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ODONATE FAUNA (INSECT: ODONATA) OF TWO PONDS IN THE CERRADO-PANTANAL ECOTONE, AQUIDAUANA, MS

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Abstract: Knowing the biodiversity of a given site is the first step in establishing strategies for its conservation, monitoring and sustainable use. The objective of the present study was to catalogue the Odonata community of two ponds in the Cerrado-Pantanal ecotone area. Collections were carried out between October 2012 and September 2013, encompassing different hydrological seasons. This study presents the first systematized survey of Odonata for lentic environments in the region. A total of 347 individuals were recorded, distributed in 41 species, 22 genera and three families. The suborder Zygoptera was represented by the Coenagrionidae and Lestidae families, while the suborder Anisoptera was represented by the Libellulidae family. The *Acanthagrion*, *Erythemis* and *Erythrodiplax* genera were the most representative. The results indicate that there is seasonality in the occurrence of the species. The wide diversity found in lentic environments emphasizes the importance of long-term monitoring of these ecosystems, in order to understand the effect of seasonality and of anthropic alterations to the surrounding environment on the Odonata community.

Keywords: Anisoptera; Central-West; lentic environments; seasonality; Zygoptera.

INTRODUCTION

The Odonata order includes insects popularly known as "dragonflies and damselflies". In the neotropical region, the group is divided into two suborders, Zygoptera and Anisoptera. They are hemimetabolous, the adults are terrestrial-aerial with aquatic larva found in lotic and lentic aquatic environments, while some species are found in phytotelma environments, places with water accumulated in the leaf sheaths of bromeliads and in tree hollows (Souza *et al.* 2007).

Odonates are important organisms in the food chains of aquatic and terrestrial ecosystems (Corbet 2004, Valente-Neto *et al.* 2016). In the aerial adult phase, they make connections between bodies of water and food webs of riparian vegetation and the surrounding area (Huryn & Wallace 2000). Some species are sensitive to pollution and environmental alterations and may be used as indicators of water quality and environmental conditions in the area surrounding water bodies (Souza & Costa 2006, Rodrigues *et al.* 2016, Calvão *et al.* 2018). Riparian vegetation, canopy cover and water macrophytes, as well as some physical-chemical variables of the bodies of water, are among the principal factors that help in the understanding of patterns of diversity found in the group (Corbet 2004, Rodrigues *et al.* 2016, Valente-Neto *et al.* 2016).

In Brazil, around 860 species, distributed across

146 genera (Pinto 2018) are found. In Brazil, various studies have been carried out with Odonates in recent years, contributing to the knowledge on different biomes (Miguel *et al.* 2017), although said studies are generally concentrated close to sites offering access, infrastructure and logistics. A total of 209 species have been listed for the state of Mato Grosso do Sul (Rodrigues & Roque 2017, Rodrigues *et al.* 2018a). However, there are many gaps in the knowledge, with few regions having been explored and a scarcity of systematized collections, with little information in respect to richness and distribution (Costa *et al.* 2000, Rodrigues *et al.* 2018a). Information on the group is still fragmented and restricted to determined regions with a predominance of Atlantic Forest and *Cerrado* savanna (Koroiva *et al.* 2017, Rodrigues & Roque, 2017, Rodrigues *et al.* 2018a). The present study had the objective of carrying out a survey of Odonata in two ponds located in the municipality of Aquidauana (MS), contributing to diminishing gaps in knowledge on the group in the region.

MATERIAL AND METHODS

The collections were carried out in two ponds of the Cerrado-Pantanal ecotone region, in the municipality of Aquidauana, State of Mato Grosso do Sul, Brazil (Figure 1). The climate of the region is Tropical Savanna type (subtype Aw; Peel *et al.* 2007) with two well-defined seasons, one dry and cold (winter), from May to September, and the

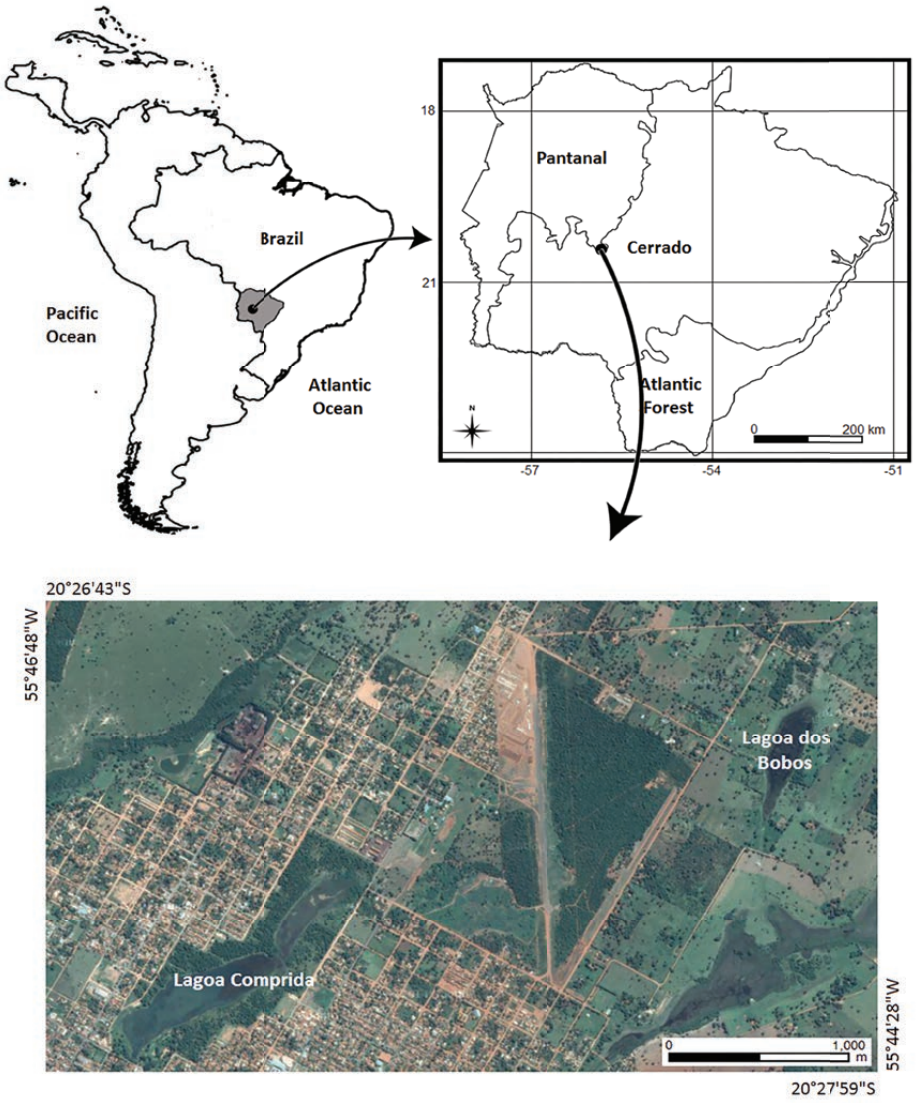

Figure 1. Location of the study areas in the municipality of Aquidauana, state of Mato Grosso do Sul, Brazil.

other rainy and hot (summer), from October to April. Mean annual precipitation is 1,200 mm and maximum and minimum temperatures are 33 and 19°C, respectively (Schiavo *et al.* 2010).

Lagoa Comprida (20°27'44" S, 55°46'26" O) is situated at the urban perimeter, in an environmental-protection area of a little over 70 ha. One part of its border is forested; however, it suffers from high anthropic pressure, due to urban growth. The urbanization of its surroundings favors increased contamination of its waters through liquid and solid waste, as there is discharge of raw sewage (Sontag & Mello 2009). Lagoa dos Bobos (20°27'1" S, 55°44'44" O) is situated in a rural area that is practically devoid of forest, its surrounding being used for cattle grazing. Both ponds present aquatic macrophyte coverage. Physical-chemical variables of the ponds were assessed and are presented descriptively for better specification of the environments.

Ten collections were carried out between October/2012 and September/2013, using the sweeping method around the bodies of water (between 200 and 300 m). The two ponds were sampled on consecutive days for about two hours per day at each lake (09:00-11:00 h), totaling 40 h of active search. For standardization, just one collector was used for sampling. All the adult individuals were collected with an entomological net, female Zygoptera being released due to difficulty of identification. Identification was carried out down to the lowest taxonomic level possible, with the use of specialized bibliography (Garrison *et al.* 2006, 2010, Heckman 2006, Lencioni 2005, 2006, 2017). This material was deposited in the Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul and in the Coleção Zoológica da Universidade Estadual de Santa Cruz.

The Shannon diversity index was calculated for each pond (natural logarithm), with its respective evenness. Estimated richness (Chao 1) and the Bray Curtis dissimilarity between collection points were calculated using the BioDiversity Pro software. Direct ordination (CA) was carried out to assess species distribution along the months, considering the frequency of species occurrence during the study period.

RESULTS

A total of 332 individuals were captured, belonging to 40 species divided into three families; Libellulidae (Anisoptera) with 26 species, Coenagrionidae (Zygoptera) with 12 species and Lestidae (Zygoptera) with two species (Table 1; Figure 2). The species are divided into 21 genera, of which 12

Table 1. Odonata species recorded at Lagoa Comprida and Lagoa dos Bobos, in the municipality of Aquidauana, state of Mato Grosso do Sul, Brazil.

Suborder/Family/Species	Lagoa Comprida	Lagoa dos bobos
ZYGOPTERA		
Coenagrionidae		
Acanthagrion cuyabae Calvert, 1909	11	1
Acanthagrion jessei Leonard, 1977	11	1
Acanthagrion lancea Selys, 1876	24	0
Acanthagrion temporale Selys, 1876	6	1
Argentagrion ambiguum (Ris, 1904)	4	0
Homeoura nepos (Selys, 1876)	19	11
Ischnura capreolus (Hagen, 1861)	7	4
Ischnura fluviatilis Selys, 1876	6	10
Telebasis carmesina Calvert, 1909	1	0
Telebasis simulacrum (Calvert, 1909)	8	7
Telebasis willinki Fraser, 1948	9	0
Tigriagrion aurantinigrum Calvert, 1909	1	0

Table 1. Continued on next page...

Table 1. ...Continued

Suborder/Family/Species	Lagoa Comprida	Lagoa dos bobos
Lestidae		
Lestes forficula Rambur, 1842	0	1
Lestes jurzitzai Muzón, 1994	1	2
ANISOPTERA		
Libellulidae		
Brachymesia sp.	1	0
Brechmorhoga sp.	3	1
Diastatops obscura (Fabricius, 1775)	3	0
Erythemis carmelita Williamson, 1923	2	0
Erythemis peruviana (Rambur, 1842)	2	3
Erythemis plebeja (Burmeister, 1839)	2	0
Erythemis sp.	1	0
Erythemis vesiculosa (Fabricius, 1775)	0	1
Erythrodiplax branconensis Sjöstedt, 1929	34	6
Erythrodiplax famula (Erichson in Schomburgk, 1848)	3	0
Erythrodiplax latimaculata Ris, 1911	3	0
Erythrodiplax lygaea Ris, 1911	0	1
Erythrodiplax maculosa (Hagen, 1861)	1	3
Erythrodiplax umbrata (Linnaeus, 1758)	0	2
Gynothemis venipunctata Calvert, 1909	1	0
Libellula herculea Karsch, 1889	2	0
Miathyria marcella (Selys in Sagra, 1857)	1	23
Miathyria simplex (Rambur, 1842)	2	0
Micrathyria iheringi Santos, 1946	1	1
Micrathyria spuria (Selys, 1900)	1	3
Nephepeltia aequisetis Calvert, 1909	27	7
Oligoclada nemesis (Ris, 1911)	21	9
Orthemis discolor (Burmeister, 1839)	0	5
Pantala flavescens (Fabricius, 1798)	2	0
Pantala hymenaea (Say, 1839)	1	1
Perithemis mooma Kirby, 1889	0	6
Abundance	222	110
Number of species	34	24
Estimated number of species (Chao 1)	45	45
Number of exclusive species	16	6
Singletons	11	9

presented only one species each. Seven genera were exclusive to Lagoa Comprida, two genera exclusive to Lagoa dos Bobos and 12 genera were common to both ponds. At both ponds the richest genera were *Acanthagrion* (4 spp.), *Erythemis* (5 spp.) and *Erythrodiplax* (6 spp.).

Erythrodiplax branconensis was the most abundant species with 40 individuals, followed by *Nephepeltia aequisetis* with 34 individuals, *Oligoclada nemesis* and *Homeoura nepos* with 30 individuals each, and *Miathyria marcella* and *Acanthagrion lancea* with 24 individuals each. The *Erythemis vesiculosa*, *Erythrodiplax lygaea*, *Gynothemis venipunctata*, *Lestes forficula* and

Telebasis carmita species, as well as an unidentified species of *Brachymesia* and *Erythemis*, were considered "singletons", being represented by only one individual (Table 1).

The rarefaction curve did not present a tendency towards stabilization (Figure 3), however, comparing observed richness (40 spp.) and estimated richness (Chao 1 = 45 spp.), around 89% of the species occurring in the study area have probably been sampled. Species richness was greater at Lagoa Comprida than at Lagoa dos Bobos (Table 1; Figure 3). The Shannon diversity index and evenness were similar for the two ponds, with a higher value at Lagoa Comprida (H' = 2.95 nats/ind.; J' = 0.83) in

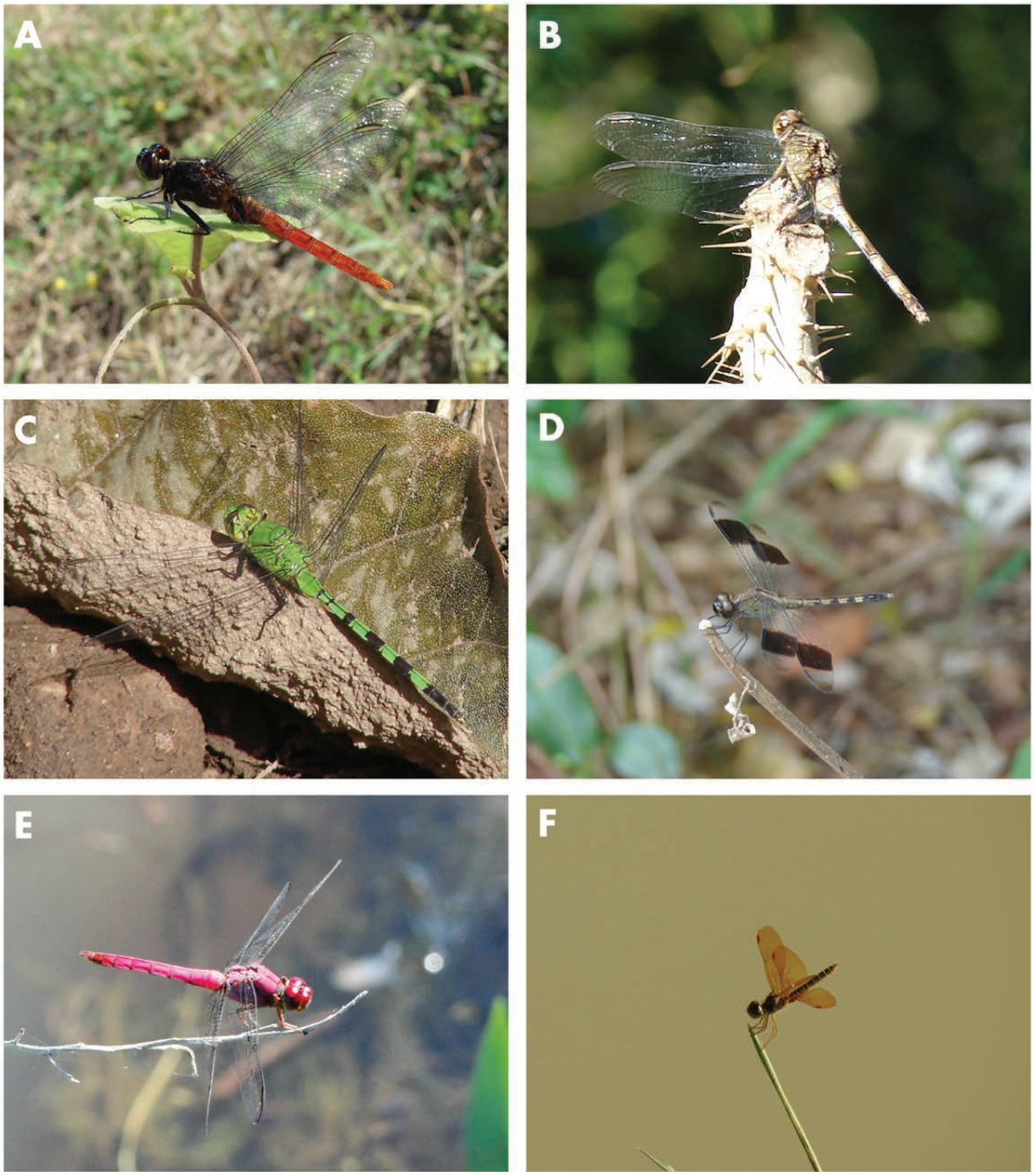

Figure 2. Odonata species recorded at two ponds in the Cerrado-Pantanal ecotone in the municipality of Aquidauana, state of Mato Grosso do Sul, Brazil: A) *Erythemis peruviana*, B) *Erythemis plebeja*, C) *Erythemis vesiculosa*, D) *Erythrodiplax umbrata*, E) *Orthemis discolor*, and F) *Perithemis mooma*. Photos: Camila Aoki.

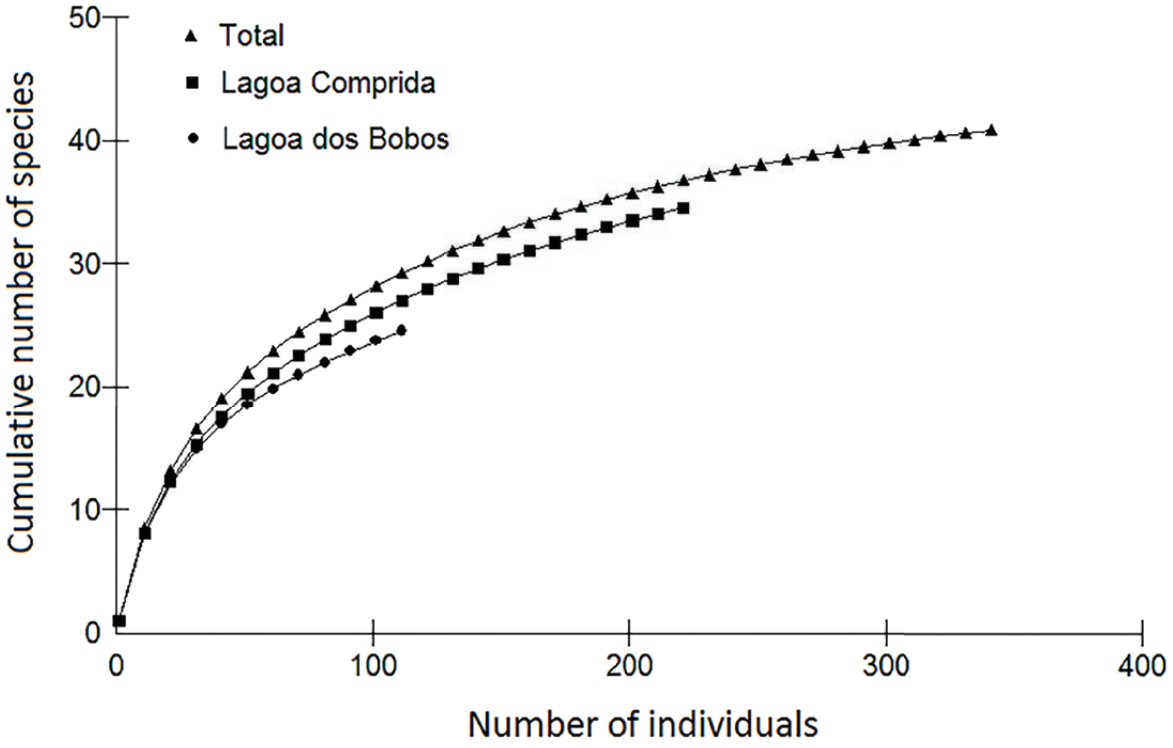

Figure 3. Accumulation curve of Odonata species at two ponds in the Cerrado-Pantanal ecotone in the municipality of Aquidauana, state of Mato Grosso do Sul, Brazil.

relation to Lagoa dos Bobos (H' = 2.78 nats/ind.; J' = 0.87). However, the structure of the community demonstrates as different in the two areas. Of the 40 species collected, 16 are exclusive to Lagoa Comprida, six are exclusive to Lagoa dos Bobos and 18 are common to both (Table 1), showing low similarity on Bray-Curtis index (39.77). Besides the differences regarding the presence of riparian forest, the ponds differed in percentage of dissolved oxygen (means/standard deviation for years 2012/2013 at Lagoa Comprida = 72.22% ± 20; Lagoa dos Bobos = 47.3% ± 12), in conductivity (Lagoa Comprida = 40.2 µs/cm ± 14; Lagoa dos Bobos = 19 µs/cm ± 5) and in quantity of total dissolved solids (Lagoa Comprida = 20 µs/cm ± 7; Lagoa dos Bobos = 9.4 µs/cm ± 3).

No species was registered in all the campaigns, although two were present in more than 70% of the samples; *Erythrodiplax branconensis* and *Ischnura capreolus*. The highest richness (19 spp.) was observed during the dry season (in June/2013), during which some species were exclusive, or primarily collected, as is the case of Homeoura nepos, Ischnura fluviatilis, *Erythrodiplax maculosa*, *Acanthagrion temporale* and *Micrathyria spuria*. In contrast, 24 species were collected only, or primarily, during the rainy season (Figure 4).

DISCUSSION

The number of species recorded in the present study (40 spp.) is intermediate in comparison to other studies carried out in the region and represents around 19.6% of all registers for the state of Mato Grosso do Sul (Rodrigues & Roque 2017, Rodrigues *et al.* 2018a). Souza (2003) collected 55 species in Serra da Bodoquena, while Dalzochio *et al.* (2011) catalogued 37 species in the same region. Souza & Costa (2006) recorded 111 species in the north-eastern region of the state, in Aporé Sucuriú (Cerrado), and Teixeira-Gamarra *et al.* (2012) recorded 24 species in the Serra do Amolar, in the Pantanal. However, none of the studies were conducted specifically in lentic environments in the state. Studies with Odonata in lentic environments remain scarce, especially in regions that are part of the Pantanal, one of the Brazilian biomes where the diversity of Odonata is still little known (De Marco & Viana 2005). Thus, these surveys are of urgent need, especially in regions that have been suffering constant modifications arising from urban and agricultural development, as is the case of the municipality of Aquidauana.

Libellulidae and Coenagrionidae, two of the

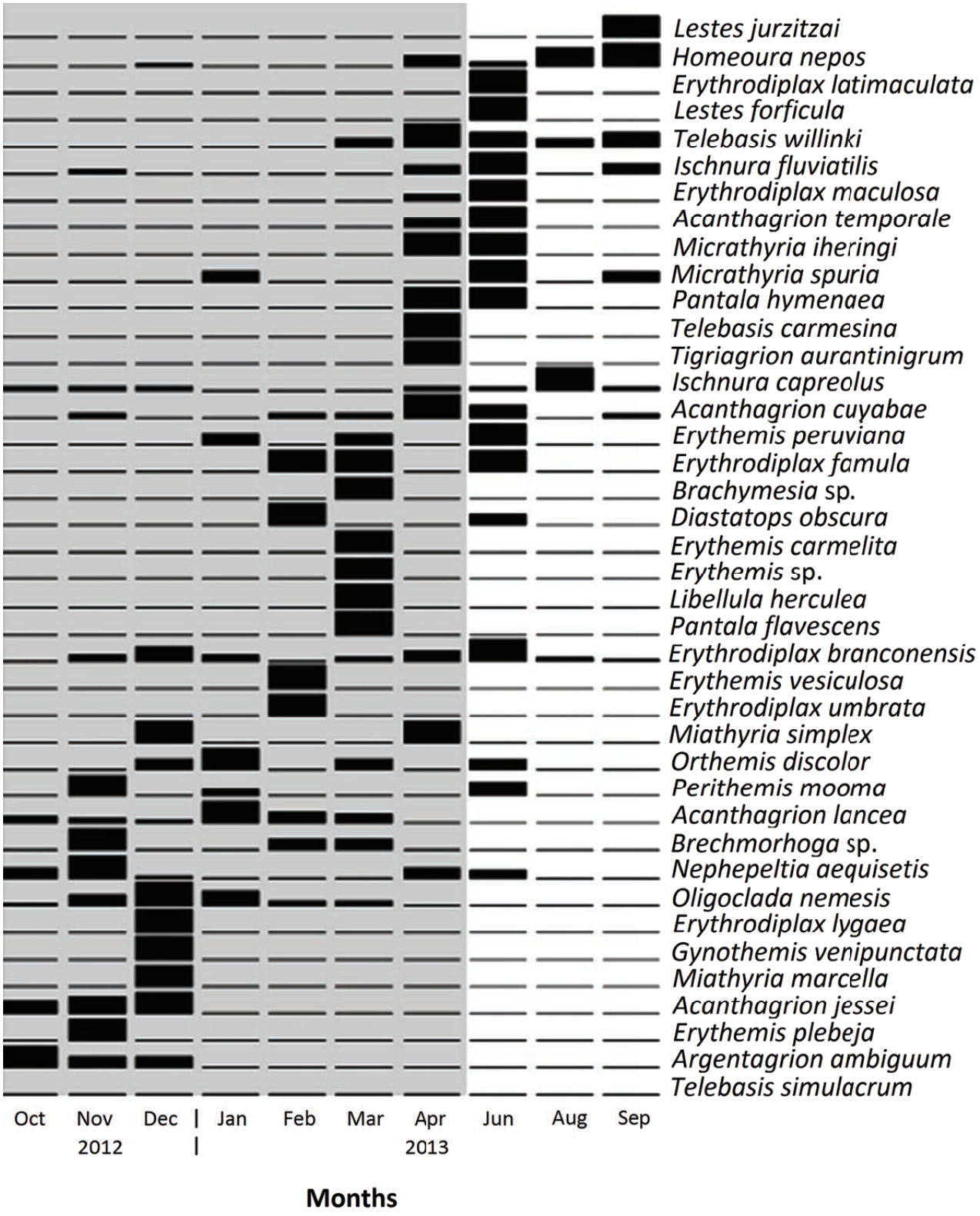

Figure 4. Odonatas recorded throughout the study period at two ponds in the Cerrado-Pantanal ecotone in the municipality of Aquidauana, state of Mato Grosso do Sul, Brazil. Gray area = rainy season.

three families recorded in the present study, are the largest families in terms of richness of species of the Anisoptera and Zygoptera suborders, respectively (Costa *et al.* 2000), and present wide distribution in Brazil (Garrison *et al.* 2006, 2010). Erythemis, Erythrodiplax and Acanthagrion are representative genera within these families and commonly figure as the richest genera in studies of Odonate fauna (Souza 2003, Souza & Costa 2006, Dalzochio *et al.* 2011, Teixeira-Gamarra *et al.* 2012). Ecological and behavioral characteristics such as the capacity of thermoregulation (endothermic or heliothermic) and the exophytic oviposition behavior in Erythemis and Erythrodiplax (De Marco *et al.* 2015, Rodrigues *et al.* 2018b), for example, may help explain the greater diversity of species of these genera recorded in environments with lentic characteristics (Souza & Costa 2006, Vilela *et al.* 2016, Rodrigues *et al.* 2018a). The presence of macrophytes, is also a factor that corroborates with the increase in richness of species with endophytic oviposition, as is the case of many species of *Acanthagrion* (Rodrigues *et al.* 2018a).

The greater richness of species at Lagoa Comprida in relation to Lagoa dos Bobos corroborates the hypothesis that environments with more riparian vegetation in the surrounding area can maintain a higher number of Odonate species. This is because marginal vegetation supplies more possibilities of shelter, foraging, reproduction sites and feeding sites, besides greater habitat stability (Corbet 2004, Rodrigues *et al.* 2016, Rodrigues *et al.* 2018b). The absence of marginal vegetation detected at Lagoa dos Bobos, simplifies the habitat structure offered for the species, enabling only more generalist groups with specific thermoregulation characteristics, and/or tolerant groups, to adapt and managing to remain in such places (De Marco *et al.* 2015). As they are animals that live in both aquatic and terrestrial environments, Odonates may suffer both from the effect of terrestrial vegetation loss and from modifications to the physical-chemical parameters of the water (Silva *et al.* 2010, Rodrigues *et al.* 2018b). Changes in soil use in the surrounding area, such as loss of riparian vegetation by the introduction of grazing areas and/or development of urban environments, as well as modifications in the physical-chemical parameters of the water through contamination and pollution, may affect the diversity of the group, as many species are not tolerant to such environmental changes (Silva *et al.* 2010, Rodrigues *et al.* 2016, Valente-Neto *et al.* 2016). These alterations act as a filter in Odonata communities, provoking the substitution of specialist species for generalist species, also modifying their behavior, abundance and morphology (Carvalho *et al.* 2018, Pereira *et al.* 2019).

Some species were only recorded at certain times of year. That is, seasonality is an important factor and should always be considered in studies covering group diversity. Species such as *Erythrodiplax lygaea, Gynothemis venipunctata, Miathyria marcella. Acanthagrion jessei, Erythemis plebeja, Argentagrion ambigua, Telebasis simulacrum, Erythemis vesiculosa, Erythrodiplax umbrata, Erythemis carmelita, Libellula herculea* and *Pantala flavescens* were recorded only during the rainy period, while *Erythrodiplax latimaculata* and *Lestes forficula* were recorded only in the dry period. The present study demonstrates that Odonate inventories should be conducted at different times of year, avoiding the exclusion of species that may respond to seasonality in their life cycle.

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