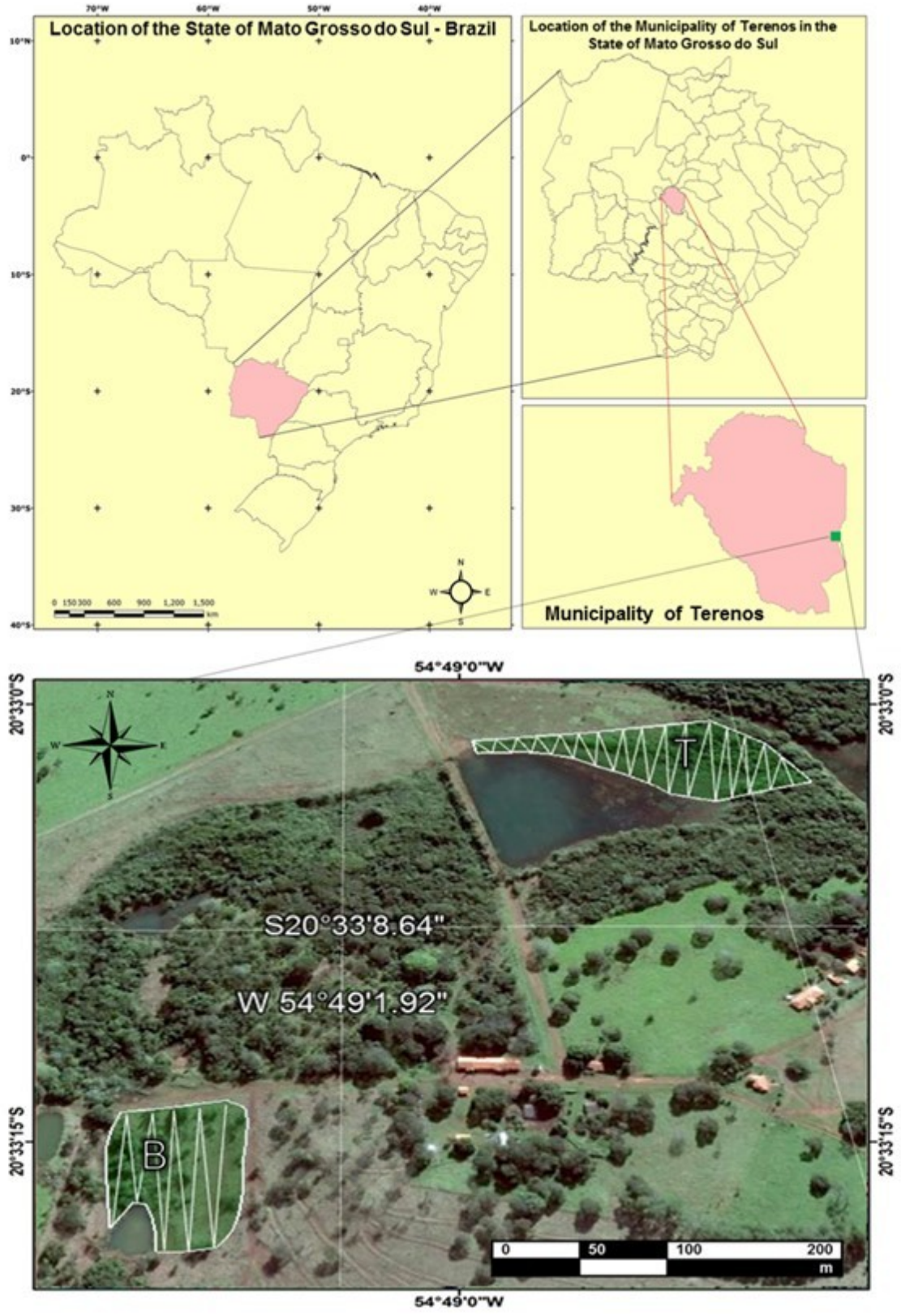

Figure 1. Satellite image of the upper part (T) and lower part (B) of vereda, research farm Fazenda Modelo of Embrapa Beef Cattle, Terenos, Mato Grosso do Sul, Brazil. Image Google Earth 2005.

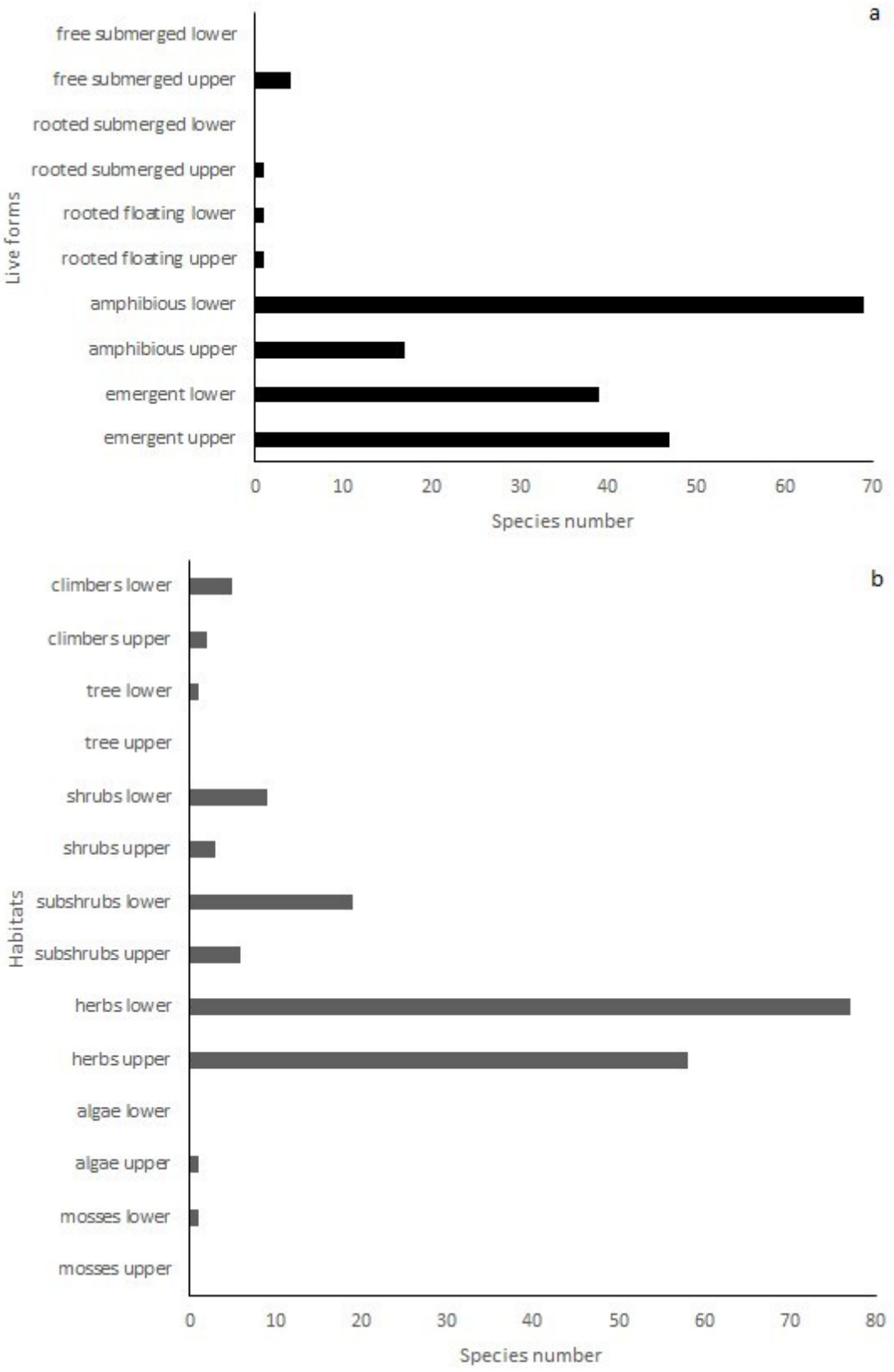

Figure 2. Life forms (a) and habitats (b) of species recorded on upper part and lower part of *vereda*, Embrapa Beef Cattle, Terenos, Mato Grosso do Sul, Brazil.

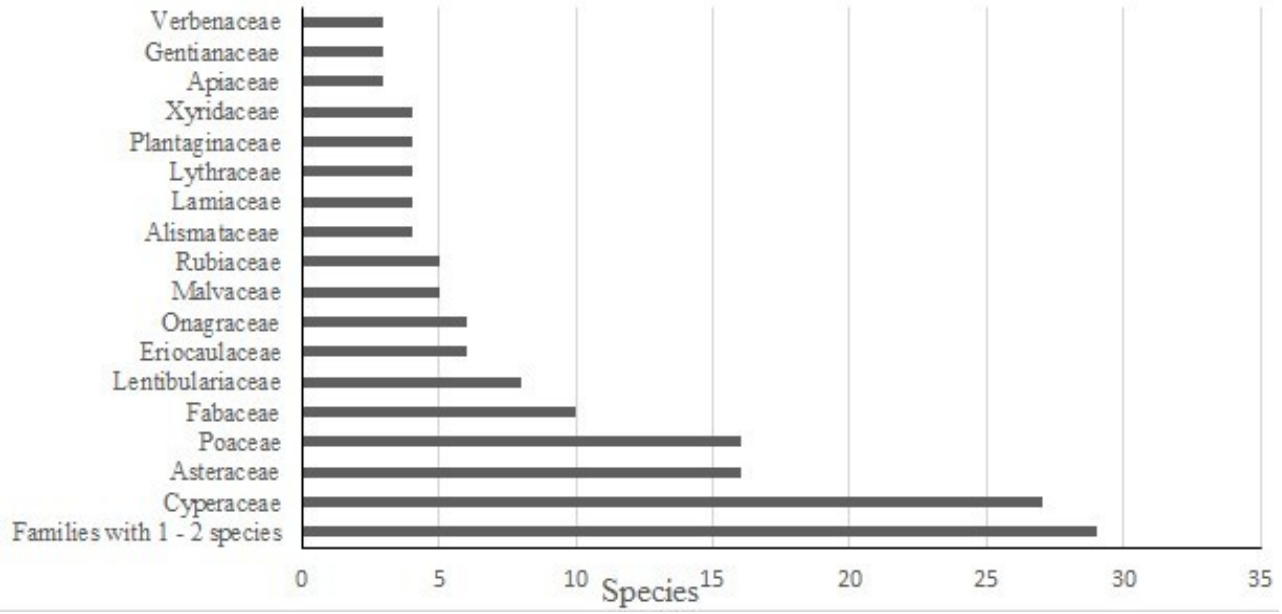

Figure 3. Families and number of species recorded on upper part and lower part of *vereda*, Embrapa Beef Cattle, Terenos, Mato Grosso do Sul, Brazil.