

Odonata (Insecta) species richness in the Parque Estadual do Ibitipoca, Southeast Brazil

Caio Silva dos Anjos¹

Lucas Rocha Milani²

Marcos Magalhães de Souza³

Abstract

There are few studies on Odonata communities in Brazil, even in its most deeply studied states, such as Minas Gerais. Therefore, it is proposed the presentation of results on the Odonata species richness of Parque Estadual do Ibitipoca (Ibitipoca State Park), located at the Zona da Mata region in the Minas Gerais state, Brazil. This Conservation Unit is considered a priority area for the conservation of the state's invertebrates. The objective of this study was to know the number of species within the area. 100 hours of sampling were carried out, distributed amongst five campaigns of four consecutive days between November 2016 and July 2017. There were recorded 20 different species, including a new record for the state and one potential new species. Species richness was low due to the sampling being focused exclusively on lotic systems, and also to the environment's homogeneity. Despite the low number of species, Parque Estadual do Ibitipoca is relevant to the conservation of the Minas Gerais state's Odonata.

Keywords: Checklist. Conservation unit. Dragonflies. Minas Gerais. Rock Field.

Introduction

The order Odonata comprises insects popularly known as dragonflies and damselflies (MACHADO et al., 1998). This group is formed by the suborders Anisoptera and Zygoptera (KALKMAN et al., 2008), distributed in Brazil in 860 species of 14 families and 146 genera (PINTO 2019).

Odonata species are important agents in the trophic chains of freshwater environments and associated terrestrial ecosystems, as most species have aquatic larvae and winged adults, and in both phases, they are predators of many other animals (KALKMAN et al., 2008; RAMÍREZ 2010, RAFAEL et al., 2012). They are great organisms to be used as bioindicators of water-bodies quality, due to their unique characteristics and special physiological needs of the larvae (CLARK; SAMWAYS, 1996; BULÁNKOVÁ 1997; DUTRA; DE MARCO 2015, MENDES et al., 2017; MIGUEL et al., 2017).

Studies of dragonflies's diversity in Minas Gerais were carried out in areas of Rocky Field on Refúgio da Vida Silvestre das Libélulas, Serra de São José (BEDÊ et al., 2015); in Semideciduous Seasonal Forest Montana, on Baú Mata, Barroso municipality (SOUZA et al., 2013), in Bueno Brandão municipality (AMORIM 2017) and Poços de Caldas (SANTOS 1966); in Deciduous Seasonal Forest,

1 Universidade Federal do Paraná, Setor de Zoologia, Programa de Pós-graduação em Entomologia. Discente. Laboratório de Sistemática de Insetos Aquáticos. caioanjos_bd@hotmail.com

2 Instituto Federal de Educação, Ciência e Tecnologia do Sul de Minas Gerais (IFSULDEMINAS), Campus Inconfidentes. Biólogo Colaborador do Laboratório de Zoologia. lucassmilani@gmail.com.

3 IFSULDEMINAS, Campus Inconfidentes. Professor doutor. Laboratório de Zoologia marcos.souza@ifsulde Minas.edu.br (Autor para correspondência)

at the Refúgio da Vida Silvestre do Rio Pandeiros (SOUZA et al., 2017); in Ombrophilous forest associated to the semideciduous Montana forest in Viçosa, Marliéria and Parque Estadual do Rio Doce (FERREIRA-PERUQUETTI; DE MARCO JR. 2002); in Cerrado in the Parque Nacional da Serra do Cipó (ALMEIDA et al., 2013) and Sucupira Reservoir in the Uberabinha River, in Uberlândia municipality (BARBOSA et al., 2019); in Cerrado and Eucalyptus monoculture region in a preserved area of the Nova Fazenda Monte Carmelo, in the Triângulo Mineiro region (BORGES et al., 2019) and in Mixed Forest and Altitude Field in the Parque Nacional da Serra do Papagaio (DOS ANJOS 2017) (Table 1).

Table 1 – Relationship between sampled area and number of species in studies conducted with species inventories in the state of Minas Gerais, Brazil.

Area	Municipalities	Phytophysiognomy	Number of species	References
Mata do Baú	Barroso	Seasonal Semi-Deciduous Montane Forest	57	Souza et al. (2013)
Bueno Brandão	Bueno Brandão	Seasonal Semi-Deciduous Montane Forest	73	Amorin et al. (2018)
Preserved Area of Nova Fazenda Monte Carmelo	Araguari, Estrela do Sul, Indianópolis, Nova Ponte, e Romaria	<i>Cerrado</i> (tropical savanna) and Eucalyptus culture	36	Borges et al. (2019)
Poços de Caldas	Poços de Caldas	Seasonal Semi-Deciduous Montane Forest	58	Santos (1966)
Serra de São José	Tiradentes	<i>Campos Rupestres</i> (rock fields)	128	Bedê et al. (2015)
Parque Estadual do Rio Doce	Viçosa e Marliéria	Ombrophilous Forest associated to Semi-Deciduous Montane Forest	28	Ferreira-Peruquetti; De Marco Jr. (2002)
Parque Nacional Serra do Cipó	Itambé do Mato Dentro, Jaboticatubas, Morro do Pilar e Santana do Riacho	<i>Cerrado</i> (tropical savanna)	26	Almeida et al. (2013)
Parque Estadual Serra do Papagaio	Aiuruoca, Alagoa, Baependi, Itamonte e Pouso Alto.	Mixed Forest and <i>Campos de Altitude</i> (high-altitude shrubby grasslands)	68	Dos Anjos (2017)
Refúgio Estadual da Vida Silvestre do Rio Pandeiros	Bonito de Minas; Cônego Marinho e Januária.	Seasonal Deciduous Forest	48	Souza et al. (2017)
Sucupira Reservoir on the Uberabinha River	Uberlândia	<i>Cerrado</i> (tropical savanna)	43	Barbosa et al. (2019)

Source: Elaborated by the authors (2020).

Despite their ecological relevance, studies on the species richness and population distribution of Brazilian Odonata are scarce, even in areas with a significant sampling record, such as the Minas Gerais state (DE MARCO JR; VIANA 2005). Therefore, the objective of this study is to provide data

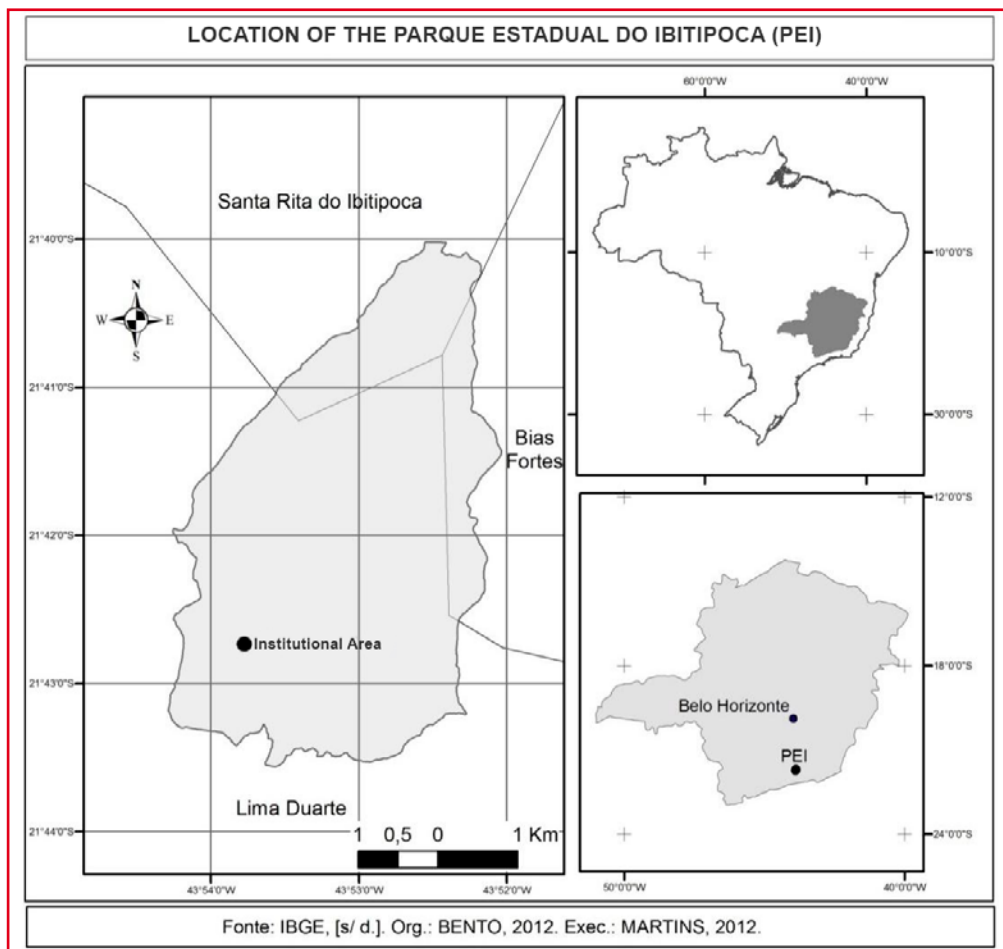
to supply the lack of information on the richness of odonates species for this Conservation Unit, and also for the Minas Gerais state.

Materials and methods

The study was conducted in Parque Estadual do Ibitipoca (from 21°40' to 21°44'S and 43°52' to 43°54'W), located in Zona da Mata, covering the municipalities of Lima Duarte, Santa Rita do Ibitipoca and Bias Fortes (Figure 1). The Conservation Unit was created in 1973, and is one of the most visited parks in the state of Minas Gerais, as well as one of the widely known in Brazil and one of the main tourist attractions in the region.

It has 1,488 hectares, presenting a mosaic of phytophysionomies (Neto *et al.*, 2007), being predominant the Rocky Fields and *Cerrado de Altitude* (RODELA 1998). The first one is characterized as an ecosystem with occurrence above 900 meters of altitude and is associated mainly with outcrops of quartzite, sandstone and iron ore, with a high rate of endemism and pseudoxeromorphic flora (MENEZES; GIULIETTI 1986). Altitude Fields are typical ecosystems of the mountains at highest points, close to 1,500 m. They occur generally associated with igneous or metamorphic rocks, such as granite and gneiss (VASCONCELOS 2011), and also vegetation adapted to the scarcity of water in the soil.

Figure 1 – Map of the location of the Parque Estadual do Ibitipoca and its location between the municipalities of Bias Fortes, Lima Duarte and Santa Rita do Ibitipoca.



Source: Adapted from Bento and Rodrigues (2013).

Five collection campaigns were carried out in the Parque Estadual do Ibitipoca, from November 2016 to July 2017, to cover all seasons of the year. Each of the campaigns was composed of four consecutive days, totaling 20 sampling days. The samples were collected daily between 10 AM and 4PM, adding to a total of 120 sample hours. Only adult individuals were collected, captured by an entomological network (SOUZA et al., 2013) with a diameter of about 30 cm.

After the capture, specimens were packed in philatelic envelopes of rigid and transparent vegetable paper (07.0 x 05.0 cm and 11.0 x 07.0 cm), and remained for a few hours until the feces were expelled and the digestive tract cleared. After death, the specimen in the envelope was completely immersed in PA acetone, where it remained for 12 to 16 hours. Acetone dissolves the lipids present in the exoskeleton and assists in the preservation of staining, important in taxonomy (CARVALHO 2007). The material was identified by Dr. Ângelo Parise Pinto, Federal University of Paraná (UFPR) where the specimens are deposited.

In order to evaluate the similarity of the species in the state, Jaccard index was used, based on all the diversity studies carried out in the state, being that of Santos (1966), Ferreira-Peruquetti and De Marco Jr. (2002), Almeida et al. (2013), Souza et al. (2013), Bedê et al. (2015), Amorim (2017), Dos Anjos (2017) e Souza et al. (2017). To evaluate the efficiency of collection, the species estimator Jackknife 1, in the Software R (R Development Core Team 2017) program. In both tests, species identified only up to gender were disregarded. The study was authorized by IEF-MG, license number 070/2016, SISBIO 53414-1.

Results and Discussion

We recorded 20 Odonata species in Parque Estadual do Ibitipoca. They belonged to 10 genera and seven families, and included a novel record for the state, *Peristicta guarellae* (Anjos-Santos and Pessacq 2013); other four species could only be identified up to the genus level (Table 2).

Table 2 – Families, species and catalog numbers for Odonata recorded at Parque Estadual do Ibitipoca, Minas Gerais state, Brazil.

Families	Species	Catalog number
Aeshnidae	<i>Castoraeschna januaria</i> (Hagen, 1857)	DZUP 498535
Aeshnidae	<i>Rhionaeschna eduardoi</i> (Machado, 1984)	DZUP 498536
Aeshnidae	<i>Rhionaeschna pauloi</i> Machado, 1984	DZUP 498537 to DZUP 498540
Aeshnidae	<i>Rhionaeschna planaltica</i> (Calvert, 1952)	DZUP 498541 to DZUP 498542
Aeshnidae	<i>Rhionaeschna</i> sp.	DZUP 498543
Gomphidae	<i>Progomphus complicatus</i> Selys, 1854	DZUP 498544
Libellulidae	<i>Erythrodiplax</i> sp.	DZUP 498545
Libellulidae	<i>Macrothemis tenuis</i> (Hagen, 1861)	DZUP 498546
Libellulidae	<i>Pantala flavescens</i> (Fabricius, 1798)	DZUP 498547 to DZUP 498548
Calopterygidae	<i>Hetaerina longipes</i> Hagen in Selys, 1853	DZUP 498549 to DZUP 498565
Coenagrionidae	<i>Argia claussemi</i> Selys, 1865 (Figure 2)	DZUP 498566 to DZUP 498602
Coenagrionidae	<i>Argia sordida</i> Hagen in Selys, 1865	DZUP 498603
Coenagrionidae	<i>Leptagrion</i> cf. <i>bocaiense</i> Santos, 1978	DZUP 498603
Coenagrionidae	<i>Oxyagrion evanescens</i> Calvert, 1909	DZUP 498604
Coenagrionidae	<i>Oxyagrion impunctatum</i> Calvert, 1909	DZUP 498605 to DZUP 498618
Coenagrionidae	<i>Oxyagrion terminale</i> Selys, 1876	DZUP 498619

(Continue...)

Table 2 – Continuation

Families	Species	Catalog number
Coenagrionidae	<i>Peristicta guarellae</i> Anjos-Santos and Pessacq, 2013	DZUP 498623 to DZUP 498631
Heteragrionidae	<i>Heteragrion</i> sp A (Figure 3)	DZUP 498620
Heteragrionidae	<i>Heteragrion</i> sp B	DZUP 498621
Megapodagrionidae	<i>Allopodagrion contortum</i> (Hagen in Selys, 1862)	DZUP 498622

Source: Elaborated by the authors (2020).

The most representative families regarding number of species were Coenagrionidae (n=7) and Aeshnidae (n=5). The other families presented 3 or less species, being Libellulidae (n=3), Heteragrionidae (n=2), Gomphidae (n=1), Megapodagrionidae (n=1) and Protoneuridae (n=1).

When compared to other studies on Odonata richness, the results of this shows lower species richness (SANTOS 1966, FERREIRA-PERUQUETTI; DE MARCO JR. 2002, ALMEIDA et al., 2013, SOUZA et al., 2013, BEDÊ et al., 2015, AMORIM 2017, DOS ANJOS 2017, RODRIGUES; ROQUE 2017, SOUZA et al., 2017).

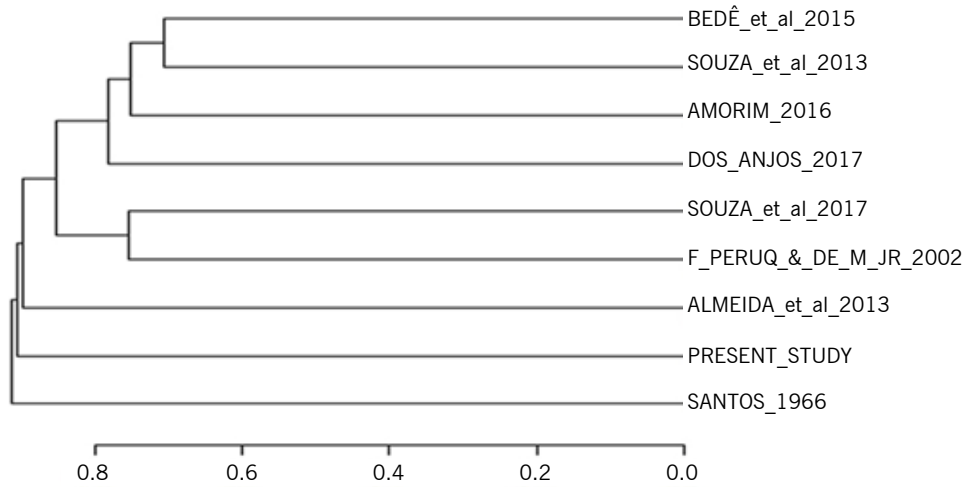
Figure 2 – *Argia clauseni*. **Figure 3** – *Heteragrion* sp A. Both species collected at Parque Estadual do Ibitipoca, Minas Gerais state, Brazil.



Source: Figure 2: Brunismann, A. G (2017). Figure 3: Souza, M. M (2017)

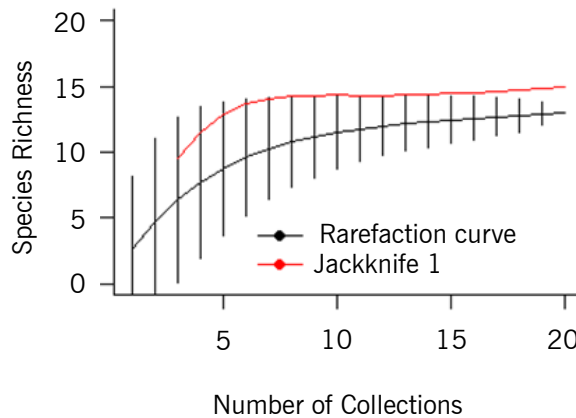
The present study showed highest similarity rates when paired with the Odonata fauna recorded by Almeida et al. (2013). In contrast, the lowest similarity was found when compared to Bedê et al. (2015) (Fig. 4). The sampling effort was deemed satisfactory, with the efficiency measured by the Jackknife 1 species estimator being over than 90% (Fig. 5).

Figure 4 – Dendrogram generated from Jackard similarity analyzes between the species richness shown for PEI (this study) and other studies on Odonata richness carried out at the Minas Gerais state, Brazil.



Source: Elaborated by the authors (2020).

Figure 5 – Rarefaction Curve of Species for the Odonata species of Parque Estadual do Ibitipoca, Minas Gerais state, Brazil.



Source: Elaborated by the authors (2020).

The species *Peristicta guarellae* had only been collected in Atlantic Forest areas before at the Parque Nacional da Serra da Bocaina (Serra da Bocaina National Park), between the Rio de Janeiro and the São Paulo states, and in the municipality of Ponta Grossa, Paraná state (ANJOS-SANTOS; PESSACQ 2013). In this study, a single specimen of that species was collected on March 4th, 2017.

The species *Leptagrion bocainense*, also represented by a single specimen, was recorded on October 12th, 2016. It was previously recorded by Santos (1979) and Costa and Mascarenhas (1998), who collected specimens from the species on Parque Nacional da Serra da Bocaina. In the study area, there were previous records only for nymphs of *L. bocainense*, which are deposited in Dr. Angelo A. B. Machado's private collection (MACHADO 2007).

The high number of Coenagrionidae species is explained by the family's status as the most species-rich in Brazil (PINTO 2016). It is widely distributed and the most species-rich within Zygoptera; it is also where the genus *Oxyagrion*, here represented by four distinct species, is the most representative, with a total 19 species.

The significant representation of Aeshnidae in this study's samples is due to two factors. Firstly, it is a numerous family, a pattern also observed in other studies (BEDÊ et al. 2015, RENNER et al. 2016, 2017), where it always figured among the three most sampled families. Secondly, according to Machado (1998), some of the family's species are abundant in *Campos Rupestres* in high altitudes and with waters with a certain concentration of Iron, both of which can be found in PEI (NUMMER 1991). In the same study, Machado (1998) states having found various individuals belonging to *Castoraeschna januarina* (Hagen 1867) and *Rhionaeschna eduardoi* (Machado 1984) species (also present in this study), hovering over small puddles on mountain areas in Minas Gerais state, near Belo Horizonte city, which have similar conditions to those described above.

The Libellulidae family, which frequently features among the families with higher species richness (BEDÊ et al. 2015, SOUZA et al. 2015a, AMORIM 2016, SOUZA et al. 2017), had only two species recorded in this study. This may be a reflex of the low environmental diversity in the PEI, since different species require distinct ecosystem structures and complexities in order to establish themselves (SOUZA et al., 2015b).

Some individuals could not be identified past genus level; they belong to three different genera and families. *Rhionaeschna* sp1 (Aeshnidae) belongs to the *decessus/serrana* complex. The individual from the *Erythrodiplox* genus (Libellulidae) was identified as a member of the *basaris* group. As for the *Heteragrion* genus (Heteragrionidae), there were recorded two morphospecies that might be new to science; the specimens are currently awaiting description by Dr. Ângelo Parise Pinto, from Universidade Federal do Paraná (UFPR). The presence of *Heteragrion* spp. on the list species indicates that the study area presents a good state of conservation, since species from the Heteragrionidae family react quickly to environmental changes and therefore act as bioindicators (MACHADO 1988, MONTEIRO-JUNIOR et al., 2015).

Three of the species collected in this work are listed in the Red Book of Endangered Fauna: *Castoraeschna januarina*, categorized as Vulnerable (VU) due to the progressive loss of being environment (streams with well-preserved riparian forest). *Rhionaeschna eduardoi*, characteristic of rupestrian field, is categorized as In Danger (EM) due to the progressive fragmentation of its habitat and decrease of the extension of occurrence thanks to the processes of land use, such as agriculture, urbanization and mining. Finally, the *Leptagrion bocainense*, classified as Vulnerable (VU) due to the fragmentation of their habitat, which puts their reproduction at risk as the larvae present phytotelmata habits develop exclusively in the rainwater accumulated in bromeliads.

Six of the species collected are also listed in The IUCN Red List of Threatened Species: *Allopodagrion contortum* (VON ELLENRIEDER, 2009), *Oxyagrion impunctatum* (VON ELLENRIEDER, 2009), *Macrothemis imitans* (PAULSON, 2017), *Progomphus complicatus* (VON ELLENRIEDER, 2009), *Rhionaeschna planaltica* (VON ELLENRIEDER, 2009) and *Pantala flavescens* (BOUDOT et al., 2016), all categorized as Least Concern (LC). The others registered species have a wide distribution in the state of Minas Gerais, occurring in different ecosystems (SOUZA et al., 2013; BEDÊ et al., 2015; AMORIM et al., 2018).

The low species richness found in PEI may be a result from sampling exclusively in lotic environments, since lentic systems such as pools and ponds could not be found in the area. This results in a decrease of ecosystem heterogeneity in study areas, negatively impacting Odonata species richness, as shown by Souza et al. (2015b). Furthermore, many species, genera and whole families exclusively require lentic environments for their reproduction habits and as nymph habitats (CARVALHO; NESSIMIAN, 1998).

The high similarity between this study and Almeida et al. (2013), who recorded 26 species in Parque Nacional do Cipó, is probably due to both studies being carried out in similar phytophysionomies, with a predominance of Rocky Field and of lotic over lentic systems; therefore, both studies show an absence of species from lentic-exclusive families.

The differences between this study's results and the those published by Bedê et al. (2015) may be due to the latter's data collection being carried out at Refúgio da Vida Silvestre Para Proteção das Libélulas, an area with different associated phytophysionomies such as Rocky Field, Seasonal Semi-deciduous Forests and *Cerrado*, and also by the presence of both lentic and lotic ecosystems, making up a more heterogeneous area and favoring a higher species richness than the one found in PEI. In addition, the sampling effort employed by Bedê et al. (2015) was significantly higher than the ones from this study, with more than five years of samples.

The high sampling efficiency reflected the similarity of the sampling sites, which were mostly lotic systems associated to Campos Rupestres; the same efficiency was not found in studies with more diverse ecosystems (SOUZA et al., 2013, BEDÊ et al., 2015). The PEI's relatively smaller area also played a part on that efficiency since it allowed sampling to be carried out throughout its whole extension and with many repetitions.

Conclusion

Despite its low species richness, the Parque Estadual do Ibitipoca hosts a new species for the Minas Gerais state and may even include two whole new species of the *Heteragrion* genus (Heteragrionidae). The area has thus been shown relevant for the state's Odonata fauna and highlights the importance of this Conservation Unit for the biota.

Acknowledgement

The authors would like to thank the Instituto Estadual de Florestas, SISBIO and the PEI's administration and staff for granting them access to the area; to IFSULDEMINAS – Campus Inconfidentes for transportation; to Dr. Mateus Clemente for his help with statistical analyzes; to the undergraduates who contributed in data collection. To Angela G. Brunismann for her help with the layout. To Frederico A. A. Lencioni for his consultation regarding species identification and for Dr. Ângelo Parise Pinto from the Universidade Federal do Paraná for the taxonomic species identification.

Riqueza de espécies de Odonata (Insecta) no Parque Estadual do Ibitipoca, Sudeste do Brasil

Resumo

Existem poucos estudos sobre as comunidades de Odonata no Brasil, mesmo nos estados mais estudados, como Minas Gerais. Dessa maneira, propõe-se a apresentação de resultados sobre a riqueza de espécies de Odonata do Parque Estadual do Ibitipoca, localizado na Zona da Mata de Minas Gerais, Brasil. Esta Unidade de Conservação é considerada área prioritária para a conservação dos invertebrados do estado. O objetivo deste estudo foi conhecer o número de espécies existentes na área. Foram realizadas 100 horas de amostragem, distribuídas em cinco campanhas em quatro dias

consecutivos entre novembro de 2016 e julho de 2017. Foram registradas 20 espécies diferentes, incluindo um novo registro para o estado e uma potencial nova espécie. A riqueza de espécies foi baixa devido à amostragem ser focada exclusivamente em sistemas lóticos e também devido à homogeneidade do ambiente. Apesar do baixo número de espécies, o Parque Estadual do Ibitipoca é relevante para a conservação das Odonatas de Minas Gerais.

Palavras-chave: Campo Rupestre. Checklist. Libélula. Minas Gerais. Unidade de conservação.

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Received: September 1st, 2019

Accepted: April 16, 2020