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Odonata community in transition areas between Cerrado and Atlantic Forest biomes in south-central Minas Gerais, Brazil

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ABSTRACT. Faunal inventories are essential for biota management and conservation, especially in areas with potential for the creation of conservation units. Inventories of insect taxa such as dragonflies and damselflies (Odonata), which perform several environmental services in aquatic and terrestrial ecosystems, are of great importance. In view of the above, this study aimed to update and expand the list of Odonata species in the Barroso region, Minas Gerais State, Brazil. This study was carried out in three areas of forest fragments in Atlantic Forest and Cerrado biomes in October 2020, December 2020, January 2021, and March 2021. The sampling effort was 8 hours per day during 20 days, totaling 140 sampling hours. A total of 43 Odonata species were recorded, which increased the richness of the study area from 57 to 76 species. The studied areas harbor rare and endangered species. However, since the last sampling in 2009, there has been a significant reduction in diversity in the Atlantic Forest fragment. In view of the changes that forest fragments are undergoing, we underscore the need to create a conservation unit, especially in Baú Forest.

Keywords: biodiversity; damselflies; dragonflies; Heteragrionidae; inventory.

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Introduction

Faunal inventories are strategic for the implementation of public policies for biota conservation (Silveira et al., 2010; Stephenson & Stengel, 2020), being even more relevant in ecosystems critically threatened by anthropic actions, such as the Atlantic Forest and the Cerrado, both of which are considered biodiversity *hotspots* (Myers, Mittermeier, Mittermeier, Fonseca, & Kent, 2000; Mittermeier, Turner, Larsen, Brooks, & Gascon, 2011; Ribeiro et al., 2011; Instituto Chico Mendes de Conservação da Biodiversidade [ICMBio], 2018). The Atlantic Forest is a tropical forest that has suffered a significant reduction in its original area owing to urban expansion, monoculture farming, and other activities, resulting in a mosaic of fragments (Silva, Santos, & Moraes, 2014; Scarano & Ceotto, 2015; Zanella, Folkard, Blackburn, & Carvalho, 2017). Likewise, the Cerrado, which is the second largest biome in Brazil in terms of geographical extension, has lost about 50% of its original area, and only 3% of the remaining sites are located in conservation units (Ganem, Drummond, & Franco, 2013; Lapola et al., 2014).

Despite the high biodiversity of these important biomes, many locations and phytophysiognomies are undersampled for different taxa, such as dragonflies and damselflies (Odonata), relevant insects in aquatic and terrestrial food chains (Moon & Silva, 2013; Souza, Pires, Brunismann, Milani, & Pinto, 2017). The order includes generalist and specialist species that can be used as bioindicators of environmental quality, given their sensitivity to human disturbances (Machado, 1988; Dijkstra & Clausnitzer, 2006; Souza, Souza, Pereira, & Machado, 2013; Juen, Oliveira-Junior, Shimano, Mendes, & Cabette, 2014; Šigutová, Šipoš, & Dolný, 2019; Guillermo & Juen, 2021).

From the 21st century onward, growing efforts have been made to understand the diversity of Odonata in Minas Gerais State, mainly in the Atlantic Forest (Ferreira-Peruquetti & De Marco-Jr., 2002; Souza et al., 2013; Souza et al., 2017; Amorim, Souza, & Dos Anjos, 2018; Silva & Souza, 2020; Ávila Júnior, Machado, Lencioni, & Carneiro, 2020; Stefani-Santos et al., 2021; Guedes, Vilela, & Souza, 2022) and Cerrado (Almeida, Pinto, Carvalho, & Takiya, 2013; Bedê, Machado, Piper, & Souza, 2015; Vilela, Ferreira, & Del-Claro, 2016;

Barbosa, Borges, Vilela, Venâncio, & Santos, 2019; Borges, Barbosa, Carneiro, Vilela, & Santos, 2019; Vilela, Koroiva, Tosta, Novaes, & Guillermo-Ferreira, 2020; Dos Anjos, Milani, & Souza, 2020; Venâncio, Vilela, Barbosa, & Santos, 2021). Some studies focused on transition areas between Atlantic Forest and Cerrado (Bedê et al., 2015), Atlantic Forest and Caatinga (Gouvêa et al., 2022), and Cerrado and Caatinga (Souza et al., 2017).

At present, about 328 Odonata species are known to occur in Minas Gerais State (Vilela, 2022). However, it is necessary to expand the information on Odonata communities, mainly in areas with potential for the creation of conservation units, such as Barroso, a municipality in the south-central region of the state (Oliveira, Henriques, Clemente, & Souza, 2021). Barroso is an important site for local biodiversity, not only of Odonata but also of other taxa (Souza, Pires, & Prezoto, 2014; Coelho, Gouvêa, Clemente, & Souza, 2022; Gouvêa, Clemente, Teófilo-Guedes, & Souza, 2021; Lima, Rubim, Pádua, & Souza, 2022). There is also a need for further inventories of dragonflies and damselflies, as the ones carried out so far indicate the existence of species exclusive to the region (Machado, 2015; Vilela & Souza, 2022). In view of the above, this study aimed to update and expand the list of Odonata species in the Barroso region, Minas Gerais State, Brazil.

Material and methods

This study was carried out in three forest fragments, two in Barroso (21°11′13″S 43°58′34″W) and one on the border between Barroso and Prados (21°13′33.20″S 44°2′0.56″W), south-central Minas Gerais State. The region is covered by Atlantic Forest, but it has enclaves or patches of Cerrado (Instituto Brasileiro de Geografia e Estatística [IBGE], 1997). Barroso is home to areas of montane semideciduous forest (Atlantic Forest domain) and refuges of Cerrado fields and gallery forests (Menini-Neto, Assis, & Forzza, 2004). The three sampled areas, namely Baú Forest (384.9 ha), Padeiro Waterfall (26.43 ha), and Lajinha Waterfall (32.25 ha) (Figures 1 and 2), have a mosaic of phytophysiognomies. These areas encompass lentic and lotic environments associated with forest fragments at different levels of conservation and stages of regeneration, as well as pastures and eucalyptus plantations.

The studied areas were characterized by consulting specialized literature, collecting information from the Company of Technical and Rural Assistance of Minas Gerais (EMATER), and conducting field observations. All areas constitute forest remnants at intermediate or advanced stages of regeneration (Menini-Neto et al., 2004; Souza, 2006; Souza, Louzada, Serráo, & Zanuncio, 2010).

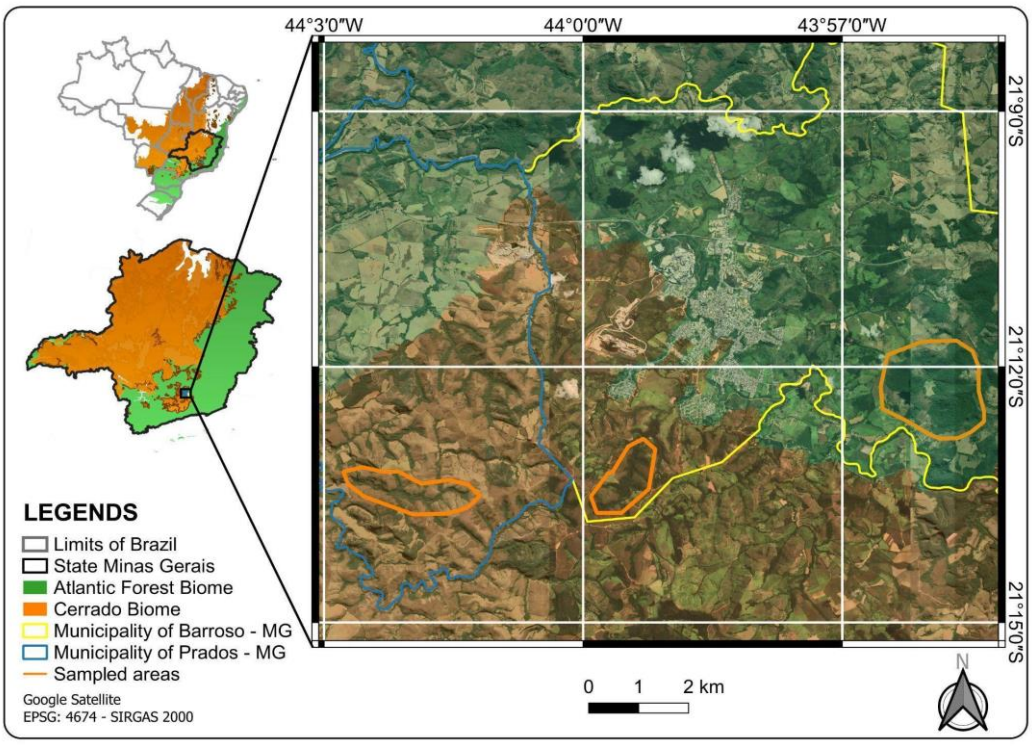

Figure 1. Location map showing areas (Baú Forest, Padeiro Waterfall, and Lajinha Waterfall) where collections of adult Odonata were carried out in the municipalities of Barroso and Prados, south-central Minas Gerais State, Brazil.

Source: The authors.

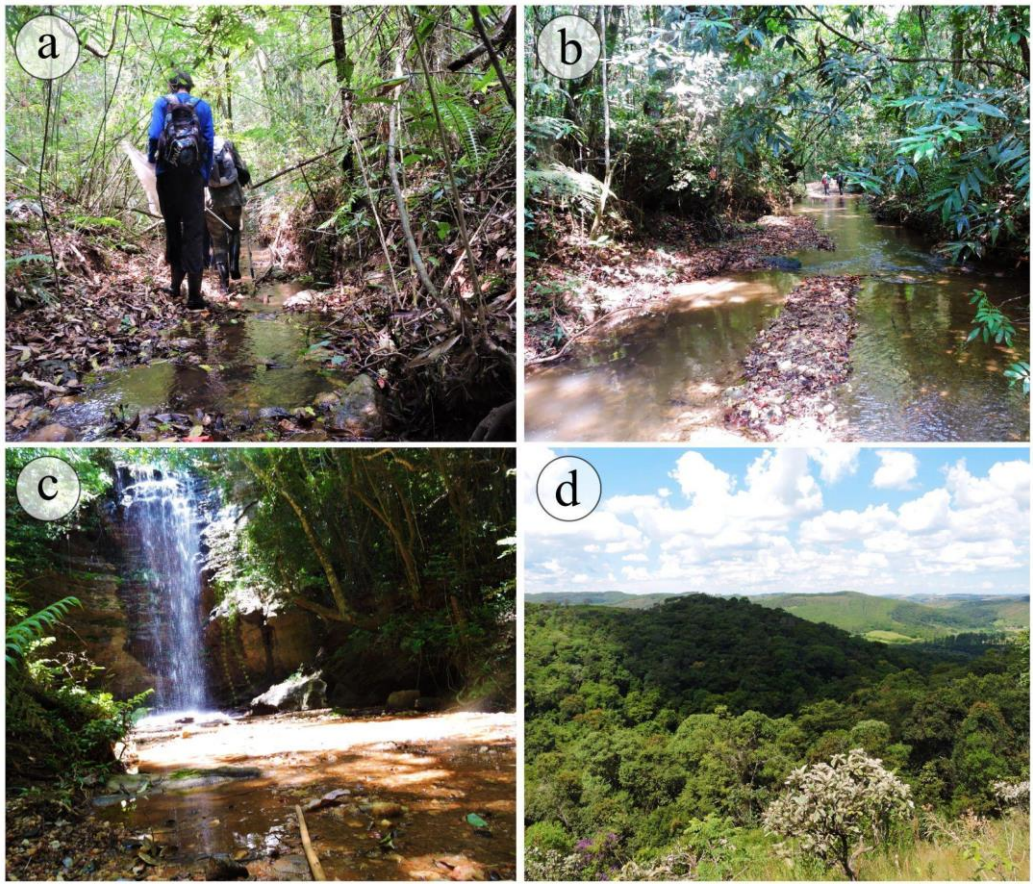

Figure 2. Active search for adult Odonata in Barroso, Minas Gerais State, Brazil. (a, b) Lajinha Waterfall and (c) Padeiro Waterfall, areas of gallery forest in the Cerrado biome. (d) Baú Forest, seasonal semideciduous forest in the Atlantic Forest biome.
Source: The authors.

Odonata adults were collected in four campaigns that took place in October 2020, December 2020, January 2021, and March 2021, with a daily sampling effort of 8 hours, totaling 20 days of collection and 140 sampling hours equally distributed among forest fragments. Sampling was carried out from 9:00 a.m. to 3:00 p.m. in lentic environments, lotic environments with different current strengths, and open and closed forest areas by the active search method using entomological nets, as suggested by Bedê et al. (2015).

Individuals were stored in entomological envelopes (7 × 11 cm), as proposed by Cezário et al. (2021). Envelopes were identified with the date and place of collection. Subsequently, individuals were sacrificed by immersion in acetone PA and incubated in this solvent for at least 12 hours to promote lipid dissolution and color preservation (Garrison, Ellenrieder, & Louton, 2006). Specimens were identified using dichotomous keys available in the literature (Garrison et al., 2006; Garrison, Ellenrieder, & Louton, 2010; Lencioni, 2017). Additionally, publications on specific genera and species were used when needed. The specimens were deposited in the Biological Collection of the *Instituto Federal de Minas Gerais*, Inconfidentes *Campus*. The sampling effort was evaluated by constructing an accumulation curve from the observed richness, 95% confidence intervals, and the Chao1 estimator in EstimateS 9.1.0 software (Cowell, 2013). This study was licensed by IBAMA/SISBIO under number 75517-1.

Results and discussion

We collected a total of 343 Odonata individuals belonging to 11 families and 43 species (Table 1, Figure 3). In the suborder Anisoptera, the most numerous family was Libellulidae, with 8 genera and 16 species, followed by Gomphidae, with 1 genus and 4 species. Among the Zygoptera, the family Coenagrionidae was the most numerous, with 3 genera and 6 species, followed by Heteragrionidae and Protoneuridae, with 1 and 3 genera, respectively, and both with 4 species. *Argia sordida* Hagen in Selys was the species with the highest abundance, corresponding to 19% of the total number of specimens (Table 1).

Table 1. Abundance, richness, and conservation status of Odonata species recorded in Atlantic Forest and Cerrado biomes in Barroso, Minas Gerais, Brazil.

Suborder	Family	Species	Atlantic Forest SSF	Cerrado GF	IUCN Status
Anisoptera	Aeshnidae	*Castoraeschna januaria* (Hagen, 1867)	1	1	LC
		Remartinia luteipennis (Burmeister, 1839)	1	0	LC
	Gomphidae	*Progomphus complicatus* Selys, 1854	0	6	LC
		Progomphus costalis Hagen *in* Selys, 1854	0	1	LC
		Progomphus gracilis Hagen *in* Selys, 1854	0	1	LC
		Progomphus teolitavius Vilela & Souza, 2022	0	1	-
	Libellulidae	*Brechmorhoga nubecula* (Rambur, 1842)	1	7	LC
		Dasythemis mincki (Karsch, 1890)	1	4	LC
		Elasmothemis schubarti (Santos, 1945)	1	5	DD
		Erythrodiplax fusca (Rambur, 1842)	2	7	LC
		Erythrodiplax latimaculata Ris, 1911	0	1	LC
		Erythrodiplax paraguayensis (Förster, 1905)	1	1	LC
		Macrothemis calliste (Ris, 1913)	0	2	DD
		Macrothemis heteronycha (Calvert, 1909)	1	0	LC
		Macrothemis imitans Karsch, 1890	4	10	LC
		Macrothemis marmorata Hagen, 1868	0	1	LC
		Macrothemis tenuis Hagen, 1868	1	2	LC
		Micrathyria didyma (Selys *in* Sagra, 1857)	3	1	LC
		Micrathyria pseudeximia Westfall, 1992	2	0	LC
		Orthemis aequilibris Calvert, 1909	0	1	LC
		Orthemis discolor (Burmeister, 1839)	0	1	LC
		Perithemis tenera (Say, 1840)	4	3	LC
Zygoptera	Calopterygidae	*Hetaerina hebe* Selys, 1853	2	22	LC
		Hetaerina rosea Selys, 1853	5	7	LC
		Mnesarete guttifera (Selys, 1873)	2	23	LC
	Coenagrionidae	*Acanthagrion gracile* (Rambur, 1842)	4	3	LC
		Argia lilacina Selys, 1865	3	3	LC
		Argia sp.	2	9	-
		Argia sordida Hagen *in* Selys, 1865	5	62	LC
		Oxyagrion basale Selys, 1876	4	10	DD
		Oxyagrion terminale Selys, 1876	9	13	LC
	Dicteriadidae	*Heliocharis amazona* Selys, 1853	0	1	LC
	Heteragrionidae	*Heteragrion aurantiacum* Selys, 1862	0	2	LC
		Heteragrion cauei Ávila Jr., Lencioni & Carneiro, 2017	3	13	VU
		Heteragrion tiradentense Machado & Bedê, 2006	7	16	LC
		Heteragrion thais Machado, 2015	3	0	DD
	Lestidae	*Archilestes exoletus* (Hagen *in* Selys, 1862)	1	0	LC
	Megapodagrionidae	*Allopodagrion contortum* (Hagen *in* Selys, 1862)	3	8	LC
	Perilestidae	*Perilestes fragilis* Hagen *in* Selys, 1862	0	3	LC
	Protoneuridae	*Peristicta jalmosi* Pessacq & Costa, 2007	0	1	LC
		Peristicta janiceae Pessacq & Costa, 2007	2	4	LC
		Epipleoneura venezuelensis Rácenis, 1955	0	1	LC
		Forcepsioneura sancta (Hagen *in* Selys, 1860)	5	3	LC
		Richness	29	38	
		Total richness	43		
		Abundance	83	260	
		Total abundance	343		

Species were classified according to the International Union for Conservation of Nature and Natural Resources (IUCN) Red List. SSF, semideciduous seasonal forest; GF, gallery forest; LC, least concern; DD, data deficient; VU, vulnerable.

Source: The authors.

With the update in species number, it can be said that the Odonata richness of the Barroso region is expressive; it harbors one of the four richest communities in Minas Gerais State (Table 2). Such richness can be attributed to the presence of different environments with different phytophysiognomies in the transition area between the Cerrado and Atlantic Forest, as also observed by Bedê et al. (2015) in the *Refúgio de Vida Silvestre Libélulas da Serra de São José*, about 30 km from the current study area.

Figure 3. Representative photographs of Odonata species sampled in Barroso, Minas Gerais State, Brazil. (a) *Elasmothemis schubarti*, (b) *Progomphus complicatus*, (c) *Argia lilacina*, (d) *Acanthagrion gracile*, (e) *Heteragrion cauei*, (f) *Heteragrion tiradentense*.
Source: The authors.

Table 2. Checklist of Odonata occurring in different biomes in Minas Gerais State, Brazil.

Reference	Biome			Richness
	Atlantic forest	Cerrado	Caatinga	
Bedê et al. (2015)	X	X		128
Venâncio et al. (2021)		X		101
Vilela et al. (2020)		X		90
Amorim et al. (2018)	X			73
Silva & Souza (2020)	X			71
Guedes et al. (2022)	X			21
Santos (1966)	X			59
Souza et al. (2013)	X			57
Gouvêa et al. (2022)	X		X	55
Souza et al. (2017)		X	X	48
This study	X	X		43(76*)
Barbosa et al. (2019)		X		42
Ávila Júnior et al. (2020)	X			40
Stefani-Santos et al. (2021)	X			39
Borges et al. (2019)		X		36
Vilela et al. (2016)		X		31
Ferreira-Peruquetti & De Marco-Jr. (2002)		X		28
Almeida et al. (2013)		X		23
Dos Anjos et al. (2020)		X		20

(*) Number of species updated for Barroso, Minas Gerais State, Brazil.
Source: The authors.

In the past 15 years, there has been a reduction in water resources in the Baú Forest, both in terms of water volume and number of small streams, resulting from an increase in gully erosion, an issue that has been reported globally (Sharma & Shakya, 2006). This situation is further aggravated by the decrease in natural areas, which have been replaced with eucalyptus plantations, differing from scenarios described in previous papers (Souza, 2006; Pires, Morgado, Souza, Carvalho, & Nemésio, 2013). *Eucalyptus* plantations may impact streamflows, thereby affecting fluvial ecosystems and their biota (Ferraz, Rodrigues, Garcia, Alvares, & Lima, 2019). These effects explain the reduction in odonatofaunal occurrences, from 57 (Souza et al., 2013) to 29 species (current study). Furthermore, it should be noted that *Heteragrion cyane* Machado and Souza, whose type locality is the study region, was not found (Machado & Souza, 2014).

Another factor corroborating to explain the decrease in richness as a result of environmental impact is the Chao1 estimator. The estimator showed that the number of species may reach 34, which is considerably lower than the 57 species sampled by Souza et al. (2013) in the past. Although the sampling effort of the 2013 study was greater, encompassing 18 months of collection and covering all seasons of the year, such a reduction in species number is relevant.

In addition to anthropogenic impacts, the vegetation matrix of forest fragments may influence Odonata communities. Surrounding environments may offer better conditions and resources to insect communities, halting biodiversity reduction and substitution of specialist species with generalist species (Popielarz & Neal, 2007; Martello, Andriolli, Souza, Dodonov, & Ribeiro, 2016).

Although the Odonata richness of the Baú Forest decreased in the last decade, the area was found to be home to rare species, such as *Heteragrion thais* Machado, previously recorded only in its type locality, a lotic environment within the Baú Forest (Machado, 2015). The family Heteragrionidae is associated with extensive forest environments under low anthropogenic pressure (Machado, 1988; Ferreira-Peruquetti & De Marco, 2002; Amorim et al., 2018; Stefani-Santos et al., 2021).

Of note, *Castoraeschna januaria* (Hagen) and *Elasmothemis schubarti* (Santos) were recorded in both phytophysiognomies. The first species is classified as least concern (LC) and the second as data deficient (DD) by the International Union for Conservation of Nature and Natural Resources (IUCN, 2022); however, ICMBio (2018) classified the species as vulnerable (VU) and endangered (EN), respectively. Both species are restricted to lotic environments with preserved riparian vegetation (ICMBio, 2018; Dos Anjos et al., 2020). Therefore, the degradation of such environments may directly influence the occurrence of these and similar species. Another taxon recorded here was *Macrothemis calliste* (Ris), a species previously documented in the state but lacking information on its ecology and geographic distribution (Garrison & Ellenrieder, 2006). This species only occurred in mid-December, suggesting greater adult activity in the middle of the rainy season. More detailed studies are needed to validate this hypothesis.

This is the first report of *M. calliste*, *Progomphus gracilis* Hagen *in* Selys, *Perilestes fragilis* Hagen *in* Selys, and *Heteragrion cauei* Ávila Jr., Lencioni and Carneiro occurring in gallery forests and Cerrado fields in Brazil. Until now, they had been recorded only in semideciduous forests, a phytophysiognomy of the Atlantic Forest (Souza et al., 2013; Lencioni, 2017; Amorim et al., 2018; Ávila Júnior et al., 2020; Stefani-Santos et al., 2021). *H. cauei* is classified as vulnerable (VU) by the IUCN, as it faces a high risk of extinction in the wild (IUCN, 2022). The biotic and abiotic variables of these phytophysiognomies likely influenced the survival strategies of species throughout evolution. New studies are needed to understand the ecological and ethological patterns of these taxa in such environments.

We recorded *Macrothemis marmorata* Hagen for the first time in a gallery forest and Cerrado field in Minas Gerais State. This record contributed to our knowledge of the distribution of the species in different ecosystems in the state (Costa, Machado, Lencioni, & Santos, 2000; Souza et al., 2013; Amorim et al., 2018). According to Renner, Dalzochio, Périco, Sahlén, & Suhonen (2020), *M. marmorata* is a generalist species. The specimen was collected in the Padeiro Waterfall (gallery forest), possibly indicating a reduction in the natural resources of the environment.

The present study provided new information on the occurrence of Odonata species in the Barroso region. The number of recorded species increased from 57 to 76. As such, the region ranks fourth in Odonata species richness in Minas Gerais State. The following species were recorded for the first time in the area: *Hetaerina hebe* Selys, *Mnesarete guttifera* (Selys), *A. sordida*, *H. cauei*, *Archilestes exoletus* (Hagen *in* Selys), *P. fragilis*, *Peristicta jalmosi* Pessacq & Costa, *P. janiceae* Pessacq & Costa, *Remartinia luteipennis* (Burmeister, 1839), *Progomphus complicatus* Selys, *Progomphus costalis* Hagen *in* Selys, *P. gracilis*, *Progomphus teolitavius* Vilela

and Souza, 2022, *M. calliste*, *Macrothemis tenuis* Hagen, *Micrathyria didyma* (Selys *in* Sagra), *Micrathyria pseudeximia* Westfall, and *Orthemis aequilibris* Calvert.

Conclusion

The gallery forest and semideciduous forest fragments of Barroso, Minas Gerais State, harbor an expressive Odonata richness, including rare species, species of restricted occurrence, and those threatened with extinction. We underscore the need to create a conservation unit, given the changes that these fragments, particularly the Baú Forest, are undergoing.

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References

Almeida, M. V. O. D., Pinto, Â. P., Carvalho, A. D. L., & Takiya, D. M. (2013). When rare is just a matter of sampling: unexpected dominance of clubtail dragonflies (Odonata, Gomphidae) through different collecting methods at Parque Nacional da Serra do Cipó, Minas Gerais State, Brazil. *Revista brasileira de Entomologia*, *57*, 417-423. DOI: https://doi.org/10.1590/S0085-56262013005000042

Amorim, M. S., Souza, M. M., & Anjos, C. S. (2018). Riqueza de libélulas (Insecta: Odonata) no município de Bueno Brandão, sul de Minas Gerais. *MG Biota, 11*(1), 16-32.

Ávila Júnior, W. F., Machado, G. L. V., Lencioni, F. A. A., & Carneiro, M. A. A. (2020). Distribution and composition of Dragonfly and Damselfly species (Odonata) of the upper Rio das Velhas, Ouro Preto, Minas Gerais State, Brazil. *Papéis Avulsos de Zoologia, 60*, e20206065. DOI: https://doi.org/10.11606/1807-0205/2020.60.65

Barbosa, M. S., Borges, L. R., Vilela, D. S., Venâncio, H., & Santos, J. C. (2019). Odonate Communities of the Sucupira Reservoir, Rio Uberabinha, Minas Gerais, Brazil. *Papéis Avulsos de Zoologia*, *59*. DOI: https://doi.org/10.11606/1807-0205/2019.59.22

Bedê, L. C., Machado, A. B. M., Piper, W., & Souza, M. M. (2015). Odonata of the Serra de São José–Brazil's first Wildlife Reserve aimed at the conservation of dragonflies. *Notulae odonatologicae, 8*(5), 117-155.

Borges, L. R., Barbosa, M. S., Carneiro, M. A. A., Vilela, D. S., & Santos, J. C. (2019). Dragonflies and damselflies (Insecta: Odonata) from a Cerrado area at Triângulo Mineiro, Minas Gerais, Brazil. *Biota Neotropica*, *19*. DOI: https://doi.org/10.1590/1676-0611-BN-2018-0609

Cezário, R. R., Pena Firme, P., Pestana, G. C., Vilela, D. S., Juen, L., Cordero-Rivera, A., & Guillermo, R. (2021). Sampling methods for dragonflies and damselflies. In J. C. Santos, & G. W. Fernandes. *Measuring Arthropod Biodiversity. A handbook of sampling methods* (p. 223-240). Cham, CH: Springer.

Coelho, M. L. S., Gouvêa, T. P., Clemente, M. A., & Souza, M. M. (2022). Effect of forest fragment size on Polistinae (Hymenoptera, Vespidae) in a transitional area of Cerrado and Atlantic Forest in south central Minas Gerais state, Brazil. *EntomoBrasilis*, *15*, e994-e994. DOI: https://doi.org/10.12741/ebrasilis.v15.e994

Costa, J. M., Machado, A. B. M., Lencioni, F. A. A., & Santos, T. C. (2000). Diversidade e distribuição dos Odonata (Insecta) no estado de São Paulo, Brasil: Parte I-Lista das espécies e registros bibliográficos. *Publicações Avulsas do Museu Nacional, 80*, 1-27.

Cowell, R. K. (2013). EstimateS: Statistical estimation of species richness and shared species from samples. (Software and User's Guide), Version 9 and earlier. Retrieved from https://www.robertkcolwell.org/pages/1407-estimates

Dijkstra, K. D. B., & Clausnitzer, V. (2006). Thoughts from Africa: how can forest influence species composition, diversity and speciation in tropical Odonata. Forest and Dragonflies. *Pensoft Publishers*, 127-151.

Dos Anjos, C. S., Milani, L. R., & Souza, M. M. (2020). Odonata (Insecta) species richness in the Parque Estadual do Ibitipoca, Southeast Brazil. *Revista Agrogeoambiental, 12*, 79-90. DOI: https://doi.org/10.18406/2316-1817v12n320201468

Ferraz, S. F. B., Rodrigues, C. B., Garcia, L. G., Alvares, C. A., & Lima, W. P. (2019). Effects of *Eucalyptus* plantations on streamflow in Brazil: moving beyond the water use debate. *Forest Ecology and Management, 453*, 117571. DOI: https://doi.org/10.1016/j.foreco.2019.117571

Ferreira-Peruquetti, P. S., & De Marco Jr., P. J. (2002). Efeito da alteração ambiental sobre comunidades de Odonata em riachos de Mata Atlântica de Minas Gerais, Brasil. *Revista brasileira de Zoologia, 19*(2), 317-327. DOI: https://doi.org/10.1590/S0101-81752002000200002

Ganem, R. S., Drummond, J. A., & Franco, J. L. A. (2013). Conservation polices and control of habitat fragmentation in the Brazilian Cerrado biome. *Ambiente & Sociedade, 16*(3), 99-118. DOI: https://doi.org/10.1590/S1414-753X2013000300007

Garrison, R. W., & Ellenrieder, N. Von (2006). Generic diagnoses within a closely related group of genera: *Brechmorhoga*, *Gynothemis*, *Macrothemis*, and *Scapanea* (Odonata: Libellulidae). *The Canadian Entomologist, 138*, 269-284. DOI: https://doi.org/10.4039/n05-048

Garrison, R. W., Ellenrieder, N. Von, & Louton, J. A. (2006). *Dragonfly genera of the new word: an illustrated and annotated key to the Anisoptera*. Baltimore, MD: Johns Hopkins University Press.

Garrison, R. W., Ellenrieder, N. Von, & Louton, J. A. (2010). *Damselfly genera of the new world: an illustrated and annotated key to the Zygoptera*. Baltimore, MD: Johns Hopkins University Press.

Gouvêa, T. P., Clemente, M. A., Teófilo-Guedes, G., & Souza, M. M. (2021). Ocorrência de *Chloronia corripiens* (Walker, 1858) (Megaloptera) em mata de galeria, Cerrado, Centro-Sul de Minas Gerais. *Revista Cientifica MG Biota*, *14*(1), 69-76.

Gouvêa, T. P., Oliveira, T. M. D., Ferreira, E. D. F., Jacques, G. C., Teófilo-Guedes, G., Vilela, D. S., & Souza, M. M. (2022). Response of Odonata communities to dry season in a Deciduous Forest in the Northern Minas Gerais, Brazil. *EntomoBrasilis*, *15*, e1020-e1020. DOI: https://doi.org/10.12741/ebrasilis.v15.e1020

Guedes, M. B., Vilela, D. S., & Souza, M. M. (2022). Odonata (Insecta) community in the Environmental Protection Area of the Machado River hydrographic basin, southern Minas Gerais State, Brazil. *Papéis Avulsos de Zoologia*, *62*. DOI: https://doi.org/10.11606/1807-0205/2022.62.061

Guillermo, R., & Juen, L. (2021). Odonate ethodiversity as a bioindicator of anthropogenic impact. *International Journal of Odonatology*, *24*, 149-157. DOI: https://doi.org/10.23797/2159-6719_24_11

Instituto Brasileiro de Geografia e Estatística [IBGE]. (1997). *Recursos naturais e meio ambiente. Uma visão do Brasil* (2nd Ed). Rio de Janeiro, RJ: IBGE.

Instituto Chico Mendes de Conservação da Biodiversidade [ICMBio]. (2018). *Livro vermelho da fauna brasileira ameaçada de extinção* (Vol. 1). Brasília, DF: ICMBio.

International Union for the Conservation of Nature and Natural Resources [IUCN]. (2022). The IUCN Red List of Threatened Species: Version 2022-2. Recovered from https://www.iucnredlist.org/search

Juen, L., Oliveira-Junior, J. M. B. D., Shimano, Y., Mendes, T. P., & Cabette, H. S. R. (2014). Composição e riqueza de Odonata (Insecta) em riachos com diferentes níveis de conservação em um ecótone Cerrado-Floresta Amazônica. *Acta Amazonica, 44*(2), 223-233. DOI: https://doi.org/10.1590/S0044-59672014000200008

Lapola, D. M., Martinelli, L. A., Peres, C. A., Ometto, J. P., Ferreira, M. E., Nobre, C. A., ... & Vieira, I. C. (2014). Pervasive transition of the Brazilian land-use system. *Nature Climate Change*, *4*(1), 27-35.

Lencioni, F. A. A. (2017). *Damselflies of Brazil – an illustrated identification guide – Southeast region* (E-book). Jacareí, SP: Ed. Dou Autor.

Lima, D. R., Rubim, L. G. T., Pádua, T. H. R., Souza, M. M. (2022). Efeito do tamanho do fragmento florestal sobre as comunidades de Opiliones (Arachnida) em diferentes fitofisionomias no centro sul do estado de Minas Gerais. *Acta Biológica Catarinense*, *9*, 54-65.

Machado, A. B. M. (1988). *Heteragrion petiense* spec. nov., from the state of Minas Gerais, Brazil (Zygoptera: Megapodagrionidae). *Odonatologica, 17*, 267-274.

Machado, A. B. M. (2015). *Heteragrion thais* sp. nov. from the Atlantic Forest of Brazil (Odonata: Heteragrionidae). *Odonatologica, 44*(3), 391-396.

Machado, A. B. M., & Souza, M. M. (2014). A remarkable new species of *Heteragrion* from Brazil (Odonata: Megapodagrionidae). *International Journal of Odonatology, 17*(2-3), 95-99. DOI: https://doi.org/10.1080/13887890.2014.925514

Martello, F., Andriolli, F., Souza, T. B., Dodonov, P., & Ribeiro, M. C. (2016). Edge and land use effects on dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae) in Brazilian cerrado vegetation. *Journal of Insect Conservation, 20*, 957-970. DOI: https://doi.org/10.1007/s10841-016-9928-0

Menini-Neto, L., Assis, L. C. S., & Forzza, R. C. (2004). A família Orchidaceae em um fragmento de floresta estacional semidecidual no município de Barroso, Minas Gerais, Brasil. *Lundiana, 5*(1), 9-27. DOI: https://doi.org/10.35699/2675-5327.2004.21896

Mittermeier, R. A., Turner, W. R., Larsen, F. W., Brooks, T. M., Gascon, C. (2011). Global biodiversity conservation: the critical role of *hotspots*. In F. E. Zachos, J. C. Habel (Eds), *Biodiversity Hotspots* (p. 3-22). Berlin; Heidelberg, DE: Springer.

Moon, D. C., & Silva, D. (2013). Environmental heterogeneity mediates a cross-ecosystem trophic cascade. *Ecological Entomology*, *38*, 23-30. DOI: https://doi.org/10.1111/j.1365-2311.2012.01398.x

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Fonseca, G. A., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature*, *403*, 853-858. DOI: https://doi.org/10.1038/35002501

Oliveira, G. C. S., Henriques, N. R., Clemente, M. A., & Souza, M. M. (2021). Conservation Units as a protection tool for social wasps in Minas Gerais state, Brazil. *Papéis Avulsos de Zoologia, 61*, 1-10. DOI: https://doi.org/10.11606/1807-0205/2021.61.25

Pires, E. P., Morgado, L. N., Souza, B., Carvalho, C. F., & Nemésio, A. (2013). Community of orchid bees (Hymenoptera: Apidae) in transitional vegetation between Cerrado and Atlantic Forest in southeastern Brazil. *Brazilian Journal of Biology, 73*(3), 507-513. DOI: https://doi.org/10.1590/S1519-69842013000300007

Popielarz, P. A., & Neal, Z. P. (2007). The niche as a theoretical tool. *Annual Reviews of Sociology, 33*, 65-84. DOI: https://doi.org/10.1146/annurev.soc.32.061604.123118

Renner, S., Dalzochio, M. S., Périco, E., Sahlén, G., & Suhonen, J. (2020). Odonate species occupancy frequency distribution and abundance–occupancy relationship patterns in temporal and permanent water bodies in a subtropical area. *Ecology and Evolution, 10*, 7525-7536. DOI: https://doi.org/10.1002/ece3.6478

Ribeiro, M. C., Martensen, A. C., Metzger, J. P., Tabarelli, M., Scarano, F., & Fortin, M. J. (2011). The Brazilian Atlantic Forest: a shrinking biodiversity hotspot. In F. E. Zachos, J. C. Habel (Eds.), *Biodiversity hotspots* (p. 405-434). Berlin; Heidelberg, DE: Springer. DOI:https://doi.org/10.1007/978-3-642-20992-5_21

Santos, N. D. (1966). Odonatas da região de Poços de Caldas, Minas Gerais. *Atas da Sociedade de Biologia do Rio de Janeiro, 10,* 65-69.

Scarano, F. R., & Ceotto, P. (2015). Brazilian Atlantic forest: impact, vulnerability, and adaptation to climate change. *Biodiversity and Conservation*, *24*, 2319-2331. DOI: https://doi.org/10.1007/s10531-015-0972-y

Sharma, R. H., & Shakya, N. M. (2006). Hydrological changes and its impact on water resources of Bagmati watershed, Nepal. *Journal of Hydrology, 327*(3-4), 315-322. DOI: https://doi.org/10.1016/j.jhydrol.2005.11.051

Šigutová, H., Šipoš, J., & Dolný, A. (2019). A novel approach involving the use of Odonata as indicators of tropical forest degradation: when family matters. *Ecological Indicators*, *104*, 229-236. DOI: https://doi.org/10.1016/j.ecolind.2019.05.001

Silva, G. A. C., & Souza, M. M. (2020). Odonatofauna (Libélulas) em Floresta Estacional Semidecidual Montana do Sul do Estado de Minas Gerais. *Revista Ifes Ciência*, *6*(2), 184-194. DOI: https://doi.org/10.36524/ric.v6i2.476

Silva, L. G., Santos, S., & Moraes, F. (2014). Fragmentação da Mata Atlântica de interior: análise de paisagem do corredor verde sul-americano e florestas do alto Paraná. *Boletim de Geografia, 32*(3), 61-68. DOI: https://doi.org/10.4025/bolgeogr.v32i3.21881

Silveira, L. F., Beisiegel, B. D. M., Curcio, F. F., Valdujo, P. H., Dixo, M., Verdade, V. K., ... & Cunningham, P. T. M. (2010). Para que servem os inventários de fauna? *Estudos Avançados*, *24*(68), 173-207.

Souza, M. M. (2006). Barroso, uma história de desmatamentos e de esforços atuais para conservação. *Vertentes (UFSJ), 27*, 16-26.

Souza, M. M., Pires, E. P., & Prezoto, F. (2014). Seasonal richness and composition of social wasps (Hymenoptera: Vespidae) in areas of Cerrado biome in Barroso, Minas Gerais, Brazil. *Bioscience Journal, 30*(2), 539-545.

Souza, M. M., Louzada, J., Serráo, J. E., & Zanuncio, J. C. (2010). Social wasps (Hymenoptera: Vespidae) as indicators of conservation degree of riparian forests in southeast Brazil. *Sociobiology, 56*, 1-10.

Souza, M. M., Souza, B., Pereira, M. C. S. A., & Machado, A. B. M. (2013). List of Odonates from Mata do Baú, Barroso, Minas Gerais, Brazil. *Check List, 9*(6), 1367-1370. DOI: https://doi.org/10.15560/9.6.1367

Souza, M. M., Pires, E. P., Brunismann, Â. G., Milani, L. R., & Pinto, Â. P. (2017). Dragonflies and damselflies (Odonata) from the wetland of the Rio Pandeiros, northern region of Minas Gerais State, Brazil, with a description of the male of *Archaeogomphus vanbrinki* Machado (Anisoptera: Gomphidae). *International Journal of Odonatology*, *20*(1), 13-26. DOI: https://doi.org/10.1080/13887890.2017.1281848

Stefani-Santos, G., Ávila Júnior, W. F., Clemente, M. A., Henriques, N. R., Souza, A. S. B., Vilela, D. S., & Souza, M. M. (2021). Odonata (Insecta) communities along an elevational gradient in the Atlantic Forest of southeastern Brazil, with the description of the female of *Heteragrion mantiqueirae* Machado, 2006. *International Journal of Odonatology, 24*, 178-196. DOI: https://doi.org/10.23797/2159-6719_24_14

Stephenson, P. J., & Stengel, C. (2020) An inventory of biodiversity data sources for conservation monitoring. *PLoS ONE, 15*(12), e0242923. DOI: https://doi.org/10.1371/journal.pone.0242923

Venâncio, H., Vilela, D. S., Barbosa, M. S., & Santos, J. C. (2021). Libélulas de uma região do Triângulo Mineiro, Minas Gerais: lista de espécies e adições taxonômicas. *Biota Neotropica*, *21*(3). DOI: https://doi.org/10.1590/1676-0611-BN-2020-1182

Vilela, D. S. (2022). *Libélulas de Minas Gerais. Dados compilados sobre Odonatos coletados no estado de Minas Gerais*. Retrieved from http://libelulasdemg.com.br

Vilela, D. S., & Souza, M. M. (2022). A new species of *Progomphus* Selys, 1854 (Odonata: Anisoptera: Gomphidae) from Minas Gerais state, Southeastern Brazil. *Zootaxa*, *5124*, 69-74. DOI: https://doi.org/10.11646/zootaxa.5124.1.4

Vilela, D. S., Ferreira, R. G., & Del-Claro, K. (2016). The Odonata community of a Brazilian vereda: seasonal patterns, species diversity and rarity in a palm swamp environment. *Bioscience Journal*, *32*, 486-495. DOI: https://doi.org/10.14393/BJ-v32n2a2016-30491

Vilela, D. S., Koroiva, R., Tosta, T. H. A., Novaes, M. C., & Guillermo-Ferreira, R. (2020). Dragonflies and damselflies from the West of Minas Gerais, Brazil: checklist and new records. *Biota Neotropica*, *20*(1). DOI: https://doi.org/10.1590/1676-0611-BN-2019-0851

Zanella, L., Folkard, A. M., Blackburn, G. A., & Carvalho, L. M. (2017). How well does random forest analysis model deforestation and forest fragmentation in the Brazilian Atlantic forest? *Environmental and Ecological Statistics, 24*, 529-549. DOI: https://doi.org/10.1007/s10651-017-0389-8