Biota Neotropica 20(1): e20190851, 2020
www.scielo.br/bn

biotaneotropica
ISSN 1676-0611 (online edition)
Inventory

Dragonflies and damselflies from the West of Minas Gerais, Brazil: checklist and new records

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VILELA, D. S., KOROIVA, R., TOSTA, T. H. A., NOVAES, M. C., GUILLERMO-FERREIRA, R. **Dragonflies and damselflies from the West of Minas Gerais, Brazil: checklist and new records**. Biota Neotropica. 20(1): e20190851. http://dx.doi.org/10.1590/1676-0611-BN-2019-0851

Abstract: The knowledge about the richness and distribution of Brazilian dragonflies is still being unveiled. Over the years, inventories, reviews, and descriptions have been made. These contributions, apart from the taxonomic value, also provide valuable data on the occurrence of species and their distributions, which are rarely accompanied by notes about natural history and behavior. Keeping this legacy in mind, we collected dragonflies between 2011 and 2019 in Minas Gerais state, which resulted in the registration of 90 species, 41 genera and 11 families. Our results also increase distribution data, an important tool for conservation actions, and provide additional information about habitat and biology of species.
Keywords: *Zygoptera, Anisoptera, biodiversity, species list, inventory.*

Libélulas do Oeste de Minas Gerais, Brasil: lista de espécies e novos registros

Resumo: O conhecimento sobre a riqueza e distribuição das libélulas do Brasil ainda está sendo desvelado. Ao longo dos anos, inventários, revisões e descrições foram feitas. Essas contribuições, além do valor taxonômico, também fornecem um conjunto de dados precioso sobre a ocorrência das espécies e suas distribuições, estas que raramente são acompanhadas de anotações sobre história natural e comportamento. Mantendo este legado em mente, nós realizamos coletas de libélulas entre 2011 e 2019 no estado de Minas Gerais, o que resultou no registro de 90 espécies, 41 gêneros e 11 famílias. Nossos resultados aumentam os dados de distribuição, uma ferramenta importante para ações de conservação, e fornecem informações sobre o habitat e a biologia das espécies.
Palavras-chave: *Zygoptera, Anisoptera, biodiversidade, lista de espécies, inventário.*

Introduction

Mainly in the last 80 years, the efforts spent on taxonomic studies (Santos 1944, 1945, 1950, Machado 1964, 1985, Machado et al. 1991, Lencioni 2005, 2006, 2017) and surveys (Dalzochio et al. 2011, Calvão et al. 2014, Vilela et al. 2016, Koroiva et al. 2017a, Koroiva et al. 2017b, Rodrigues & Roque 2017) helped to cover gaps on knowledge of Brazilian odonates. Of the over 6000 hitherto described Odonata species, about 1700 are known to occur in the Neotropical region, and over 800 are recorded for Brazil (von Ellenrieder 2009, Neiss 2012). Despite these efforts, there are many species yet to be described.

In the past five years, most of the surveys generated taxonomic and distributional novelties. In a recent expedition (Oct-Nov 2015) to Chapada dos Guimarães over 100 Odonata species, one of them a new species described and two larvae of *Argia* (Odonata:Coenagrionidae) were recorded (Vilela, et al. 2018a,b, Cezário et a. 2018). Furthermore, Calvão et al. (2014) recorded five species new to Mato Grosso State, Brazil; Dalzochio et al. (2018) reported 182 species and seven new records to the state of Rio Grande do Sul and Rodrigues & Roque (2017) recorded 33 species new for the state of Mato Grosso do Sul.

In the state of Minas Gerais (MG), however, few studies aimed to list Odonata species. Machado (1998) compiled records of 218 species for the entire state. Ferreira-Peruquetti & de Marco Jr (2002) found 17 species in the municipality of Viçosa. Souza et al. (2013) recorded 57 Odonata species in the Baú Forest, municipality of Barroso, and Bedê et al. (2015) collected 128 species in Serra de São José. More recently, Machado & Bedê (2015) described nine new species from a small area in Serra da Canastra, and Vilela et al. (2016) recorded three new species for the state, including one new to science (Guillermo-Ferreira et al. 2016).

Distributional studies are also important under a conservationist point of view since to determine if a given area needs conservational actions, the local fauna have to be taken into account. In this sense, the International Union for Conservation of Nature (IUCN 2019) relies on several types of species data, such as population size and distributional range, in order to assess the conservation status of species around the globe. IUCN is a global program for evaluating the conservation status of plant and animal species and providing some information on species habitat and biology can help to increase those conservationist actions (IUCN 2019). However, if there is a gap on the distributional data of a given species, it makes the IUCN work difficult or even impossible, disabling actions that may be taken towards the conservation of the species and its habitat. Furthermore, considering the last two great ecological disasters caused by mining in Minas Gerais (see Freitas et al. 2019), studies on the local biodiversity are crucial to know what we lose with such environmental crimes (e.g. MMA/IBAMA 2015).

Not only the species are understudied, but also some phytophisiognomies are almost unexplored. In the west of Minas Gerais, the predominant biome is the Cerrado, which presents a great array of freshwater ecosystems. Within this biome, the Veredas play an important role on the hidrology, being consisted by permanently water saturated soil and a dense vegetation, including the palm tree *Mauritia flexuosa* L (Fonseca 2005). Additionally, Veredas are an important source of shelter and food from insects to fishes and birds, playing an important role on the ecological balance in the Cerrado. Odonates are little explored within such areas, despite recent studies show that this ecosystem holds a great number of species of the order (Vilela et al. 2016; Barbosa et al. 2019; Borges et al. 2019).

The main objective of this study is to increase the knowledge of the geographical distribution of Odonata species.. For this, here we compile data on species from the western part of Minas Gerais State and make our database available to the academic community. In summary, our study aimed to contribute to the species conservation actions, such as the IUCN Red List of Threatened Species™ and the Latin-American Odonatological Society evaluations, which many times rely on species distributional data for assessments.

Material and methods

1. Field sampling sites and methodology

Altogether, we surveyed 49 localities in ten municipalities (Figure 1):

- Campina Verde (Altitude 494m): Chácara (CVC, -19.5476, -49.4936; small pond, formed by the damming of a Vereda, Figure 2d) and Granja (CVG, -19.5357, -49.5062; small pond connected to a Vereda), both sampled in February 2013.
- Guarda-Mor (Altitude 616m): Ponto 1 (GMP1, -17.7828, -47.1301; small stream) and Ponto 2 (GMP2, -17.7726, -47.1332; small stream), both sampled in December 2014.
- Ituiutaba (Altitude 605m): Lagoa Temporária (ITBL, -18.9776, -49.4103; temporary pond) in April 2014; Ribeirão São Lourenço (ITBSL, -18.9853, -49.4179 and -19.0611,-49.3213; medium order stream, Figure 2e) sampled in December 2013 and April 2014; Rio Tijuco (ITBT, -18.9418,-49.4768; -18.9209,-49.5664 and -18.9525,-49.3377; medium sized river, Figure 2f) sampled in December 2011 and March 2012; Estância Paraíso (EPA, -18.9522, -49.3399; small stream connected to a river, Figure 2g) sampled in April 2014.
- Matutina (Altitude 1060m, Figure 2h): Matutina 1 (MAT1, -19.1377, -46.0669; small stream connected with a Vereda), Matutina 2 (MAT2, -19.1251, -46.0568; small pond), Matutina 3 (MAT3, -19.1563, -46.0369; small stream) and Matutina 4 (MAT4, -19.1221, -46.0673; small stream) all sampled in March 2015.
- Paracatu (Altitude 688m): Ranchão (PAR, -16.8608, -46.9811; stream connected with a Vereda, Figure 2c) sampled in July 2014.
- Prata (Altitude 631m): Rodovia (PRA, -19.3210, -48.9454; stream connected with a Vereda) sampled in October 2012.
- São Roque de Minas, Serra da Canastra (Altitude 819-1300m): Cachoeira Rio do Peixe (CRP, -20.2569, -46.4096; small stream by a waterfall, Figure 2a), Aqueduto (AQD, -20.2648, -46.3968; stream near to a Vereda), Riacho Costela de Vaca (RCV, -20.2658, -46.3957; stream near to a Vereda), Cerradão (CER, -20.1914, -46.3858; stream near to a Vereda, Figure 2b), Barro Sujo (BS, -20.2145, -46.3808; small stream), Cerca elétrica (CE, -20.2385, -46.3847; stream near to a Vereda), Espraiado (Subida) (ESS, -20.2411, -46.3857; stream near to a Vereda), Rio São Francisco (RSF, -20.3330, -46.4361; large river), Água Branca (AGB, -20.2922, -46.3658; small stream), Cachoeira da Chinela (CHI, -20.3002, -46.3955; stream by a waterfall), Casca D'anta (CCD, -20.2974, -46.5227; stream by a waterfall), Rolinho (RL, -20.1706, -46.5615; small stream near a Vereda), Nascente (NAS, -20.2433, -46.4463;

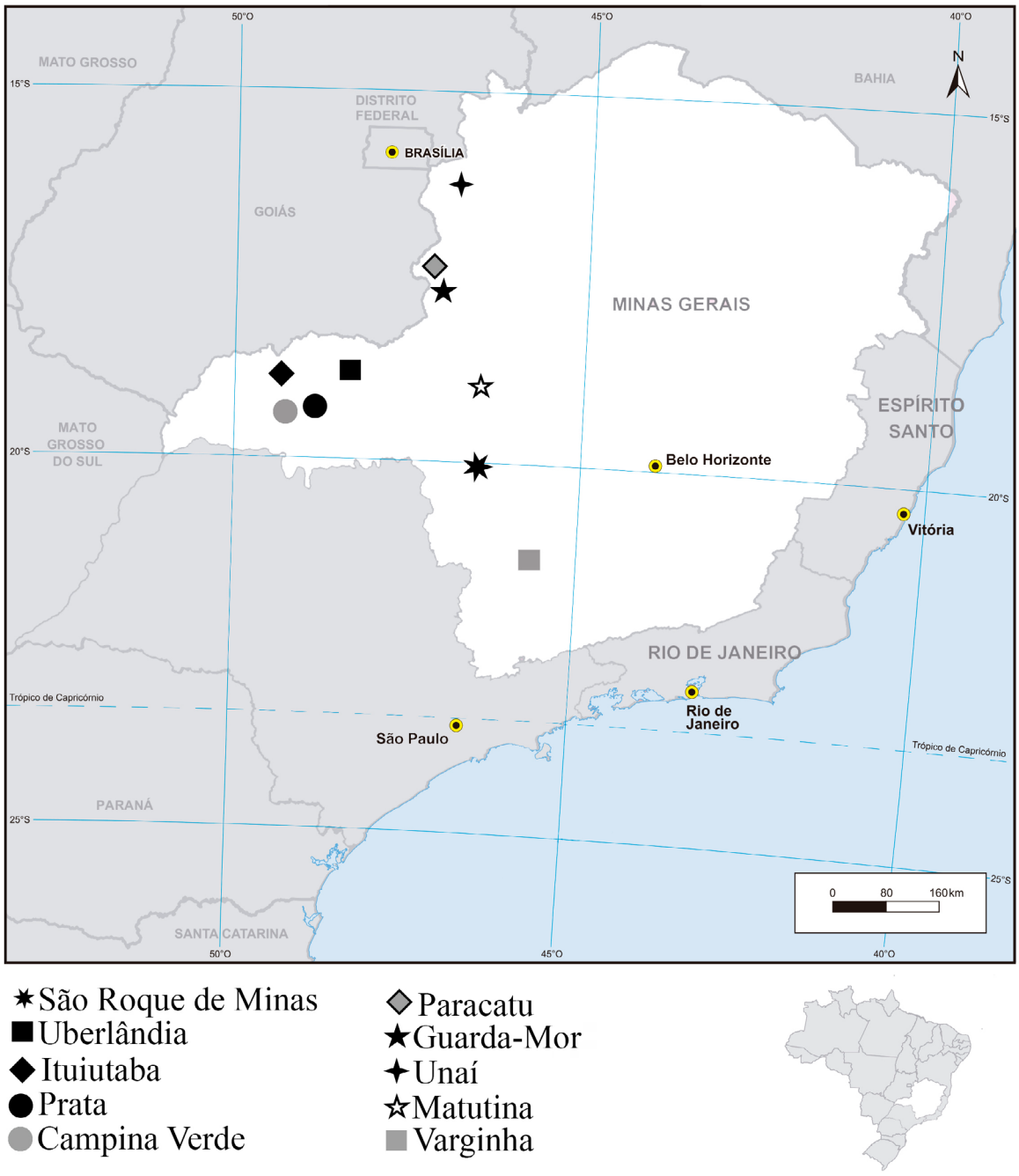

Figure 1. Map of Minas Gerais state, southeast Brazil, showing the ten sampled municipalities.

small stream connected to a Vereda), Ponte 1 (PO1, -20.2402, -46.5875; small stream connected to a Vereda), Ponte 2 (PO2, -20.2325, -46.6083; small stream connected to a Vereda), Quintal da Canastra (QUI, -20.3282,-46.5038; large pond), Cachoeira da Capivara (CPV, -20.6287,-46.2863; large stream by a waterfall), Lago Tio Zezico (ZZC, -20.3121,-46.5319; small pond), Córrego Tio Zezico (ZZC, -20.3116,-46.5324; stream), Lago P31 (P31, -20.1656,-46.6877; two small ponds within a Vereda), Riacho Sr. Vicente (VCT, -20.3033,-46.5492; ; small stream connected to a Vereda), Córrego Guariba (GUA, -20.3017,-46.5483; small stream near a Vereda), Córrego Passageiro (PSG, -20.2668,-46.5554; small stream with rocky bottom), Córrego Rasga Canga (CAN, -20.1761,-46.5603; stream by a waterfall), Portaria Sul (SUL, -20.3063,-46.5236; small stream), Portaria 2 (PR2, -20.1523,-46.6605; small stream by a waterfall), Centro de Visitantes (VIS, -20.2541,-46.4168; small stream) sampled in May and October 2017, March and November 2018 and April 2019.

- Uberlândia (Altitude 863m): Marileuza (UDI,-18.8712, -48.2481; small stream near a Vereda, which nowadays is turning to a habitation area) sampled in February 2015.

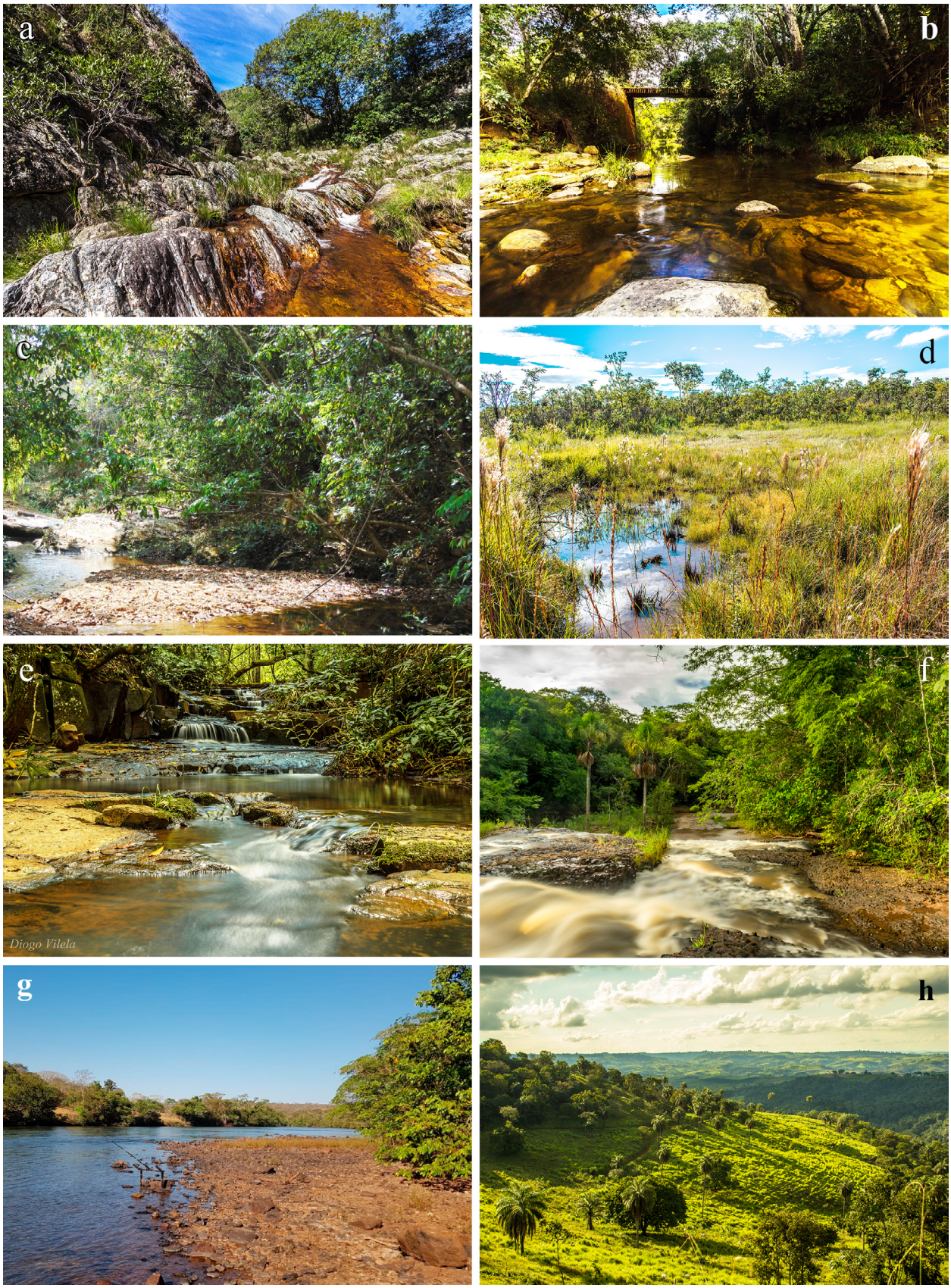

Figure 2. Some of the sampled sites in this study: a. Cachoeira Rio do Peixe (CRP), São Roque de Minas; b. Cerradão (CER), São Roque de Minas; c. Ranchão (PAR), Paracatu; d. Chácara (CVC), Campina Verde; e. Ribeirão São Lourenço (ITBSL), Ituiutaba; f. Rio Tijuco (ITBT), Ituiutaba; g. Estância Paraíso (EPA), Ituiutaba; h. Landscape between Matutina 3 (MAT3) and Matutina 4 (MAT4), Matutina.

- Unaí (Altitude 640m): Lagoa-Riacho (UNAI, -16.4822, -47.4149; medium order river and a pond) sampled in July 2014.
- Varginha (Altitude 915m): Sítio Juriti (SRI, -21.5854, -45.4070; small pond), Carro Velho (CAR, -21.5901, -45.3721; small stream), Lagoa Soberana de Minas Jorge (JOR, -21.6289, -45.4342; small stream and pond), Faz. Tachos (TCH, -21.6154, -45.4803; small stream) sampled in June 2018.

The collections were made *ad libitum* in different hours of the day, for at least one hour per site, always between 8:00 to 14:00h. An entomological net was used to collect the specimens and they were placed in individual paper envelopes. The collection authorization process was issued by IBAMA, through SISBio system under the numbers 53026-3 and 54386-6. The identifications were made using the keys of Lencioni (Lencioni 2005, 2006, 2017) and Garrison et al. (2006, 2010). The specimens collected are deposited in the Laboratory of Ecological Studies on Ethology and Evolution (LESTES, UFSCar), São Carlos, São Paulo and in the personal collection of Frederico Lencioni in Jacareí, São Paulo.

During fieldwork, we observed and noted the following behavioral traits: (i) territoriality status, (ii) mate-guarding behavior and (iii) oviposition behavior. Such behavioral traits are important because they reveal important aspects of reproductive tactics, habitat occupancy and selection, competition and even larval development (Corbet 1999).

When not possible to notice behavioral traits on the moment of collections, we searched for such information on the literature on two online platforms (Google scholar: https://goo.gl/MtXqZN; Scopus: https://goo.gl/2F36gs) with the terms "*species name*", "behavior", "behaviour". The terms were used all together, in different orders and separately along with the species names. For example: "*Tigriagrion aurantinigrum*" "behavior" "behaviour" or solely "*Tigriagrion aurantinigrum*".For every sampled species, we checked the IUCN conservation status (iucnreslist.org) (IUCN 2019). When a species is assessed by specialists, a code is given to represent its conservational status. For example, if a species is lacking distributional data and nothing much is known of its conservational situation, it is given to it a data deficient status, or DD. Other classification status are: LC (least concern), when a species is well distributed, occurring in many localities, including protected areas; NT (near threatened), when its assessment indicates any degree of conservational threat, usually applied to species occurring near expanding urban areas, which can be threatened in a near future; VU (vulnerable), species facing extinction risk in nature, with a limited distributional range (<5000 km²) in areas threatened by human activities; CR (critically endangered), species inhabiting areas less than 100 km², occurring in usually one locality, often threatened by human activities.

The map was adapted from IBGE - Brazilian Geography and Statistics Institute (2019) using Adobe Photoshop 2017.1.1. Habitus scan of species was made using an EPSON V600 Perfection and posterior plate assembling using Adobe Photoshop 2017.1.1. Photographs of the sampling sites were all made by the authors, except for (Fig. 3g), courtesy of Edson Soares dos Santos.

Results

1. *Sampled species*

We collected individuals from 11 families, 41 genera and 90 species (Table 1; Figure 3a−l). The family Libellulidae was the most representative of Anisoptera, with 13 genera and 27 species, whereas Coenagrionidae was the most specious family of Zygoptera, with 12 genera and 35 species (Table 1). PAR was the most speciose site with 16 records, whereas NAS recorded 15 species and ITBT and UNAI recorded 14 species each. On the other hand, VIS and RL were the least specious site with one species each (Table 2).

Table 1. Representation of each collected family by genera and species in 49 sampling points distributed in the State of Minas Gerais, Brazil.

Anisoptera		**Number of genera**	**Number of species**
	Aeshnidae	5	5
	Corduliidae	1	1
	Gomphidae	3	4
	Libellulidae	13	27
Zygoptera			
	Calopterygidae	2	7
	Coenagrionidae	12	35
	Dicteriadidae	1	1
	Heteragrionidae	1	4
	Lestidae	1	3
	Megapodagrionidae	1	1
	Protoneuridae	1	2
Total	11 Families	41	90

Furthermore, Machado (1998) reported 218 Odonata species to Minas Gerais state. Therefore, adding new species descriptions (n = 29) and new records (n = 22) since 1998, the number raises to 269 species to Minas Gerais (Table 3).

2. *First records and new species*

We found two new records of odonate species for Minas Gerais, one belonging to Coenagrionidae and the other to Calopterygidae: *Neoneura waltheri* Selys and *Hetaerina hebe* Selys, respectively. Also, we found a new species from the Heteragrionidae family: *Heteragrion denisye* Vilela, Koroiva and Guillermo-Ferreira.

Hetaerina hebe Selys, three males (Figure 3h): This species is recorded in the states of Rio de Janeiro (Santos 1970) and São Paulo (Lencioni 2017). Our specimens of *H. hebe* were found in streams with channel shading by riparian vegetation and presence of rapids in sampling sites of Varginha and Serra da Canastra. We have noticed females perform endophytic oviposition.

Neoneura waltheri Selys, one male (Figure 3i): *Neoneura waltheri* occurs in Brazil and Argentina. There are records of this species in the

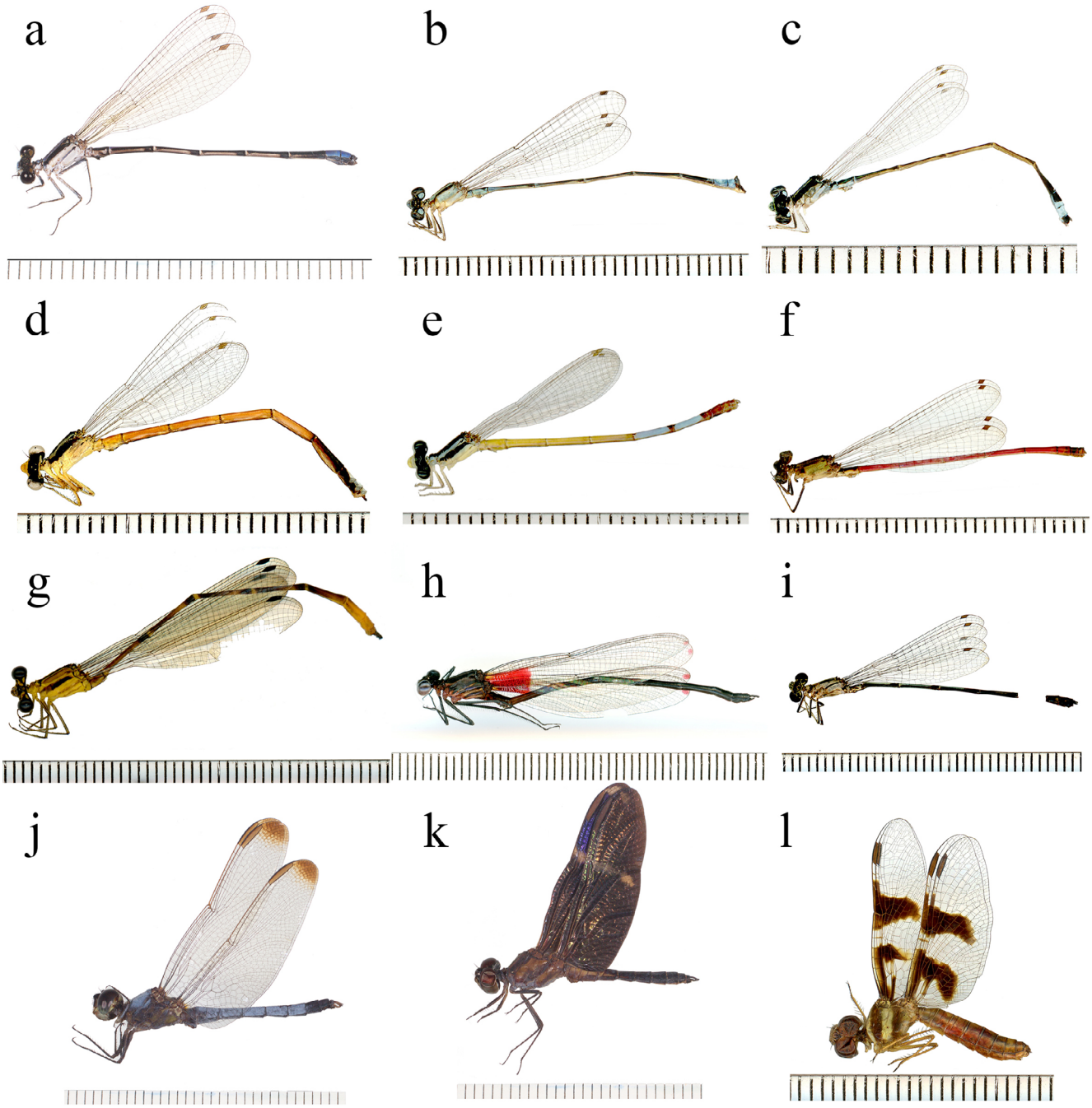

Figure 3. Habitus scan of some species sampled in our expeditions: a. *Argia lilacina* Selys; b. *Acanthagrion aepiolum* Tennessen; c. *Ischnura capreolus* Hagen; d. *Minagrion waltheri* Selys; e. *Minagrion franciscoi* Machado & Bedê; f. *Oxyagrion chapadense* Costa; g. *Heteragrion triangulare* Hagen in Selys; h. *Hetaerina hebe* Selys; i. *Neoneura waltheri* Selys; j. *Erythrodiplax ana* Guillermo-Ferreira, Vilela, Del-Claro & Bispo; k. *Zenithoptera lanei* Santos; l. *Perithemis mooma* Kirby.

states of Rio de Janeiro and Paraná. Specimens collected at the margins of the Tijuco River in Ituiutaba were perched in a clump of *Elionurus* sp. Jurzitza (1981), made some observations on specimens in National Park of Iguazu, Argentina. We have noticed females perform endophytic oviposition in tandem with the male, at running waters.

Heteragrion denisye Vilela, Koroiva and Guillermo-Ferreira, one male: this species was recently described (Vilela et al. 2019) inhabiting altitude fields within the Serra da Canastra National Park. We only found one specimen despite sampling the type location in two occasions. This species is peculiar because was found in small bushes in an open area, whereas other *Heteragrion* species are known to inhabit shaded areas with gallery woods.

3. *Endemic and peculiar species*

In addition to these records, we collected some of the endemic species of Serra da Canastra described by Machado & Bedê (2015),

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Table 2. Sampled localities with the respective number of species collected on each site.

Locality	Code	N. Species
Paracatu	PAR	16
Nascente	NAS	15
Rio Tijuco	ITBT	14
Unaí	UNAI	14
Ribeirão São Lourenço	ITBSL	12
Marileuza	UDI	12
Matutina Ponto 2	MAT2	10
Quintal da Canastra	QUI	10
Cachoeira da Capivara	CPV	9
Cachoeira Rio do Peixe	CRP	9
Aqueduto	AQD	8
Cerradão	CER	8
Rio São Francisco	RSF	8
Lago Tio Zezico	LZZ	8
Córrego Tio Zezico	ZZC	7
Carro Velho	CAR	7
Fazenda Sr. Gilberto	GIL	7
Granja	CVG	7
Guarda Mor Ponto 1	GMP1	7
Matutina Ponto 4	MAT4	7
Prata	PRA	7
Lago P31	P31	6
Guarda Mor Ponto 2	GMP2	6
Matutina Ponto 1	MAT1	6
Riacho Costela de Vaca	RCV	6
Espraiado (Subida)	ESS	6
Cachoeira da Chinela	CHI	6
Lagoa Temporária	ITBL	5
Matutina Ponto 3	MAT3	5
Ponte 1	PO1	5
Ponte 2	PO2	5
Riacho Sr. Vicente	VCT	5
Fazenda dos Tachos	TCH	4
Chácara	CVC	4
Barro Sujo	BS	4
Casca D'Anta	CCD	4
Cerca	CE	4
Córrego Guariba	GUA	4
Córrego Passageiro	PSG	4
Córrego Rasga Canga	CAN	4
Portaria Sul	SUL	4
Portaria 2	PR2	3
Sítio Juriti	SRI	3
Lagoa S. M. Jorge	JOR	3
Água Branca	AGB	3
Alojamento (P17)	P17	2
Estância Paraíso	EPA	2
Centro de Visitantes	VIS	1
Rolinho	RL	1

Table 3. List of new Odonata species and new records to the state of Minas Gerais, published after 1998.

Author	Year	Type of data	Number of records
Machado	2000	New species	1
Costa et al.	2000	New species	1
Machado	2002	New species	1
Tennessen	2004	New species	1
Machado	2005a	New species	1
Machado	2005b	New species	1
Garrison	2006	New species	1
Machado	2006	New species	1
Machado & Bedê	2006	New species	1
Machado	2007a	New species	1
Machado	2007b	New species	1
Pessacq & Costa	2007	New species	2
Costa et al.	2009	New species	1
Santos et al.	2010	New species	1
Machado	2010	New species	1
Almeida et al.	2013	New record	1
Machado	2014	New species	1
Machado	2015	New species	1
Machado & Bedê	2015	New species	7
Bedê et al.	2015	New records	6
Guillermo-Ferreira et al.	2016	New species	1
Vilela et al.	2016	New record	1
Pinto & Almeida	2016	New species	1
Ávila-Júnior et al.	2017	New species	1
De Souza et al.	2017	New records	7
Borges et al.	2018	New records	1
Barbosa et al.	2019	New records	6
Vilela et al.	2019	New species	1
This study		New records	2
		Total	**51**

such as *Franciscagrion franciscoi* Machado & Bedê, *Franciscagrion longispinum* Machado & Bedê, *Franciscobasis franciscoi* Machado & Bedê, *Franciscobasis sonia* Machado & Bedê, *Minagrion franciscoi* Machado & Bedê (Fig. 2e) and *Oxyagrion franciscoi* Machado & Bedê. Despite the extensive sampling effort throughout western region of Minas Gerais, these species remain restricted to the Serra da Canastra National Park.

Given our large sampling size, some hard to sample species were collect in Serra da Canastra such as *Limnetron debile* Karsch and *Neocordulia volxemi* Selys, both at sites with running water and little shaded areas. Additionally, the larvae of *Castoraeschna corbeti* Carvalho, Pinto & Ferreira, a possible new Libellulidae species and the hitherto undescribed female of *Mnesarete rhopalon* Garrison were also sampled.

4. *Behavioral and ecological traits*

As most of the collections were made in the course of an hour, freshwater habitat selection was the only ecological trait that could be inferred for all species. **We emphasize that some of the observed traits were already reported in the literature and the data observed by us are highlighted in bold** (Table 4).

Data on behavioral traits are derived from personal observations or from literature: territoriality status, mate-guarding behavior and oviposition behavior. Of all traits possible, however, 168 (63%) were not found on the literature or observed in our field study (*i.e*. ND). Moreover, 40 (45%) of all species had no behavioral information available. Territoriality was the most representative trait, determined for

Table 4. Odonata species collected in this study with information about freshwater habitat selection, territoriality status, mate-guarding (MGB) and oviposition behavior. LE: lentic habitat; LO: lotic habitat; FA: female alone; IT: in tandem; NC: no contact; T: territorial; NT: non-territorial; EX: exofitic oviposition; END: endofitic oviposition; PE: percher; FL: flier; IUCN Status: LC (least concern), DD (data deficient); ND: no data recorded in the study area or literature. * First record to Minas Gerais State; ** Under evaluation by IUCN specialists. **Traits in bold were observed in this study**.

Species	Habitat	Territoriality	MGB	Oviposition	IUCN status	Sampled localities	References other than this study
Acanthagrion aepiolum	**LO**	ND	ND	ND	ND	CER, GMP1, MAT2, MAT4, PAR, GIL	Tennessen, 2004; von Ellenrieder & Garrison, 2007; Muzón et al. 2008
Acanthagrion gracile	**LO, LE**	ND	IT	**END**	ND	CER, CVG, ESS, GMP1, MAT3, PAR, SRI, CAR, TCH, QUI, LZZ	Paiva-Silva et al. 2010; Lencioni, 2011; Calvão et al. 2014; Nobre & Carvalho, 2014
Acanthagrion lancea	**LO, LE**	**NT**	**FA**	**END**	ND	CVG, ITBSL, MAT4, PAR	von Ellenrieder & Garrison, 2007; von Ellenrieder, 2009b; Paiva-Silva et al. 2010; Vilela et al. 2016
Acanthagrion temporale	**LO, LE**	ND	ND	ND	ND	RSF, P31	Leonard, 1977; Souza, 2003
Acanthagrion truncatum	**LE**	NT	**IT**	**END**	LC	MAT2, MAT4, QUI, LZZ	von Ellenrieder, 2009; Guillermo-Ferreira & Del-Claro, 2012a, 2013; Vilela et al. 2016
Allopodagrion contortum	**LO**	ND	ND	ND	LC	GUA, VCT	von Ellenrieder, 2009
Archaeogomphus infans	**LE**	ND	ND	ND	ND	ZZC	Barbosa et al. 2019
Anax amazili	**LE**	ND	ND	END	ND	GMP2	Convey, 1989; von Ellenrieder & Garrison, 2007
Argia claussenii	**LO**	ND	ND	ND	ND	CPV, GUA, VCT	Lencioni, 2017
Argia croceipennis	**LO**	ND	ND	ND	LC	NAS	Costa et al. 2008; von Ellenrieder, 2009; Dalzochio et al. 2011
Argia lilacina	**LO**	ND	ND	ND	ND	AQD, RCV, CER, CE, CRP, CHI, CAR, PO2, PR2	Machado, 1988; Machado & Bedê, 2015
Argia modesta	**LO**	ND	ND	ND	ND	CPV, VIS, SUL, ZZC, CAN, VCT, PR2	Ferreira-Peruquetti, & Trivinho-Strixino, 2003
Argia mollis	**LO**	ND	ND	ND	ND	CAR, GIL, SUL, CAN	Cezário et al. 2018
Argia reclusa	**LO**	T	**IT, FA**	**END**	ND	ITBT, MAT1, MAT2, PAR, EPA, GIL, TCH, CPV	Guillermo-Ferreira & Del-Claro, 2012b; Vilela et al. 2016
Argia smithiana	**LO**	ND	ND	ND	ND	CRP, ITBSL, ITBT, MAT2, CPV	Vilela et al. 2016
Argia tamoyo	**LO, LE**	ND	ND	ND	ND**	AQD, CRP, RCV, CER, ESS, RSF, AGB, CHI, CAN	Dalzochio et al. 2011
Brechmorhoga praedatrix	**LO**	ND	ND	ND	LC	CPV	Fleck, 2004; von Ellenrieder, 2009
Cacoides latro	**LE**	ND	ND	ND	ND	GMP2	Borges et al. 2019
Castoraeschna januaria	**LO**	ND	ND	ND	ND	CRP, P17	Carvalho et al. 2009
Coryphaeshna adnexa	**LE**	ND	ND	ND	LC	UNAI	von Ellenrieder & Garrison, 2007; Paulson, 2009; Vilela et al. 2016
Cyanallagma ferenigrum	**LE**	**T**	ND	END	DD	MAT4	von Ellenrieder, 2009a; Vilela et al. 2016
Diastatops obscura	**LE**	T	**NC**	**EXO**	ND	CVC	Vilela et al. 2016
Epipleoneura machadoi	**LO**	ND	**IT**	**END**	ND	UNAI	Rácenis, 1960; Lencioni, 2017

 http://dx.doi.org/10.1590/1676-0611-BN-2019-0851

Continuation Table 4.

Species	Habitat	Territoriality	MGB	Oviposition	IUCN status	Sampled localities	References other than this study
Epipleoneura williamsoni	**LO**	NT	**IT**	**END**	LC	ITBSL, UNAI	von Ellenrieder, 2009; Vilela et al. 2016
Erythemis credula	**LE**	ND	ND	ND	ND	ITBT	Vilela et al. 2016
Erythemis vesiculosa	**LE**	ND	FA	END	LC	GMP2, UDI, UNAI	von Ellenrieder & Garrison, 2007; Paulson, 2009; Vilela et al. 2016
Erythrodiplax ana	**LE**	T	**NC**	**EXO**	ND**	NAS, CCD	Guillermo-Ferreira et al. 2016; Vilela et al. 2016
Erythrodiplax castanea	**LE**	ND	ND	ND	ND	AQD, CAR, JOR, CPV, ZZC, QUI	Brooks, 1989; von Ellenrieder, 2011; Monteiro-Junior et al. 2013; Borges et al. 2019
Erythrodiplax fusca	**LO, LE**	T	NC	EXO	ND	GMP1, ITBL, ITBT, MAT3, PAR, UDI, AQD, CER, RSF	Convey, 1989; Louton et al. 1996; Paiva-Silva et al. 2010; Nobre & Carvalho, 2014; Vilela et al. 2016
Erythrodiplax juliana	**LE**	T	NC	EXO	LC	ITBL, MAT2, PAR, CRP, AQD, RCV, ESS	von Ellenrieder, 2009; Vilela et al. 2016
Erythrodiplax latimaculata	**LE**	T	NC	EXO	ND	GMP1, ITBT, MAT2, MAT3, UNAI	Calvão et al. 2013; Vilela et al. 2016
Erythrodiplax lygaea	**LE**	ND	**FA**	**EXO**	LC	CAN	von Ellenrieder, 2009
Erythrodiplax pallida	**LO, LE**	ND	ND	EXO	LC	NAS	Costa et al. 2001; von Ellenrieder, 2009; Del Palacio & Muzon, 2016
Erythrodiplax umbrata	**LE**	T	FA	EXO	ND	CVG, PAR, PRA, UDI, UNAI	Garcia-Diaz, 1937; Convey, 1989; Paulson, 1998; Von Ellenrieder & Garrison, 2007; Vilela et al. 2016
Franciscagrion franciscoi	**LO, LE**	NT	**IT**	**END**	ND**	NAS	Machado & Bedê, 2015
Franciscagrion longispinum	**LO, LE**	NT	ND	ND	ND**	NAS	Machado & Bedê, 2015
Franciscobasis franciscoi	**LO, LE**	NT	ND	ND	ND**	NAS	Machado & Bedê, 2015
Franciscobasis sonia	**LO, LE**	NT	ND	ND	ND**	NAS	Machado & Bedê, 2015
Heliocharis amazona	**LO**	T	ND	ND	ND	ITBSL, PAR	Dunkle, 1991; Louton et al. 1996
Hetaerina hebe*	**LO**	T	ND	**END**	LC	TCH, SUL, VCT	von Ellenrieder, 2009
Hetaerina longipes	**LO**	T	ND	ND	ND	ITBT, PAR	Pestana et al. 2018
Hetaerina rosea	**LO**	T	IT, NC	EXO	ND	ITBSL, ITBT, MAT3, PAR, EPA, CAR, GIL, CPV, ZZC	Von Ellenrieder & Garrison, 2007; Paiva-Silva et al. 2010; Guillermo-Ferreira & Del-Claro, 2011; Vilela et al. 2016
Hetaerina simplex	**LO**	ND	ND	ND	ND**	CRP, AQD, RCV, CER, BS, ESS, RSF, AGB, CHI, PSG, CCD, QUI, NAS, PO2, PR2	Garrison, 1990; Lencioni, 2017
Heteragrion aurantiacum	**LO**	T	ND	ND	LC	MAT2, UNAI	Von Ellenrieder, 2009
Heteragrion denisye	**LO**	ND	ND	ND	ND	PO2	Vilela et al. 2019
Heteragrion gracile	**LO**	ND	ND	ND	ND	CAR, SUL	Machado, 2006; Lencioni, 2013
Heteragrion triangulare	**LO**	ND	ND	ND	ND	CER, GUA	This study
Homeoura chelifera	**LO**	NT	IT	ND	ND	MAT4, JOR	von Ellenrieder & Garrison, 2007; Paiva-Silva et al. 2010; Vilela et al. 2016
Idiataphe longipes	**LE**	ND	ND	ND	ND	ZZC, QUI	Oldrini & Mascarenhas, 2005; Borges et al. 2019
Ischnura capreolus	**LE**	NT	**FA**	**END**	ND	MAT2, MAT4, PRA, UDI, UNAI, RSF, JOR, LZZ	Paiva-Silva et al. 2010; Nobre & Carvalho, 2014; von Ellenrieder & Garrison, 2007; Vilela et al. 2016; Vilela et al. 2017
Ischnura fluviatilis	**LE**	**NT**	FA, NC	ND	LC	GMP1, PRA, UNAI	von Ellenrieder & Garrison, 2007; von Ellenrieder, 2009

Continuation Table 4.

Species	Habitat	Territoriality	MGB	Oviposition	IUCN status	Sampled localities	References other than this study
Lestes auritus	**LE**	ND	IT	ND	LC	UDI	von Ellenrieder, 2009; Renner et al. 2016a
Lestes bipupillatus	**LE**	NT	ND	ND	ND	P31	Cardoso-Leite et al. 2014
Lestes forficula	**LE**	NT	IT, FA	END	ND	CVG, ITBL, MAT2, PRA, UNAI, QUI, P31	Garcia-Diaz, 1937; Von Ellenrieder & Garrison, 2007; Nobre & Carvalho, 2014
Limnetron debile	**LO**	ND	ND	ND	ND	P17	Santos, 1970; Assis et al. 2000
Macrothemis imitans imitans	**LO**	ND	ND	ND	ND	SRI, GIL, CPV	Salgado et al. 2013
Micrathyria hesperis	**LE**	ND	NC	ND	ND	CVG, GMP1, PAR	Von Ellenrieder & Garrison, 2007; Paiva-Silva et al. 2010; Vilela et al. 2016
Micrathyria ocellata dentiens	**LO**	ND	ND	ND	ND	SRI	Costa et al. 2002
Micrathyria spuria	**LO**	ND	ND	ND	LC	QUI	Costa et al. 2002; von Ellenrieder, 2009
Micrathyria stawiarskii	**LO, LE**	ND	ND	ND	LC	CPV, NAS, CCD, PO1	Costa et al. 2002; von Ellenrieder, 2009
Minagrion franciscoi	**LO, LE**	NT	ND	ND	ND**	NAS, PO1	Machado & Bedê, 201
Minagrion waltheri	**LE**	NT	ND	ND	LC	ITBSL, MAT1, PO1, PO2	von Ellenrieder, 2009; Vilela et al. 2016
Mnesarete guttifera	**LO**	T	ND	ND	LC	AQD, RCV, CER, BS, CE, ESS, RSF, AGB, CHI, CRP, ZZC, VCT	Garrison, 2006; von Ellenrieder, 2009
Mnesarete pudica pudica	**LO**	T	FA	END	ND	CVG, ITBSL, ITBT	Guillermo-Ferreira & Bispo, 2012; Vilela et al. 2016
Mnesarete rhopalon	**LO**	T	ND	ND	ND**	CHI, CRP, CCD	Garrison, 2006
Neocordulia volxemi	**LO**	ND	ND	ND	DD	GUA	von Ellenrieder, 2009
Neoneura sylvatica	**LO, LE**	ND	IT	END	ND	ITBSL, UNAI	Paiva-Silva et al. 2010; Nobre & Carvalho, 2014; Vilela et al. 2016
Neoneura waltheri*	**LO**	ND	**IT**	**END**	ND	ITBT	Jurzitza, 1981; Garrison, 1999
Oligoclada abbreviata	**LE**	ND	ND	ND	LC	CVG, GMP1, ITBL, PAR, QUI	von Ellenrieder, 2009
Orthemis aequilibris	**LE**	ND	NC	EXO	ND	GMP2, ITBT	von Ellenrieder & Garrison, 2007
Orthemis discolor	**LE**	T	NC	EXO	ND	GMP2, ITBL, ITBT, MAT1, MAT2, MAT3, PRA, UDI, ESS, LZZ	von Ellenrieder & Garrison, 2007; Paiva-Silva et al. 2010
Oxyagrion basale	**LE**	ND	ND	ND	ND	CRP, AQD, RCV, CER, BS, CE, ESS, RSF, CHI, GIL, PSG, LZZ	Hanauer et al. 2014
Oxyagrion chapadense	**LO**	ND	ND	ND	ND	PAR, NAS	Calvão et al. 2014; Tennessen, 2015
Oxyagrion franciscoi	**LO**	ND	ND	ND	ND**	PSG	Machado & Bedê, 2015
Oxyagrion hempeli	**LO**	ND	ND	ND	ND	RL, PO1	Costa et al. 2010; Renner et al. 2016b
Oxyagrion impunctatum	**LO**	ND	ND	ND	ND	NAS, PSG	Costa, 1981
Oxyagrion microstigma	**LE**	T, NT	IT	END	ND	ITBT, UDI, UNAI, NAS, PO1, PO2, QUI, P31, LZZ	Vilela et al. 2016
Oxyagrion santosi	**LE**	ND	ND	ND	ND	UDI, NAS, PO2	Costa et al. 2000; Borges et al. 2019
Oxyagrion terminale	**LE**	ND	ND	ND	ND	CER, CE, CAR, TCH	Capitulo, 1996; Von Ellenrieder & Garrison, 2006; Hanauer et al. 2014

 http://dx.doi.org/10.1590/1676-0611-BN-2019-0851

Continuation Table 4.

Species	Habitat	Territoriality	MGB	Oviposition	IUCN status	Sampled localities	References other than this study
Pantala flavescens	**LE, LO**	T, NT	NC, FA, IT	EXO	LC	CVC, GMP2, ITBSL, PRA	Convey, 1989; Dumont, 1991; Mitra, 2000; von Ellenrieder & Garrison, 2007; Paiva-Silva et al. 2010
Perithemis lais	**LE**	T	ND	ND	LC	CVC, PAR	von Ellenrieder, 2009
Perithemis mooma	**LE**	T	ND	ND	ND	CVC, ITBSL, MAT1, PAR, PRA, UDI, LZZ	Louton et al. 1996; Von Ellenrieder & Garrison, 2007; Paiva-Silva et al. 2010; Pinto et al. 2013
Progomphus costalis	**LO**	ND	ND	ND	LC	NAS	Belle, 1973; von Ellenrieder, 2009
Progomphus intricatus	**LO**	ND	ND	ND	LC	ZZC	Belle, 1973; von Ellenrieder 2009; Dalzochio et al. 2011
Telebasis carmesina	**LE**	NT	IT	END	LC	ITBT, PAR, UDI, UNAI, BS, RSF, QUI, P31, LZZ	von Ellenrieder, 2009
Telebasis coccinea	**LE, LO**	ND	ND	ND	ND	UDI	Garrison, 2009; Calvão et al. 2018; Borges et al. 2019
Tholymis citrina	**LE, LO**	ND	ND	ND	LC	UNAI	Fleck et al. 2004; Paulson 2017
Tigriagrion aurantinigrum	**LO**	T	ND	ND	ND	ITBSL, ITBT, MAT4, GIL	Paiva-Silva et al. 2010; Vilela et al. 2016
Tramea calverti	**LE**	ND	ND	ND	LC	P31	Paulson, 2017; Borges et al. 2019
Zenithoptera lanei	**LE**	NT	IT, NC, FA	EXO	ND	ITBT, MAT1	Vilela et al. 2016

38 (42%) of the species. Mate-guarding behavior (MGB) and oviposition were determined for 31 (35%) species (Table 4).

5. IUCN status

The IUCN conservational status was available for only 28 (31.5%) of the sampled species. Most of the evaluated species (26 out of 28) were assessed as being Least Concern by IUCN classification, whereas for *Cyanallagma ferenigrum* de Marmels and *Neocordulia volxemi* Selys are classified as Data Deficient (DD) (Table 4).

Discussion

After this study, with 269 recorded species, Minas Gerais is the Brazilian State with the second highest number of Odonata species, considering that Rio de Janeiro has recorded 280 species (Costa & Santos 2000), followed by São Paulo, 251 species (Costa, Machado, et al. 2000), Mato Grosso do Sul, 209 species (Rodrigues et al. 2018, Koroiva et al. 2017b), Rio Grande do Sul, 182 species (Dalzochio et al. 2018), and Goiás and the Distrito Federal, 152 species (Nóbrega & De Marco 2011). Obviously, such numbers reflect the areas where most Brazilian odonatologists explored, and the northern States of Brazil may concentrate an even higher number of species.

Concerning the sampled areas, 18 of the 49 sites were at or near Veredas, 24 areas were consisted of streams, rivers and waterfalls, and only seven of them were ponds. This consists, so far, in the most extensive (in number of species recorded and sampled areas) study of odonates in the State of Minas Gerais. Among the sampled sites, the Veredas were mostly well preserved, however few (five out of 18) of them were placed in protected areas. In fact, the Vereda in Uberlândia (UDI) is already threatened by a urbanization project with housing activities. Such anthropic pressure may permanently impact on the faunal composition of this and other unprotected areas, as Vereda areas do not regenerate after a severe disturbance (Guimarães et al. 2002; Oliveira et al. 2009).

Bearing in mind the information on species behavior, we provide a list of behavioral traits of our focal observations and the ones found in the literature. Despite being available for 55% of the sampled species, most of the information on species biology is underexplored, what requires data from more than one source per species to build a more complete behavioral perspective. Considering that only 40 of 90 species have biological information, it is important to know how much to we must advance in this sense. Although neglected, behavioral diversity is an important species feature, for it reveals a cryptic biodiversity (Cordero-Rivera 2017). For instance, for species that are morphologically similar but behave in different ways, the behavioral repertoire can be a distinguishable trait between them (Guillermo-Ferreira & Bispo 2012, Cordero-Rivera 2017).

Here, we also show that few species were assessed regarding their conservational status. Considering the current measures from the Latin-American Odonatological Society and IUCN to assess all Latin-American odonate species, our results make a great contribution to this effort. The IUCN evaluations require data of distribution ranges, altitude of occurrence, population status, and biological data (IUCN 2019). Therefore, the more information one can gather about a species, more precisely it can be evaluated. In our study, only 31.5% of the sampled species were already assessed by IUCN. Most of these species fit in the Least Concern category, which means that, although some of the species may be widespread and out of risk (IUCN 2019), others that

were not assessed may be under threat. For *Cyanallagma ferenigrum* de Marmels and *Neocordulia volxemi* Selys, the status appears as Data Deficient, which means that, at the moment of the assessment, the data available for evaluation were insufficient to set a conservational status to these species (IUCN 2019). Our records for this two species and the others that were not assessed will help in ongoing assessments. The results presented here respect the guidelines of the Latin-American Odonatological Society and are being used to assess Neotropical species conservation status. Finally, we suggest that research focus on studies of natural history and distributional ranges that cover understudied species (Data Deficient and unevaluated species) in the Cerrado biome (mainly on Veredas) to ensure a broader perspective on the Neotropical odonate fauna.

Acknowledgments

DSV thanks Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for a scholarship grant (Proc.140732/2016-0). RK thanks PNPD/CAPES and FIXAM-I/FAPEAM (Edital n°05/2018; Proc.062.01503/2018) for providing post-doc scholarships. THAT thanks CAPES for providing doctoral scholarship. RGF thanks Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) for constant support. We thank Douglas Riff, Carlos A. F. Vilela, Denisy A. Silva, Leonardo Ricoli, Rodrigo Cezário, Tatiene Zenni, Vinícius Lopez, Vanessa Gomes, Ricardo Paiva Vallim and Amanda Crivelaro for field support. DSV, RGF and MCN would like to thank The Mohamed Bin Zayed Conservation Fund for a grant that allowed us to collect at the Serra da Canastra National Park. RK, DSV and RGF also would like to thank The Rufford Foundation for a grant that allowed us to collect at the Serra da Canastra National Park (RSG 25133-2). This study was partly financed by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

Author contributions

Diogo Silva Vilela: Contribution to data collection and manuscript preparation. Substantial contribution in the concept and design of the study. Contribution to critical revision, adding intelectual content.

Ricardo Koroiva: Contribution to data collection and manuscript preparation. Substantial contribution in the concept and design of the study. Contribution to critical revision, adding intelectual content.

Thiago Henrique Azevedo Tosta: Contribution to data collection and manuscript preparation. Contribution to critical revision, adding intelectual content.

Marcos Carneiro Novaes: Contribution to manuscript preparation. Contribution to critical revision, adding intelectual content.

Rhainer Guillermo-Ferreira: Contribution to data collection and manuscript preparation. Contribution to critical revision, adding intelectual content.

Conflicts of interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

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Received: 29/07/2019
Revised: 03/10/2019
Accepted: 25/11/2019
Published online: 31/01/2020