



Odonata Community in a transition area between Atlantic Forest and Cerrado, Southern Minas Gerais, Brazil

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Abstract. The Atlantic Forest and Cerrado biomes are global biodiversity hotspots. Despite this, they are constantly losing their natural habitats, making it urgent to conduct fauna inventories for the conservation of taxa such as dragonflies (Odonata). These insects provide fundamental environmental services to both aquatic and terrestrial ecosystems and are poorly sampled in some regions of Minas Gerais state. In this regard, the present study aimed to inventory the Odonata community in the surroundings of Luminárias, a municipality located in southern Minas Gerais state, Brazil. This area consists of a transition between Cerrado and Atlantic Forest, with biotic and abiotic attributes suggesting the creation of a Conservation Unit (CU) to provide data on the distribution of this taxon for future conservation actions. The study was conducted between 2023 and 2024, in 10 locations, totaling 690 hours of sampling effort. Fifty-seven species were recorded, distributed among seven families, with four species at some risk of extinction or with insufficient data, according to the IUCN or ICMBio. Considering the significant richness of Odonata fauna obtained in this study, which includes threatened species, it is urgent to establish management actions for the protection of these populations, including the creation of a CU.

Keywords: Anthropic impacts; Biodiversity; Conservation; Inventory; Odonatofauna.

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Tropical biomes face significant threats caused by several anthropogenic impacts such as deforestation, agricultural expansion, livestock farming, logging, mining, and illegal gold mining (MapBiomias 2020), which promote biodiversity loss (Klink & Machado 2005; SOS Mata Atlântica 2020). It is estimated that half of the original coverage of these biomes has been eliminated, with a deforestation rate approaching 1% per year (Hansen *et al.* 2013; MMA 2023).

In Brazil, this situation is alarming for the Cerrado and the Atlantic Forest, two biomes considered global biodiversity hotspots (CEPF 2018; Lima *et al.* 2020). The Atlantic Forest harbors more than 8,000 endemic species of fauna and flora (Myers *et al.* 2000) and has had its native vegetation reduced to 12.4% of its original coverage. Currently, only 13% of its remaining area is included in any Conservation Unit (SOS Mata Atlântica 2021). In the Cerrado, this panorama is similar: recognized as the world's most biodiverse savanna, the Cerrado has endemism rates exceeding 44% (Klink & Machado 2005; Simon *et al.* 2009; Joly *et al.* 2019), however, about 46% of the biome was eliminated by the end of the 20th and early 21st centuries. As a result, only 11% of the biome is currently protected by Conservation Units (Strassburg *et al.* 2017; Sano *et al.* 2019).

Considering this scenario, performing inventory studies in these two biomes becomes crucial, enabling the access to biodiversity and generating essential data for decision-making management of natural areas (Silveira *et al.* 2010; Oliveira *et al.* 2016; Stephenson & Stengel 2020). This type of study also facilitates the establishment of Conservation Units, which represent the most effective tool for ensuring the protection of biodiversity and natural resources (Almeida *et al.* 2011; Salvio 2017).

Despite the importance of inventory studies, numerous taxa in Brazil remain inadequately sampled. For example, dragonflies (Odonata), totaling approximately 884 species in Brazil (IUCN 2024). These organisms provide fundamental ecosystem services, ranging from bioindication of environmental quality to participation in trophic chains of associated lentic, lotic, and terrestrial freshwater ecosystems, as they act as predators in both larval and adult stages (Gómez-Tolosa *et al.* 2021; Ferreira *et al.* 2023).

The state of Minas Gerais, in southeastern Brazil, stands out for the increasing number of Odonata fauna inventories (Vilela 2024). These initiatives enable a broad analysis of collected data and help understanding the importance of each area for biodiversity conservation (Table 1).

While sampling efforts are on the rise in Minas Gerais, there are still many undersampled areas or areas lacking information about Odonata diversity, particularly in regions characterized by the Cerrado and Caatinga biomes (Figure 1). One of these poorly sampled locations is the region of Luminárias, a municipality in the southern part of the state, which has biotic and abiotic attributes suggesting the creation of a Conservation Unit (UC) (Lima *et al.* 2011).

Table 1. Dragonfly fauna inventories conducted in Minas Gerais state, southeastern Brazil: Author and year of publication, Biomes, number of species (richness), and presence/absence in Conservation Units (CU's).

Author/Year	Biome	Richness	Conservation Unit
Santos (1966)	Atlantic Forest	59	No
Ferreira-Peruquetti & De Marco-Jr. (2002)	Atlantic Forest	28	Yes
Almeida <i>et al.</i> (2013)	Cerrado	23	Yes
Souza <i>et al.</i> (2013)	Atlantic Forest and Cerrado	57	No
Bedê <i>et al.</i> (2015)	Atlantic Forest and Cerrado transition	128	Yes
Machado & Bedê (2015)	Cerrado	34	Yes
Vilela <i>et al.</i> (2016)	Cerrado	31	Yes
Souza <i>et al.</i> (2017)	Cerrado and Caatinga transition	48	Yes
Amorim <i>et al.</i> (2018)	Atlantic Forest	73	No
Barbosa <i>et al.</i> (2018)	Cerrado	42	No
Borges <i>et al.</i> (2019)	Cerrado	36	No
Ávila-Júnior <i>et al.</i> (2020)	Atlantic Forest	40	Yes
Dos Anjos <i>et al.</i> (2020)	Atlantic Forest and Cerrado	20	Yes
Silva & Souza (2020)	Atlantic Forest	71	No
Vilela <i>et al.</i> (2020)	Cerrado	90	No
Pimenta <i>et al.</i> (2021)	Cerrado	31	No
Stefani-Santos <i>et al.</i> (2021)	Atlantic Forest	39	Yes
Venâncio <i>et al.</i> (2021)	Cerrado	101	Yes
Gouvêa <i>et al.</i> (2022)	Caatinga	55	Yes
Guedes <i>et al.</i> (2022)	Atlantic Forest and Cerrado	71	Yes
Dos Anjos <i>et al.</i> (2023)	Atlantic Forest	68	Yes
Gouvêa <i>et al.</i> (2023)	Atlantic Forest and Cerrado	76	No
Vale <i>et al.</i> (2023)	Cerrado	79	Yes
Vilela <i>et al.</i> (2023)	Atlantic Forest	45	No
De Oliveira <i>et al.</i> (2024)	Cerrado	83	Yes

Therefore, the present study aims to inventory the Odonata community in this region of southeastern Brazil, providing essential additional data on its distribution for future conservation actions.

MATERIAL AND METHODS

Study area and sampling events. The study was carried out in the municipality of Luminárias (-22.64242; -46.32947), located in a transitional area between the Atlantic Forest and Cerrado biomes. Within the Atlantic Forest domain, the phytophysionomy includes Seasonal Semideciduous Mountain Forest, Altitude Grassland, and Riparian Forest; within the Cerrado domain, it encompasses Cerrado Grassland and Dirty Grassland, as well as Rocky Grassland (Oliveira-Filho 2006). The climate falls under type Cwa (Köppen 1923), subtropical with dry winters and rainy summers, with an annual precipitation of 1,594 mm, while the average annual temperature is 17.8 °C (Alvares *et al.* 2013), with a minimum altitude of 845 m and a maximum of 1,496 m.

The study was composed of seven campaigns, covering all seasons of the year, in the months of May, September, October, November, and December 2023, and February and March 2024. Each campaign lasted for two to three consecutive days, except for October, which extended to five days. Adult Odonata collections were conducted from 09:00 to 13:00 and from 16:00 to 18:00 h, with the effort of five researchers, 138 h over 21 days per researcher (totaling 690

h), across ten locations (Table 2 and Figure 2).

Collection methods. We used both active search and *Malaise* traps for the adult dragonfly collection. The active search was performed using an entomological net in lentic, lotic, and associated terrestrial environments. The collected specimens were placed in paper envelopes (7 x 10 cm), properly labeled with information about the collection site, date, and collector's name. The specimen remained in the envelope for approximately six hours prior to fixation, for the emptying of the digestive tract (Carneiro *et al.* 2016). Subsequently, the specimens were sacrificed by immersion in PA acetone (pure for analysis) for about 12 h, depending on the size of the specimen, to dissolve lipids and preserve coloration (Garrison *et al.* 2006; Cezário *et al.* 2021).

As for the *Malaise* trap, it was suspended one meter above the water surface in a stream of gallery forest area (Cachoeira do Mamono) from October 2023 to February 2024, with a monthly biological material collection. The captured specimens were sorted and stored in 70% alcohol, properly labeled (collection location and month). For species identification, the material was removed from the 70% alcohol and placed in paper envelopes.

Taxonomic treatment and conservation status. For taxonomic identification, we used dichotomous identification keys (Garrison *et al.* 2006, 2010; Lencioni 2005, 2006, 2017), along with specific literature when necessary. The biological

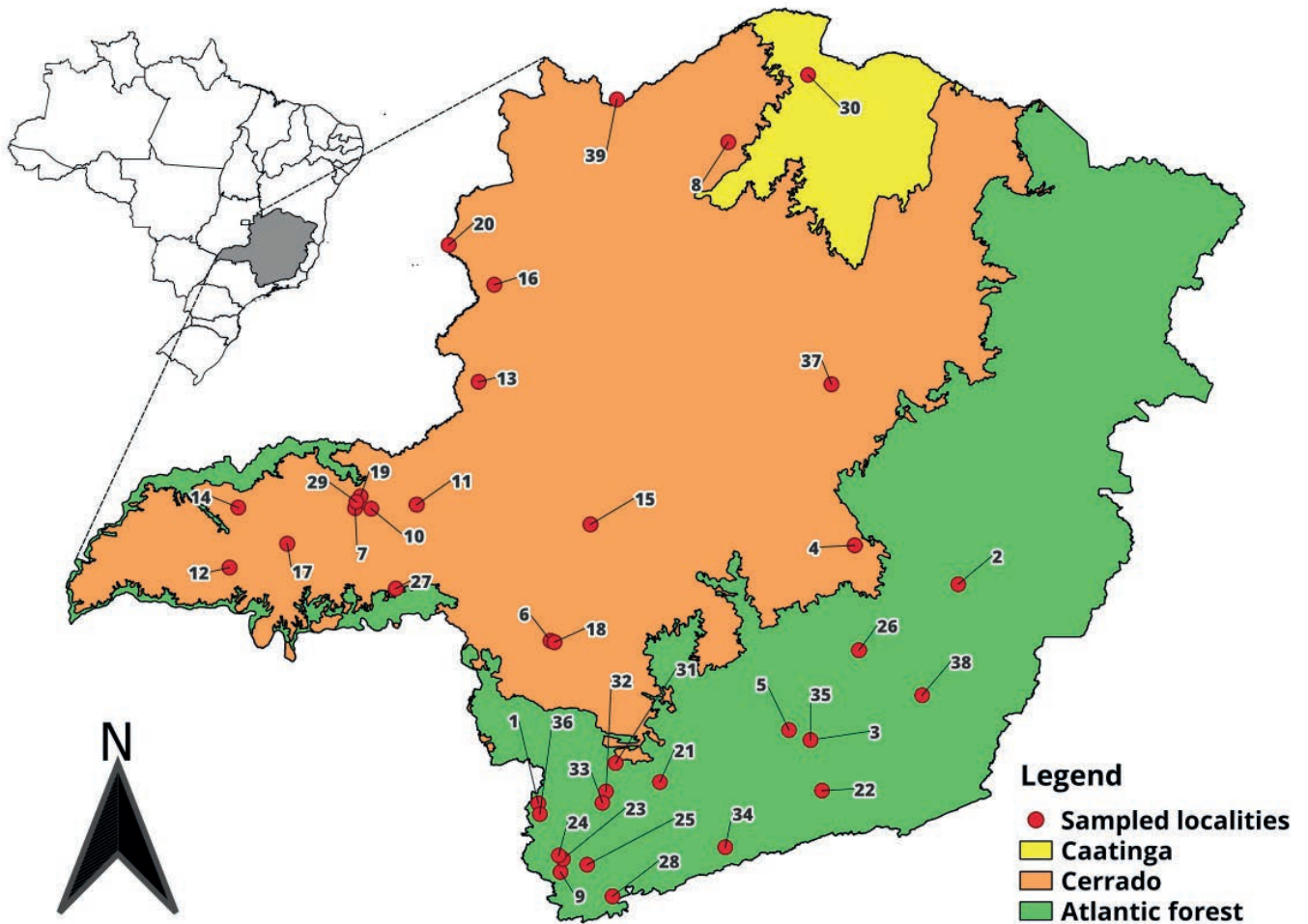


Figure 1. Odonata sampling localities in Minas Gerais state, southeastern Brazil (municipalities or Conservation Units): Poços de Caldas municipality (1, 36: Santos 1966; Vilela *et al.* 2023); Rio Doce State Park (2: Ferreira-Peruquetti & Marco-Jr. 2002); Barroso municipality (3, 35: Souza *et al.* 2013; Gouvêa *et al.* 2023); Serra do Cipó National Park (4: Almeida *et al.* 2013); São José Hill (5: Bedê *et al.* 2015); Serra da Canastra National Park (6: Machado & Bedê 2015); Uberlândia municipality (7, 10, 19, 29: Vilela *et al.* 2016; Barbosa *et al.* 2018; Vilela *et al.* 2020; Venâncio *et al.* 2021); Rio Pandeiros Wilderness State Refuge (8: Souza *et al.* 2017); Bueno Brandão municipality (9: Amorim *et al.* 2018); Nova Monte Carmelo Farm (11: Borges *et al.* 2019); municipalities of Campina Verde, Guarda Mor, Ituiutaba, Matutina, Paracatu, Prata, São Roque de Minas, Unaí and Varginha (12, 13, 14, 15, 16, 17, 18, 20, 21: Vilela *et al.* 2020); Ibitipoca State Park (22: Dos Anjos *et al.* 2020); municipalities of Inconfidentes, Ouro Fino and Tocos do Moji (23, 24, 25: Silva & Souza 2020); Andorinhas Natural Municipal Park (26: Ávila-Júnior *et al.* 2020); Uberaba municipality (27: Pimenta *et al.* 2021); Gonçalves municipality (28: Stefani-Santos *et al.* 2021); Mata Seca State Park (30: Gouvêa *et al.* 2022); municipalities of Fama, Machado and Poço Fundo (31, 32, 33: Guedes *et al.* 2022); Serra do Papagaio State Park (34: Dos Anjos *et al.* 2023); Sempre Vivas National Park (37: Vale *et al.* 2023), Viçosa municipality (38: Ferreira-Peruquetti & Marco-Jr. 2002); Grande Sertão Veredas National Park (39: De Oliveira *et al.* 2024).

Table 2. Regions of Luminárias municipality where collections were conducted, the phytophysiognomy characteristics, coordinates, and freshwater environment type.

Locality	Phytophysiognomy / Biome	Environment type / coordinates
Rio Ingaí	Riparian Forest / Atlantic Forest	Lotic / -21.61278, -44.87389
Complexo do Mandembe	Semideciduous Forest / Atlantic Forest	Lotic / -21.55944, -44.88528
Cachoeira do Mamono	Gallery Forest / Cerrado	Lotic / -21.52722, -44.84417
Estreito do Inferno	Semideciduous Forest / Atlantic Forest	Lotic / -21.57306, -44.95139
Cachoeira da Pedra Furada	Gallery Forest / Cerrado	Lotic / -21.55028, -44.84528
Serrinha	Semideciduous Forest / Atlantic Forest	Lotic / -21.49167, -44.88222
Cachoeira Serra Grande	Rocky Grassland (Campo Rupestre)	Lotic / -21.54250, -44.81583
Cachoeirinha	Gallery Forest / Cerrado	Lotic / -21.55889, -44.86889
Brejo da Pedra Furada	Pasture	Lentic / -21.54167, -44.88444
Brejo do Quintal	Semideciduous Forest / Atlantic Forest	Lentic / -21.53833, -44.92861



Figure 2. Sampling localities in Luminárias, Minas Gerais: Cachoeira da Serra Grande (A), Cachoeira do Mamono (B), Complexo do Mandembo (C), Cachoeira da Pedra Furada (D), Estreito do Inferno (E) and Brejo do Quintal (F).

material was deposited into the social wasp biological collection (CBVS) of the Zoology Laboratory at IFSULDEMINAS, Campus Inconfidentes (see: <https://specieslink.net/col/CBVS/>).

The conservation status of the species was assessed through the Chico Mendes Institute for Biodiversity Conservation (ICMbio) and the International Union for Conservation of Nature (IUCN) websites.

Data analysis. To assess the sampling effort, an accumulation curve was created using observed richness with a 95% confidence interval. We used the Bootstrap 1 estimator, in the EstimateS 9.1.0 Software (Cowell & Elsensohn 2014). SISBio License Number: 91709-1.

RESULTS AND DISCUSSION

Species list. Altogether, 57 species of Odonata were recorded, distributed among seven families (Table 3). We emphasize four species that were assessed under some risk of extinction or insufficient data according to IUCN or ICMbio: *Heteragrion cauei* Avila Junior, Lencioni & Carneiro, 2017 (Odonata: Heteragrionidae), *Heteragrion triangulare* Hagen in Selys, 1862 (Odonata: Heteragrionidae), *Elasmothemis schubarti* (Santos, 1945) (Odonata: Libellulidae), and *Castoraeschna januaria*

(Hagen, 1867) (Odonata: Aeshnidae) (Figure 3).

The richness of species observed in our study may reflect the predominance of lotic environments in the sampled areas. This is supported by the community profile, with the abundance of taxa that better exploit lotic ecosystems, such as the genus *Argia*, the family Calopterygidae, and some species of the family Libellulidae (Silva et al. 2010).

Conservation status. Regarding threatened species, *H. cauei*, is considered vulnerable by the IUCN (Vilela & Guillermo-Ferreira 2021a). Its distribution is restricted to Minas Gerais state, where it was first recorded in a riparian forest area, within a Conservation Unit in Ouro Preto municipality (Ávila-Júnior et al. 2017). The second record occurred in gallery forest, in transitioning area between the Atlantic Forest and Cerrado, in Barroso municipality. In that location, Odonata populations are threatened by various anthropogenic pressures, as evidenced by the reduction in their richness over a 10-year period (Gouvêa et al. 2023). This situation may be similar to what we found in Luminárias, as a reduction in the remaining fragments could impact the population of *H. cauei*.

Heteragrion triangulare was recently assessed by ICMbio as of least concern (Júnior et al. 2023). In the assessment available on IUCN, there is insufficient data for a complete

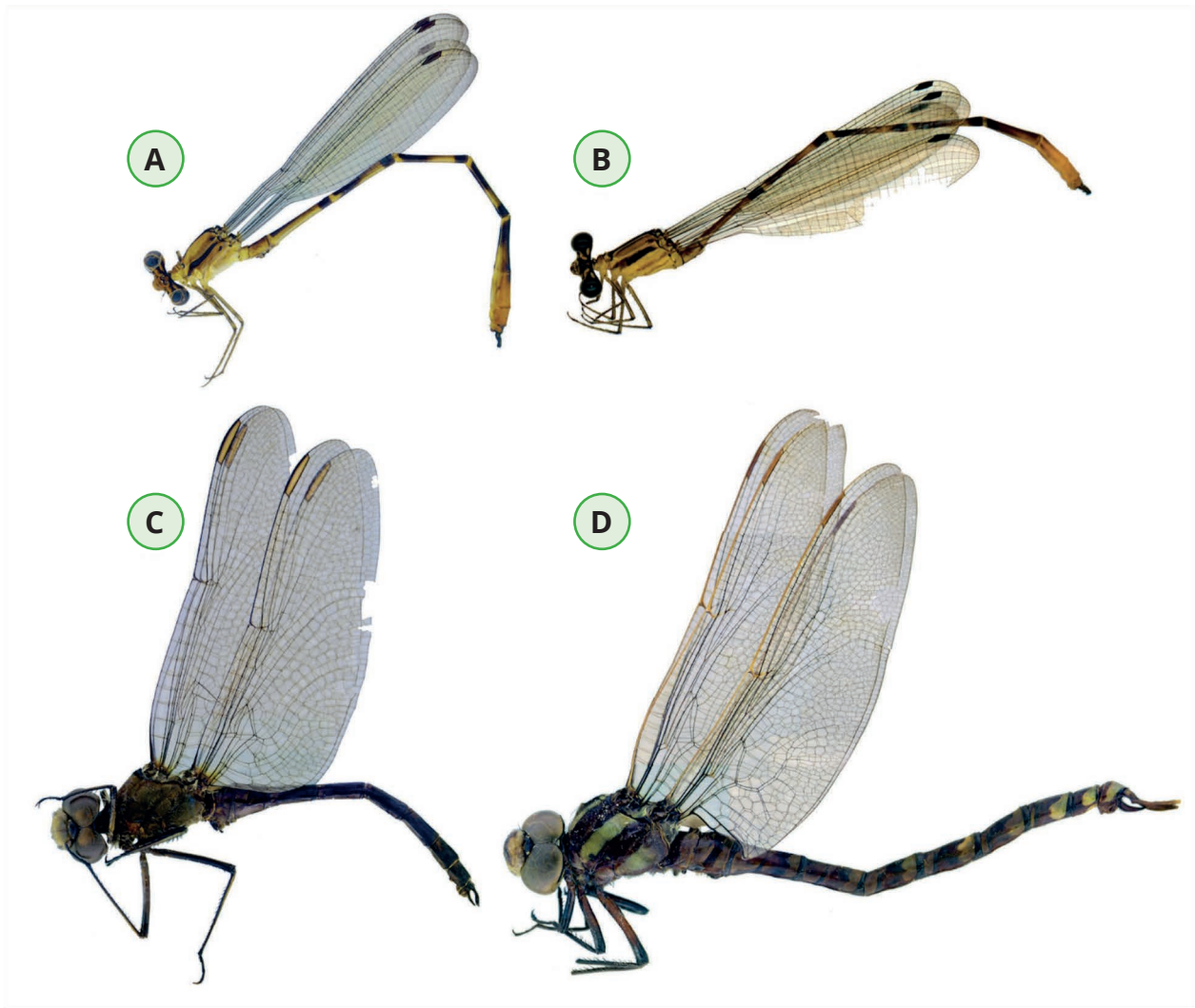


Figure 3. Species that were assessed under some risk of extinction or insufficient data according to IUCN or ICMBio: (A) *Heteragrion cauei*; (B) *Heteragrion triangulare*; (C) *Elasmothemis schubarti*; (D) *Castoraeschna januaria*.

assessment (von Ellenrieder 2009). Records of this species have been made in Rio Grande do Sul (Renner *et al.* 2015), Rio de Janeiro (Kompier 2015), and Minas Gerais states (Amorim *et al.* 2018; Souza *et al.* 2018; Vilela *et al.* 2020), associated with lotic environments in transition areas between the Atlantic Forest and the Cerrado. These locations present phytophysiognomies of Cerrado Stricto sensu, Campo Limpo, and Montane Semideciduous Forest (Vilela 2024).

The occurrence of these two species shows the importance of raising awareness about the preservation of the study area. The family Heteragrionidae is more commonly found in preserved areas or largely forested areas, as several species have specific environmental restrictions and ecological needs (Carvalho *et al.* 2013).

Elasmothemis schubarti is considered endangered (EN) according to a 2014 assessment (ICMBio 2024), and was evaluated with insufficient data (DD) by the IUCN (Vilela & Guillermo-Ferreira 2021b). Its occurrence has been recorded in the state of Minas Gerais (Bedê *et al.* 2015; Dos Anjos *et al.* 2023; Gouvêa *et al.* 2023), mainly in areas of Campo Rupestre, Atlantic Forest, and Semideciduous Forest (Vilela 2024).

Castoraeschna januaria is considered vulnerable according to a 2014 assessment (ICMBio 2024), and of least concern (LC) by the IUCN (Lozano 2021). Records of this species have been documented in Rio Grande do Sul (Dalzochio *et al.* 2018), and Minas Gerais states (Souza *et al.* 2013; Dos Anjos *et al.* 2020), where it is found in different phytophysiognomies such as Cerrado Stricto sensu, Campo Rupestre, Atlantic Forest, and Semideciduous Forest (Vilela 2024).

Such discrepancies between ICMBio and IUCN listings may occur for two reasons: the teams involved may be heterogeneous, leading to different interpretations of the available data; and the data available to both teams may be different, with some researchers having access to unpublished information, which contributes to a more robust assessment (Dos Anjos *et al.* 2023).

Another species who deserves attention is *Neocordulia setifera* (Hagen in Selys, 1871) (Odonata: Corduliidae), which, although classified as least concern (LC) by both IUCN and ICMBio, is recorded for the first time by an inventory study in Minas Gerais state (Table 1). Hence, there are no records of this species in Conservation Units within Minas Gerais. Furthermore, there is little information regarding its habitat preferences (Vilela 2024), a concerning fact that emphasizes the importance of studies like ours, as the obtained data can assist in future assessments of species conservation status.

Data analysis. According to our analysis the sampling effort proved to be sufficient, as shown by the species accumulation curve (Figure 4), which reached an asymptote. Furthermore, the estimated number of species by BootStrap1 is 64.45, within the 95% confidence limit.

Environmental considerations. The presence of endangered species in the study area highlights the urgency to establish management actions to protect the remaining populations. This includes assessing the impact of human activities on forest remnants, as the reduction of these natural environments negatively affects the quality and structure of freshwater habitats, with repercussions on the odonatofauna

Table 3. Suborder/Superfamily/Family/Species abundance and conservation status of dragonflies (Odonata) collected in Luminárias region, Minas Gerais state, southeastern Brazil. (LC) least concern; (DD) data deficiente; (VU) vulnerable; (EN) endangered; (-) data not available; (IUCN) International Union for Conservation of Nature; (ICMbio) Instituto Chico Mendes de Conservação da Biodiversidade.

Suborder/Superfamily/Family/Species	IUCN	ICMbio	Abundance
ANISOPTERA			
Aeshnidae			
<i>Anax amazili</i> (Burmeister, 1839)	LC	LC	1
<i>Castoraeschna januaria</i> (Hagen, 1867)	LC	VU	2
<i>Remartinia luteipennis</i> (Burmeister 1839)	LC	LC	5
Libelluloidea - Incertae Sedis			
<i>Neocordulia setifera</i> (Hagen in Selys, 1871)	LC	LC	1
Gomphidae			
<i>Gomphoides infumata</i> (Rambur, 1842)	LC	LC	1
<i>Phyllogomphoides regularis</i> (Selys, 1873)	LC	LC	1
<i>Progomphus complicatus</i> Selys, 1854	LC	LC	15
Libellulidae			
<i>Brechmorhoga praedatrix</i> Calvert, 1909.	LC	LC	3
<i>Dythemis nigra</i> Kirby, 1894	LC	LC	1
<i>Elasmothemis cannacrioides</i> (Calvert, 1906)	LC	LC	1
<i>Elasmothemis schubarti</i> (Santos, 1945)	DD	EN	2
<i>Erythrodiplax fusca</i> (Rambur, 1842)	LC	LC	17
<i>Erythrodiplax juliana</i> Ris, 1911	LC	LC	3
<i>Erythrodiplax latimaculata</i> Ris, 1911	LC	LC	2
<i>Erythrodiplax media</i> Borrer, 1942	LC	LC	1
<i>Macrothemis imitans</i> Karsch, 1890	LC	LC	13
<i>Macrothemis tenuis</i> Hagen, 1868	LC	LC	12
<i>Micrathyria almeidai</i> Santos, 1945	LC	LC	1
<i>Micrathyria catenata</i> Calvert, 1909	LC	LC	3
<i>Micrathyria hesperis</i> Ris, 1911	LC	LC	4
<i>Micrathyria pirassunungae</i> Santos, 1953	LC	LC	1
<i>Micrathyria stawarskii</i> Santos 1953	LC	LC	11
<i>Micrathyria unguata</i> Förster, 1907	LC	LC	1
<i>Orthemis discolor</i> (Burmeister, 1839)	LC	LC	1
<i>Pantala flavescens</i> (Fabricius, 1798)	LC	LC	1
<i>Perithemis tenera</i> (Say, 1840)	LC	LC	4
<i>Tamea binotata</i> (Rambur, 1842)	LC	LC	3
<i>Tamea rustica</i> (De Marmels & Racenis, 1982)	LC	LC	1
ZYGOPTERA			
Calopterygidae			
<i>Hetaerina longipes</i> Hagen in Selys, 1853	LC	LC	16
<i>Hetaerina rosea</i> Selys, 1853	LC	LC	11
<i>Mnesarete guttifera</i> (Selys, 1873)	LC	LC	59
Coenagrionidae			
<i>Acanthagrion aepiolum</i> Tennessen, 2004	LC	LC	2
<i>Acanthagrion gracile</i> (Rambur, 1842)	LC	LC	15
<i>Acanthagrion truncatum</i> Selys, 1876	LC	LC	8
<i>Argia lilacina</i> Selys 1865	LC	LC	3
<i>Argia modesta</i> Selys, 1865	LC	LC	30
<i>Argia mollis</i> Hagen, 1865	LC	LC	10
<i>Argia reclusa</i> Selys, 1865	LC	LC	7
<i>Argia smithiana</i> Calvert, 1909	LC	LC	2
<i>Argia sordida</i> Hagen in Selys, 1865	LC	LC	6
<i>Argia tinctipennis</i> Selys, 1865	LC	LC	19
<i>Argia tupi</i> Calvert, 1909	LC	LC	2
<i>Forcepsioneura sancta</i> (Hagen in Selys, 1860)	LC	LC	2
<i>Homeoura chelifera</i> (Selys, 1876)	LC	LC	7
<i>Ischnura capreolus</i> (Hagen, 1861)	LC	LC	3
<i>Oxyagrion basale</i> Selys, 1876	LC	LC	11
<i>Oxyagrion chapadense</i> Costa, 1978	LC	LC	3

to be continue...

Table 3. continue...

Suborder/Superfamily/Family/Species	IUCN	ICMbio	Abundance
<i>Oxyagrion microstigma</i> Selys, 1876	LC	LC	1
<i>Oxyagrion terminale</i> Selys, 1876	LC	LC	11
<i>Peristicta aeneoviridis</i> Calvert, 1909	LC	LC	14
<i>Telebasis carmesina</i> Calvert, 1909	LC	LC	18
Dicteriadidae			
<i>Heliocharis amazona</i> Selys, 1853	LC	LC	5
Heteragrionidae			
<i>Heteragrion cauei</i> Ávila Junior, Lencioni & Carneiro, 2017	VU	-	9
<i>Heteragrion triangulare</i> Hagen in Selys, 1862	DD	LC	4
Lestidae			
<i>Lestes forficula</i> Rambur, 1842	LC	LC	1
<i>Lestes paulistus</i> Calvert, 1909	LC	LC	1
Megapodagrionidae			
<i>Allopodagrion contortum</i> (Hagen in Selys, 1862)	LC	LC	14

(Callisto *et al.* 2004; Gouvêa *et al.* 2023). The decrease in diversity and abundance of these insects affects the entire ecological trophic chain in which they are embedded (Souza *et al.* 2018; Ferreira *et al.* 2023; Gouvêa *et al.* 2023). In this context, the creation of Conservation Units emerges as a fundamental measure to ensure the conservation of Brazilian biota and natural resources, as this is considered the most efficient tool to increase protection over ecosystems used for reproduction, refuge, and foraging of species, as well as to mitigate or eliminate anthropic actions. In fact, the establishment of a State Park in Luminárias region was also previously suggested (Lima *et al.* 2011).

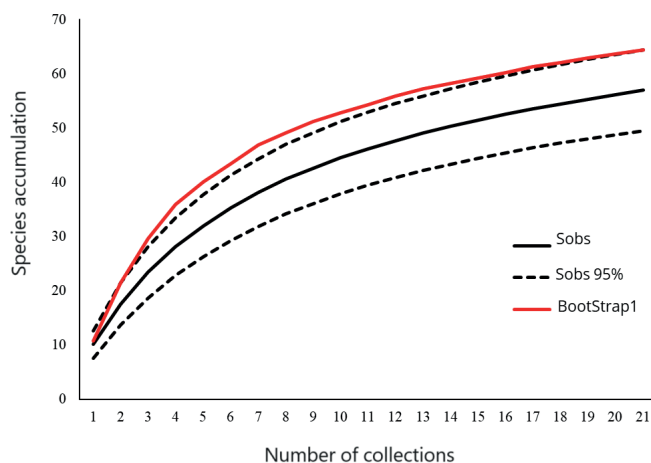


Figure 4. Species accumulation curve of dragonflies collected in Luminárias municipality. Observed species richness (within a 95% confidence interval) and the estimated species richness (Bootstrap 1) were applied.

The creation of the Conservation Unit (UC) is also justified as remnants of native vegetation are pressured by anthropogenic activities (Silva *et al.* 2011), contrasting with their significant ecological relevance (Lima *et al.* 2011). It also highlights the need to raise awareness among the local population and government about the species present in the area for the preservation of regional fauna, essential for maintaining its ecosystem, and thus reconciling economic development and conservation.

The forest remnants in the municipality of Luminárias harbor a significant richness of Odonata, including species at risk of extinction or with insufficient data for evaluation. The reduction or elimination of these areas may lead to the local extinction of these taxa. Therefore, there is an urgent need to establish management actions to protect the populations of these species.

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AUTHORS CONTRIBUTIONS

LGRA: Sampling, analysis of metadata and writing of the article; EDF: Sampling, analysis of metadata, species identification, and writing of the article; TMDO: Sampling, analysis of metadata and writing of the article; DSV: Sampling, analysis of metadata, species identification, and writing of the article; GCJ: Sampling, analysis of metadata and writing of the article; MMS: Conceptualization, sampling, analysis of metadata and writing of the article.

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CONFLICT OF INTEREST STATEMENT

The authors state that there is no conflict of interest.

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