

# Urbanization promotes the local extinction of odonatas in veredas from Minas Gerais/Brazil

## Abstract

The order Odonata is one of the most fascinating among insects, with an estimated 6,000 described species. Little is known about the Odonata fauna in many regions of Brazil; including Vereda's areas. This unique plant formations occur only in Brazil. Despite being considered a preservation area, for over 70 years; there are a continuous degradation of this unique formation. The aim of this study was to survey the species of Odonata that occur in four areas of Veredas, within the urban perimeter of Uberaba/Minas Gerais. Two points were selected in the central region and two peripheral points. Four collections were carried out on sunny days, with two people intercepting the flight with entomological nets in May, September, December 2018 and March 2019. The total number of adults captured was 163. In the central points of the city we find generalist species, while in the peripheral points we find individuals endemic to Veredas and indicators of preserved environments. Data indicate that the Veredas have been severely abandoned by the Government and damaged by urbanization, and that the Odonata are an appropriate group to monitor the integrity of this type of environment, which gives rise to several important rivers in the region.

**Keywords:** environmental assessment, checklist, dragonflies, damselfly, biotic integrity

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## Introduction

Odonata order is a small group of insects when compared to holometabolous. Still, they are one of the most studied group among insects. It is estimated that there are around 6.000 species described in the world and around 856 species cataloged in Brazil that leads itself to the greatest diversity in the world.<sup>1,2</sup> The increased taxonomic information that we have nowadays led to more studies about Odonata in Brazil considering how easy is to be observed and captured by the fascination created by this group.<sup>3-5</sup> Most of these surveys are about description of new species and their respective ecologic role<sup>6</sup> and geographic distribution.<sup>7-10</sup> There is a lack of information in many Brazilian regions due to the absence of infrastructure, logistic and study group. From this perspective, Brazil northeast is the region with the fewest data and catalogued species and southeast and south where are located most of the studies about this order.<sup>7</sup> Considering the Triângulo Mineiro, the region where the present study was conducted, there are some studies that contribute to improving the knowledge about the Order.<sup>1,2,9</sup>

Although more studies have been taken place in Triângulo Mineiro, the anthropic action including deforestation and urbanization, keeps impacting the Vereda's areas.<sup>1,11</sup> Despite this, the Brazilian Forest Code, and the law 12.651 established the preservation of the Veredas and the maintenance of 20% of native areas of Savanna in private farms, respectively.<sup>12</sup> According to Souza et al.<sup>13</sup> the deforestation has a straight impact on the Odonata fauna richness because of their low resilience.<sup>6</sup> Recent studies described a new endemic specie of Odonata in the region of Veredas in Triângulo Mineiro that brings out the importance of studying Odonata richness and its diversity as well as the preservation of their habitats.<sup>1,2,9</sup> Uberaba city is in Triângulo Mineiro region Minas Gerais (MG/Brazil). It is considered a commercial center, with important agribusiness and industrial park.<sup>14</sup> In agreement with Costa et al.<sup>15</sup> the phytophysognomy presented in this city are Savanna Strict Sense, Savanna Typical and Dense, Non-floodable gallery forest, Veredas and Semideciduous Dry Forest, which show a high biodiversity. Moreover, little is known

about Odonata fauna of Uberaba/MG, and their distribution. This knowledge may collaborate to rescue critical areas and to improve environmental conservation programs, especially in areas of Veredas. Here, we aimed to create an inventory of the Odonata fauna in the Veredas from Uberaba-MG.

## Material and methods

The present study was developed in Uberaba city, in Minas Gerais State. Then, 4 regions were selected from Veredas inside the urban area of Uberaba/MG. To this end, we used Google Maps® and Google Earth Pro®. Regarding the georeferencing, we used the portable GPS iFINDER Go2, which was done two points in the central region (1 and 2) and two peripheral points (3 and 4). The Point 1 (19°44'50.64" S, 47°54'46.29" W) was located at the Acácia Park accessed by Professor Francisco Brigagão Street, Jardim do Lago neighborhood. The place presents a water reservoir and exotics plants from the grass family known as signalgrass (*Brachiaria* spp.) that were observed on the riverside and exposed to the sunlight (Figure 1). The point 2 (19°45'5.87" S, 47°57'16.35" W) was located at the Advogado's Avenue, Santa Maria neighborhood. This area was damaged by ruined wires before we could access the Permanent Preservation Area (Figure 2).

The Point 3 (19°39'46.0" S, 47° 57' 36.0" W) was at 400 João Batista Ribeiro Street, Industrial district II, inside the (IFTM) Instituto Federal de Educação Ciência e Tecnologia do Triângulo Mineiro at the olive growing sector. Veredas has a long extension, with a dam and a drainage point (Figure 2). The Point 4 (19°39'46.0" S, 47° 57' 36.0" W) was located at 400 João Batista Ribeiro Street, Industrial district II, inside the IFTM nearby a eucalypt plantation on the Institute road. This place is characterized by dense vegetation of difficult access and a little water stream (Figure 2).

Were carried out four collections of Odonata fauna at points 1, 2, 3 and 4, in May, September, December 2018 and March 2019. To capture the insects, the entomological nets were used. The collections were prioritized on sunny days between 8 am and 12 pm. The

collection team was composed of two people who performed the active research during ninety minutes at each point.<sup>10</sup> A permanent license for the collection of zoological material issued by SISBIO with number 63276 was requested and granted. The dragonfly and damselflies collections were carried out in areas of approximately 50 x 25 meters.



**Figure 1** South America map and location of the four points at Veredas in Uberaba/MG.



**Figure 2** Vereda's area (1,2,3 and 4) where were performed the collection of Odonata specimens in Uberaba/MG, 2018 to 2019.

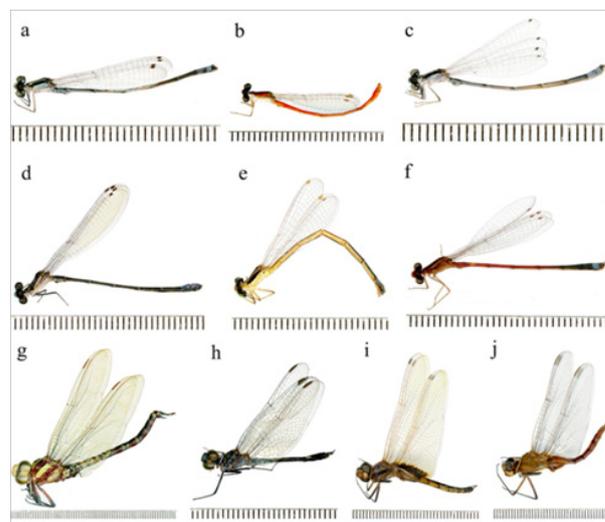
The collected individuals were placed in entomological envelopes with a label (containing place, date, and collector) and deposited in the entomological PELL Collection, in Uberaba/MG. Subsequently, identification was performed in the laboratory, according to the species level, using the Olympus SZX12 stereomicroscope and dichotomous keys by Borror<sup>16</sup>; Garrison et al.<sup>17,18</sup>; Lencioni;<sup>19,20,21</sup> Costa et al.<sup>22</sup> and a collection that was kindly identified by Prof. Dr. Ângelo Barbosa Monteiro Machado. The parameters of richness (R), Simpson Diversity Index ( $1/D=1 / [\sum (ni \times ni-1) / (Nt \times Nt-1)]$ ) and collector curve were analyzed through Microsoft Office Excel® program, as described by.<sup>23</sup>

## Results & discussion

Were collected 163 adults of Odonata distributed in 4 families,

17 genera and 31 species (Table 1 and Figure 3). In Zygoptera, eight genera were recorded; *Acanthagrion* presented five species; *Oxyagrion* three species; *Argia* and *Hetaerina* occurred with two species; and with one species each the genera: *Ischnura*, *Homeoura*, *Minagrion* and *Telebasis*. In Anisoptera, one genus for Aeshnidae and eight genera for Libellulidae were collected: *Erythrodiplax* (with seven species) and one species of each: *Brachymesia*, *Elasmothemis*, *Idiataphe*, *Miathyria*, *Micrathyria*, *Oligoclada* and *Tramea*. The suborder Zygoptera was the most abundant with 131 individuals, and Anisoptera was represented by 32 individuals.

Point 1 presents 4 species of richness in the months of September 2018 and March 2019. The lowest richness value for this area was equal to 1 *taxon* in May and December 2018 (Table 1; Figure 4). At Point 2, no individual from Odonata was sampled in May 2018. In September 2018, 5 were sampled and in December of the same year, 2 were sampled. In March 2019, 8 were sampled. Point 3 presents the Odonata richness equal to 11 *taxa* in December 2018. The lowest richness for this area was 7 *taxa* in March 2019. At Point 4, richness values equal to 4 *taxa* were sampled in September and December 2018. In the other months, only two species were captured, despite the apparently well-preserved environment.



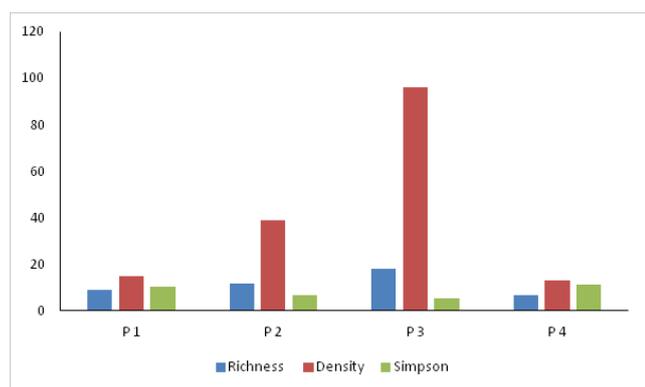
**Figure 3** Some species sampled in the present study: a. *Acanthagrion gracile*; b. *Telebasis carmesina*; c. *Acanthagrion truncatum*; d. *Argia reclusa*; e. *Minagrion waltheri*; f. *Oxyagrion microstigma*; g. *Castoraeschna colorata*; h. *Micrathyria hesperis*; i. *Miathyria marcella*; j. *Elasmothemis cannaecioides*.

The richness found in these points were considered partially preserved (Points 3 and 4) were 18 and 7, respectively. In the points considered totally uncharacterized (1 and 2), the were 9 and 12 (Figure 4). Simpson's Diversity average ( $1/D$ ) of Odonata found in Points 3 and 4 were 5,4 and 11,1. In Points 1 and 2, it was 10,5 and 7,0.

For Simpson's Diversity Index, the higher the value, the greater the richness and evenness of the biological community. Point 3 had better environmental conditions, that is, greater environmental integrity, than the other points, with lower values of the Simpson index, which seems to be a contracense. The authors believe that this deviation occurred due to the dominance of three species in the sample: *Acanthagrion gracile*; *Acanthagrion truncatum* and *Oxyagrion microstigma*, with 12, 18 and 35 captured animals, respectively. As already reported by Magurra<sup>23</sup> the index used may have flaws, especially because it weighs more abundant species in a different way.

**Table 1** List of Odonata collected, in four collections, at Points 1, 2, 3 and 4, in Veredas in the city of Uberaba / MG, between 2018 and 2019

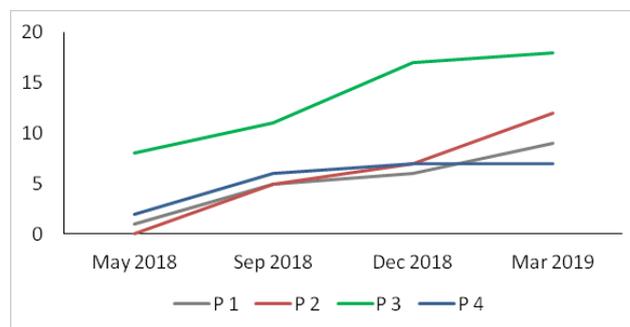
Family	Species	May-18				Sep-18				Dec-18				Mar-19			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Coenagrionidae	<i>Acanthagrion</i> sp.							1									9
Coenagrionidae	<i>Acanthagrion aepiolum</i> Tennessen, 2004				1												
Coenagrionidae	<i>Acanthagrion gracile</i> Rambur, 1842	1		7				1	1	1			1	2			3
Coenagrionidae	<i>Acanthagrion lancea</i> (Selys, 1876)								2								3
Coenagrionidae	<i>Acanthagrion truncatum</i> Selys, 1876			6		1			3				1				8
Coenagrionidae	<i>Argia lilacina</i> Selys, 1865												1				8
Coenagrionidae	<i>Argia reclusa</i> Selys, 1865								1					1			
Coenagrionidae	<i>Ischnura capreolus</i> Hagen, 1861												1				
Coenagrionidae	<i>Homeoura chelifera</i> (Selys, 1876)					3							1			1	
Coenagrionidae	<i>Minagrion waltheri</i> (Selys, 1876)													1			1
Coenagrionidae	<i>Oxyagrion</i> sp.		1														1
Coenagrionidae	<i>Oxyagrion basale</i> Selys, 1876								1					1			1
Coenagrionidae	<i>Oxyagrion microstigma</i> Selys, 1876			12				1	2					13			8
Coenagrionidae	<i>Telebasis carmesina</i> Calvert, 1909			2					2					2			8
Calopterygidae	<i>Hetaerina</i> sp.								1								1
Calopterygidae	<i>Hetaerina simplex</i> Selys, 1853																1
Aeshnidae	<i>Castoraeschna colorata</i> (Martin, 1908)													1			
Libellulidae	<i>Brachymesia herbida</i> (Gundlach, 1889)														1		
Libellulidae	<i>Elasmotheremis cannaeoides</i> (Calvert, 1909)					1											
Libellulidae	<i>Idiataphe amazonica</i> (Kirby, 1889)					1											
Libellulidae	<i>Erythrodiplax</i> sp.						1							2			
Libellulidae	<i>Erythrodiplax ana</i> Guillermo-Ferreira & Vilela, 2016													1			1
Libellulidae	<i>Erythrodiplax castanea</i> (Burmeister, 1839)			2				1									1
Libellulidae	<i>Erythrodiplax connata</i> (Burmeister, 1839)			2													
Libellulidae	<i>Erythrodiplax juliana</i> Ris, 1911													1			
Libellulidae	<i>Erythrodiplax latimaculata</i> Ris, 1911			3					1					1			1
Libellulidae	<i>Erythrodiplax umbrata</i> Linnaeus, 1758													1		1	
Libellulidae	<i>Miathyria marcella</i> (Selys, 1857)								1								
Libellulidae	<i>Micrathyria hesperis</i> (Ris, 1911)													3			
Libellulidae	<i>Oligoclada abbreviata</i> (Rambur, 1842)							1			2						
Libellulidae	<i>Tramea calverti</i> (Muttkowski, 1910)				1												



**Figure 4** Average Richness (R), Simpson's Diversity Index (I/D) of the community of Odonata fauna of four points of Veredas in Uberaba/MG.

Point 4, with lower richness, had the highest value for the Simpson diversity index. Also, in this environment the collected species were sensitive, endemic and indicators of preserved environments. The Points 1, 2 and 3 (which had the highest number of species), the collector curve did not stabilize at the end of the last sampling, showing a tendency for new species to increase (Figure 5). The

authors point out the need to carefully assess the number of species in biological communities, as well as the need to use new tools for this purpose.<sup>24-28</sup>



**Figure 5** Curve of the collector of Odonata species, collected between May 2018 and March 2019, in Veredas, in Uberaba/MG.

### Conclusion

In the present study, typical species from lentic environments were found, for example: *Acanthagrion lancea* Selys, *Erythrodiplax juliana* Ris and *Erythrodiplax latimaculata* Ris and species of lotic environments, such as *Hetaerina simplex* Selys and *Argia reclusa*

Selys, a pattern also evidenced by previous studies.<sup>9,26</sup> These results allow us to infer that the peripheral areas (3 and 4) still retain some important characteristics for the occurrence of these species, like the heterogeneity of the environment and the quality of the water. This also corroborated to the collection of rare species in collections and in field studies, such as *Minagrion waltheri* Selys and *Erythrodiplax ana* Guillermo-Ferreira, Vilela. These species, in addition to being typical of flooded environments such as Veredas, are also species sensitive to anthropic action, having been collected primarily in conserved areas.<sup>26,27</sup>

In contrast, in the most centralized locations (Points 1 and 2), predominantly generalist species were found, which are often observed in degraded areas, just as *Erythrodiplax castanea* Burmeister, *Erythrodiplax juliana* Ris, *Erythrodiplax umbrata* Linnaeus and *Ichnura capreolus* Hagen.<sup>1,13</sup> The areas in question already have an advanced degree of anthropic impact like the artificial water impoundment, exotic grasses (*Brachiaria*) and exposed soil, which contributes to the homogenization of the habitat and consequently the predominant occurrence of generalist species.<sup>1,13</sup>

In fact, in a study on the impact of habitat homogenization in the Brazilian Savanna,<sup>25</sup> state that due to the fact that anthropic actions degrade natural areas, endemic species tend to cease to exist in these places and in some cases may be at risk of local extinction, as they depend on specific abiotic conditions and cannot reproduce on account of absence of compartmentalization of habitats, loss of riparian forest, invasive aquatic plants, excess of organic matter such as manure, branches and trunks over the water.

According to Vilela et al.<sup>9</sup> recent studies show that the Veredas within urban areas are home to many species, consequently it is important to preserve the forest cover around the water resource, as they promote and sustain the fauna's biodiversity. Considering the lack of information about dragonflies, the various species that have not been described yet and the human activities threat, it is recommended to conserve and monitor these environments.<sup>7</sup> The observed differences, in the biological communities between the seasons, indicate that the areas of Veredas in the central region of the municipality are in an accelerated process of total de-characterization. The fact indicates the inefficiency of the Public Power in caring for the Patrimony of all, not observing the Brazilian Forest Code, which indicates the areas of Vereda, a unique system on the Planet, as Permanent Preservation Areas, given their environmental, social, and economic importance.

In conclusion, it can be said that Odonata can be used as a bioindicator, requiring identification at a specific level; is important to performer taxonomic studies and the distribution of Odonata species for the preservation and conservation of areas of Veredas, that are losing attributes and diversity; Uberaba has a rich and diverse Odonata fauna; the Veredas are an important component of the Brazilian Cerrado landscape; the fauna of the Veredas reflects the use and occupation of the soil in the micro-region; and the urbanization process compromise the integrity of the Veredas in the region.

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## Conflicts of Interest

None.

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