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article

Leptophlebiidae (Insecta: Ephemeroptera) from state of Bahia, Brazil

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Abstract: Leptophlebiidae is the family with the most diversity of species and wide distribution in the Southern Hemisphere. There are 95 species of Leptophlebiidae recorded in Brazil, but for the state of Bahia there are only 21 species. A check list and new records of Leptophlebiidae (Ephemeroptera) are presented to the State of Bahia. A total of 16 genera and 40 species of Leptophlebiidae were identified on this study. The species *Fittkaulus cururuensis, Hylister obliquus, Miroculis* (*atroari*) *duckensis* and *Miroculis* (*Ommaethus*) *froehlichi* are reported for the first time to the State of Bahia, increasing the number of Leptophlebiidae species from 21 to 25. Now, the Bahia is one of the states with the largest number of Leptophlebiidae species records, behind only of the state of Espírito Santo which has 26 species of this family.

Keywords: *Neotropical, Northeastern, Check List.*

Leptophlebiidae (Insecta: Ephemeroptera) do Estado da Bahia, Brasil

Resumo: Leptophlebiidae é a família com maior diversidade de espécies e com maior distribuição no Hemisfério Sul. Existem 95 espécies de Leptophlebiidae registradas no Brasil, mas no estado da Bahia existem apenas 21 espécies. Uma lista e os novos registros de Leptophlebiidae (Ephemeroptera) são apresentados ao Estado da Bahia. Um total de 16 gêneros e 40 espécies de Leptophlebiidae foram identificadas neste trabalho. As espécies *Fittkaulus cururuensis*, *Hylister obliquus, Miroculis (atroari) duckensis* e *Miroculis (Ommaethus) froehlichi* são relatadas pela primeira vez no Estado da Bahia, aumentando o número de espécies de Leptophlebiidae de 21 para 25. Agora, a Bahia é um dos estados com o maior número de registros de espécies de Leptophlebiidae, atrás apenas do estado do Espírito Santo com 26 espécies desta família.

Palavras-chave: *Neotropical, Nordeste, Check List.*

Introduction

The family Leptophlebiidae composes the most diverse group of Ephemeroptera on Neotropical region, with wide distribution and greater diversity in the Southern Hemisphere (Domínguez et al. 2006). In South America, the family is represented by 43 genera and 168 species, all belonging to the subfamily Atalophlebiinae and Terpidinae (Domínguez et al. 2013, Salles et al. 2017). Among the genera described for South America, 26 of them are recorded in Brazil, being *Miroculis* Edmunds and *Thraulodes* Ulmer, the most representative genera in the country in number of described species (Lopes et al. 2007, Salles et al. 2017).

There are 95 species of Leptophlebiidae recorded in Brazil, but in state of Bahia there is only 21 species (Campos et al. 2016, Campos et al. 2017, Salles et al. 2017): *Askola emmerichi* Domínguez, Molineri & Mariano, 2009; *Farrodes carioca* Domínguez, Molineri & Peters, 1996; *F. tepui* Domínguez Molineri & Peters, 1996; *Fittkaulus maculatus* Savage & Peters, 1978; *Hagenulopsis minuta* Spieth, 1943; *Hermanella angeli* Almeida, Costa & Mariano, 2016; *Hermanella mazama* (Nascimento, Mariano & Salles, 2012); *Hydrosmilodon gilliesae* Thomas & Péru, 2004; *Hylister plaumanni* Domínguez & Flowers, 1989; *Massartella brieni* (Lestage, 1924); *Miroculis* (*Miroculis*) *fittkaui* Savage & Peters, 1983*; Needhamella ehrhardti* (Ulmer, 1920); *Paramaka convexa* (Spieth, 1943); *Perissophlebiodes flinti* (Savage, 1982); *Simothraulopsis demerara* (Traver, 1947); *S. diamantinensis* Mariano, 2010; *S. janae* Mariano, 2010; *Thraulodes luizgonzagai* Lima et al., 2013; *Ulmeritoides angelus* Souto et al., 2016; *Ulmeritoides flavopedes* (Spieth, 1943) and *Ulmeritus saopaulensis* (Traver, 1946).

Due to the importance of the family in relation to ecology, conservation of aquatic environments and considering the limited knowledge of the taxonomy of the group in Bahia, this study aims to present an inventory of the fauna the family Leptophlebiidae (Ephemeroptera: Insecta) in state of Bahia.

Studies involving the diversity of aquatic insects are important for biodiversity. The Ephemeroptera distribution and diversity knowledge in Brazil are still incipient as well discussed by some authors (Mariano and Polegatto 2011, Lima et al. 2010, Salles et al. 2014, Campos et al. 2016). This occurs not just in mayflies but also in others groups of aquatic insects such as Trichoptera (Calor 2011) and Plecoptera (Froehlich

2011). Most of this gap probably is due the few projects developed in the Northeast region, as well as the lack of specific groups of researchers in this region. This work shows that there is a lot to be done since of all the previously registered Leptophlebiidae species for the State of Bahia, only four of them were described with material collected from the state (*H. angeli*, *T. luizgonzagai*, *S. diamantinensis* and *S. janae*).

Material and Methods

The material examined was obtained between 2008 and 2016 in 23 municipalities from state of Bahia, Brazil. All material is deposited in the collection of the Laboratório de Organismos Aquáticos from Universidade Estadual de Santa Cruz, Ilhéus, State of Bahia, Brazil (LOA/UESC). The nymphs were collected using D-shaped nets and the adults were collected with light trap and light pan trap (Calor & Mariano 2012), then all material was preserved in ethyl alcohol 80%. Male legs, genitalia and nymphal parts were dissected and mounted in Euparal; wings were mounted dry. The identification of the species were based according to Domínguez et al. 2006 and other specific papers.

The samples were made in lentic and lotic environments, in different substrates (litter deposited in the bottom of the bed, litter retained in areas of stream, sand, stone and roots). When possible, some nymphs were reared in the field with the aim to obtain the subimago stage and later the imago for possible associations between it. The collections had SISBIO Authorization number 24195-1.

1. Study area

The State of Bahia (Figure 1) is located in the northeastern region of Brazil, covering an area of 564,692,669 km^2, thus the largest State in the territorial extension of the Northeast region and approximately 7% of the national territory. The state presents three biomes: Atlantic Forest and Savanna (Cerrado and Caatinga), as well as the Coastal Zone, with its ecosystems that are repeated all along the coast. The vegetation is distinguished by a great diversity of ecosystems, rupestrian fields, mangrove, transition areas, as well as seasonal forests and ecosystems such as: beaches and mangroves. The study was carried out in the State of Bahia in the municipalities listed in Table 1. There were 43 collection points between varied water bodies, i.e. streams, rivers and waterfalls (Figure 2). (SEI 2017).

Results and Discussion

After the compilation of species records for the State (Da-Silva 1992; Da-Silva, Salles & Polegatto 2008; Lima et al. 2012; Mariano & Costa 2014; Almeida et al. 2016; Campos et al. 2016; Lima et al. 2016; Campos et al. 2017, Salles et al. 2017) and the material deposited at MZUESC, a table with all the occurrence and new records of mayfly species from state Bahia is provided below (Table 2). For each species we list the data of geographical distribution and the reference.

A total of 5.746 specimens from the 43 sites were collected, distributed in 16 genera and 40 species of Leptophlebiidae were founded on this work (Table 2.). From these 40 morphotypes, 25 were identified in species and 10 identified in morphotypes because we are not able to determine the species, mostly because of the undescribed stage of some Leptophlebiidae species. Besides there are four new species in process of description. The new records are: *Fittkaulus cururuensis*, *Hylister obliquus, Miroculis* (*Atroari*) *duckensis*, and *Miroculis* (*Ommaethus*) *froehlichi*. Four new species are in description process, i.e. *Miroculis* (*Miroculis*) sp. nov., *Needhamella* sp. nov., *Paramaka* sp. nov. and *Ulmeritoides* sp. nov.. Now, Bahia has 25 species of Leptohlebiidae and is one of the states with the largest number of Leptophlebiidae species records, together with the state of Espírito Santos which has 26 species of Leptophlebiidae (Salles et al. 2017).

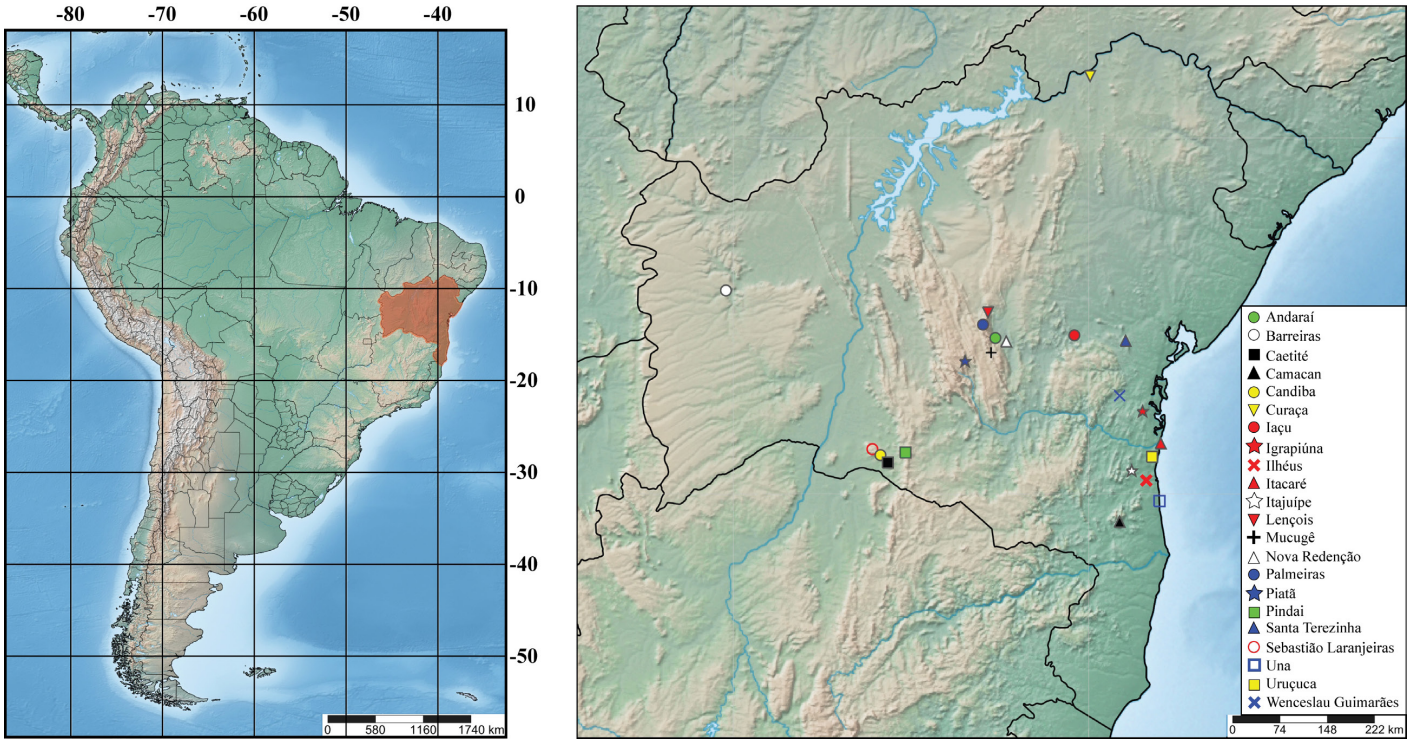

Figure 1. Sampling sites in the State of Bahia region where Leptophlebiidae (Insecta: Ephemeroptera) species were collected.

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Table 1. Sample sites (P) at state of Bahia, Brazil, followed by county, location, date, coordinates and collectors. (PESC= Parque Estadual da Serra do Conduru; PNCD= Parque Nacional da Chapada Diamantina; RPPN= Reserva Particular do Patrimônio Natural; REM= Reserva Ecológica da Michelin; LEAq: Laboratório de Entomologia Aquática; LOA: Laboratório de Organismos Aquáticos).

COUNTY	SITES	LOCATION	DATES	COORDENATES	COLLECTORS
Abaíra	**P1**	Catolés, Cachoeira do Guarda Mó	x.2013	13º49'29.2"S, 39º10'27.2"W, 1266m	Calor, Dias & Campos
	P2	Catolés, Rio Catolés de cima, Entrada para Inúbia (Abaixo da Ponte)	x.2013	-	Calor, Dias & Campos
	P3	Catolés, Rio da Grota	x.2013	13º17'10"S, 41º52'8.3"W, 1119m	Calor, Dias & Campos
Andaraí	**P4**	Rio Água Boa, Igatu district	ii.2011; iii.2011	11°53'S,45°25'W, 573m	Calor, Camalier & Zanata; Bravo, Menezes, Silva & Neto
	P5	Rio Coisa Boa, Igatu district	iii.2011	-	-
Barreiras	**P6**	Rio das Ondas	x.2008	12°08'334"S, 45°06'140"W	Calor, Mariano & Mateus
	P7	Rio de Janeiro, Cachoeira Acaba Vidas	x.2008	11°53'673"S, 45°36'096"W	Calor, Mariano & Mateus
Caetité	**P8**	Rio Cachoeira Alta	xi.2012; ii.2013; v.2013; viii.2013	14º33'41,5"S,42º49'35,3"W, 823m	Nogueira, Santos & Silva
	P9	Rio Moita dos Porcos	viii.2012; xi.2012; ii.2013; v.2013	14º10'09,1"S,42º31'16,3"W, 800m	Nogueira, Santos & Silva
Camacan	**P10**	Córrego Ponte	viii.2008	352m	Calor, Lecci, Pinho & Moretto
	P11	Fazenda Altamira	x.2008	15°25'16"S, 39°33'57"W, 300m	Calor, Mariano & Mateus
	P12	Fazenda Paris, Rio Braço do Sul	iv.2011	15°25'17"S, 39°34'0,2"W	França & Barreto
	P13	Fazenda Waldemar da Farmácia	iii.2011; viii.2008	15°25'17"S, 39°34'011"W, 310 m	Calor, Quinteiro, Lecci & Barreto; Calor, Lecci, Pinho & Moretto
	P14	RPPN Serra Bonita, Riacho 1 MCAM 3	iv.2011	15°23'31"S, 39°33'53"W	Quinteiro, França & Barreto
	P15	RPPN Serra Bonita, Segundo Riacho Trilha da Cachoeira	iii.2011	15°23'31"S, 39°33'53"W	França
Candiba	**P16**	Rio Brejo da Taboa	viii.2012; xi.2012; v.2013	42°55'37"S, 14°27'22"W, 1054m	Nogueira, Santos & Silva
Curaçá	**P17**	Recanto Campestre, Rio São Francisco	v.2011; v.2011	-	França
Iaçu	**P18**	Rio Paraguaçu	v.2010	-	-
Igrapiúna	**P19**	REM	ii.2010; ix.2012	-	Equipe LEAq
	P20	REM, Córrego das Matas, trilha do Guigó	ix.2012	13º49'24.6"S, 39º10'9.0"W	Equipe LEAq
	P21	REM, Pacangê – 2ª ponte	ix.2012	13º50'17.1" S, 39º14'27.7" W	Equipe LEAq
Ilhéus	**P22**	Ilhéus, UESC, Rio Cabruca	ix.2014	14°47'42.4"S, 39°10'19.2"W	Equipe LOA
Itacaré	**P23**	Cachoeira Bom Sossego	vii.2012; ix.2012	14°20'05.2"S, 39°01'27.4"W	Mariano, Almeida & Costa
	P24	Fazenda Me Adora, Afluente Rio de Contas	viii.2012	-	Mariano, Almeida & Costa
	P25	Riacho da Prainha	viii.2012	14°17'27.6"S 38°59'09.2"W	Mariano, Almeida & Costa
	P26	Taboquinhas, Cachoeira (entrada a direita antes da cidade)	x.2008	14°21'21.2"S, 39°09'56.4"W	Mariano, Silva & Craveiro
Itajuípe	**P27**	Rio Almada	xii.2011; iii.2012; vii 2012; ix.2012	14º40'26,9"S, 39º23'36,8"W	Souza; Souza & Silva
Lençóis	**P28**	PNCD, Córrego Ribeirão	x.2008	04°85'021"S, 83°98'176"W	Calor, Mariano & Mateus
	P29	PNCD, Rio Capivara	x.2008	-	Calor, Mariano & Mateus
	P30	PNCD, Rio Mucugezinho	viii.2010; x.2008	12°27'638"S, 41°25'205"W	Calor, Lecci, Brantes, Quinteiro, França & Camalier; Calor, Mariano & Mateus
Mucugê	**P31**	Rio Cumbuca	vii.2010	-	Calor, Lecci, Camelier, Arantes, Quinteiros & França
Nova Redenção	**P32**	Rio Paraguaçú	vii.2010	-	Equipe LEAq.
Palmeiras	**P33**	Riacho Cachoeira Batista	vii.2011	12°37'21,7"S, 41°29'11,7"W	Calor, Camalier & Burguer
Piatã	**P34**	Rio Machado, Cachoeira Caxibarí	vii.2010	12°08'334"S, 45°06'140"W, 492m	Equipe LEAq.
Pindaí	**P35**	Rio Umburanas	viii.2012; xi.2012; ii.2013; v.2013	14º25'08,5"S, 42º34'38,1"W 877m	Nogueira, Santos & Silva
	P36	Rio Pires		42°49'27"S, 14°33'43"W, 856m	Nogueira, Santos & Silva
Santa Terezinha	**P37**	Reserva Gambá, Pedra Branca, Serra da Jibóia, Cachoeira, Lajedo	xi.2010	12°51'00"S, 39°28'48"W, 678m	Calor, Mariano & Quinteiros
Sebastião Laranjeiras	**P38**	Riacho da Mandiroba	viii.2012; xi.2012; ii.2013; v.2013	14°22'09"S, 43°02'34"W, 950m	Nogueira, Santos & Silva
	P39	Rio da Mata	viii.2012; xi.2012; ii.2013; v.2013	14°15"50"S, 43°09'59"W, 1150m	Nogueira, Santos & Silva
Una	**P40**	RPPN Fazenda Ararauna	2014	15°18'12.8"S, 39°09'41.8"W	Pereira, T.P.L.
Uruçuca	**P41**	PESC, Córrego da Samambaia, Lago da Sede, Córrego dos Pinga	iv.2011; vi.2011; iii.2011; x.2010; vi.2011	14°29'36.5"S, 39°08'09.3"W 14°29'32.2"S, 39°08'09.9"W	Costa & Mariano; Mariano, Costa & Soledade; Mariano, Costa & Pereira; Mariano, Costa, Pereira & Silva; Mariano, Costa & Soledade
	P42	PESC	-	-	Equipe LOA
Wenceslau Guimarães	**P43**	Cachoeira Serra Grande, Sede	x.2010; x.2010	-	-

Table 2. List of species of Leptophlebiidae from in state of Bahia, Northeast region, Brazil, followed by sites, previously records and references. * *Askola* sp. 1 was recorded in three differents localities, Santa Terezinha (Costa & Mariano 2014), Igrapiúna (Campos et al. 2016) and Catolés (Campos et al. 2017).

Genus	Species	Sites	Previously records	References (Records for State of Bahia)
***Askola* Peters, 1969**	*A. emmerichi* Domínguez, Molineri & Mariano, 2009	-	AM, RR, BA (Barreiras)	Lima et al. 2016
	Askola sp1.*	P41	BA (Santa Teresinha; Igrapiúna; Catolés)	Mariano & Costa 2014; Campos et al. 2016; Campos et al. 2017
	Askola sp2.	-	BA (Igrapiúna; Santa Terezinha)	Campos et al. 2017
***Farrodes* Peters, 1971**	*F. carioca* Domínguez, Molineri & Peters, 1996	P4, P5, P6, P7, P10, P12, P13, P14,P19, P28, P30, P31, P32, P34, P43	ES, RJ, BA (Barreiras; Igrapiúna; Catolés; Lençois; Santa Terezinha)	Lima et al. 2016; Campos et al. 2016; Campos et al. 2017
	F. tepui Domínguez, Molineri & Peters, 1996	-	PE, BA (Barreiras)	Lima et al. 2016
	Farrodes sp1.	P9, P16, P27, P35, P38, P39, P42	-	-
***Fittkaulus* Savage & Peters, 1978**	*Fi. cururuensis* Savage, 1986	P42	ES, MT, PA, PE, **NEW RECORD FOR BAHIA**	-
	Fi. maculatus Savage & Peters, 1978	-	PA, BA (Nova Viçosa)	Da-Silva 1992
***Hagenulopsis* Ulmer, 1920**	*H. minuta* Spieth, 1943	-	AM, PA, RR, BA (Barreiras)	Lima et al. 2016
	Hagenulopsis sp1.	P27	-	-
***Hermanella* Needham & Murphy, 1924**	*Hermanella angeli* Almeida, Costa & Mariano, 2016	-	BA (Itacaré; Igrapiúna)	Almeida et al. 2016; Campos et al. 2016
	He. mazama (Nascimento, Mariano & Salles, 2012)	-	ES, BA (Igrapiúna)	Campos et al. 2016
	Hermanella sp1.	P38	-	-
***Hydrosmilodon* Flowers & Domínguez, 1992**	*Hy. gilliesae* Thomas & Péru, 2004	P19, P27	AM, ES, MT, PE, BA (Ituberá, Igrapiúna; Lençois; Barreiras)	Lima et al. 2012; Campos et al. 2016; Salles et al. 2016
***Hylister* Domínguez & Flowers, 1989**	*Hyl. obliquus* Nascimento & Salles, 2013	P40	ES, **NEW RECORD FOR BAHIA**	-
	Hyl. plaumanni Domínguez & Flowers, 1989	-	ES, MG, PR, RJ, SC, BA (Ituberá, Igrapiúna)	Lima et al. 2012; Campos et al. 2016
***Massartella* Lestage 1930**	*M. brieni* (Lestage, 1924)	P8, P15	ES, MG, PR, RJ, RS, SP, ba (Santa Teresinha; Catolés; Elísio Medrado)	Mariano & Costa 2014; Campos et al. 2017
***Miroculis* Edmunds, 1963**	*Mi.* (*atroari*) *duckensis* Savage & Peters, 1983	P41	AM, **NEW RECORD FOR BAHIA**	-
	Mi.(*Miroculis*) *fittkaui* Savage & Peters, 1983	P22	ES, PA, PE BA (Igrapiúna)	Campos et al. 2016
	Mi. (*Ommaethus*) *froehlichi* Savage & Peters, 1983	P43	RJ, SP, **NEW RECORD FOR BAHIA**	-
	Miroculis sp.	P40, P42	-	-
	Miroculis (*Miroculis*) sp. nov.	P9, P35, P38, P39	-	-
***Needhamella* Domínguez & Flowers, 1989**	*N. ehrhardti* (Ulmer, 1920)	-	AM, ES, GO, PR, PE, RJ, RS, SC, BA (Amargosa; Lençois)	Lima et al. 2012
	Needhamella sp. nov.	P26	-	-
***Paramaka* Savage & Domínguez, 1992**	*P. convexa* (Spieth, 1943)	P7	MT, PA, BA (Barreiras)	Mariano 2011
	Paramaka sp.	P27	BA (Barreiras)	Lima et al. 2016
	Paramaka sp. nov.	P42	-	-
***Perissophlebiodes* Savage, 1983**	*Pe. flinti* (Savage, 1982)	-	ES, MG, RJ, SP, BA (Lençois)	Da-Silva, Salles & Polegatto 2008
***Simothraulopsis* Demoulin, 1966**	*S. demerara* (Traver, 1947)	P19, P20, P43	AM, AP, ES, MT, PA, PE, PI, RO, RR, BA (Barreiras; Côcos; Igrapiúna)	Lima et al. 2016; Campos et al. 2016; Nascimento et al. 2017
	S. diamantinensis Mariano, 2010	P5, P12, P13, P18, P30, P31, P33, P42	ES, BA (Abaíra; Andaraí; Lençois; Palmeira; Catolés)	Mariano 2010; Campos et al. 2017; Nascimento et al. 2017
	S. janae Mariano, 2010	P7	MT, MG, PA, PE, RO, RR, BA (Barreiras; Rio de Contas)	Mariano 2010; Nascimento et al. 2017

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Table 2. Continued...

Genus	Species	Sites	Previously records	References (Records for State of Bahia)
***Thraulodes* Ulmer, 1920**	*T. luizgonzagai* Lima, Mariano & Pinheiro 2013	-	PE, BA (Juazeiro)	Lima, Mariano & Pinheiro 2013; Campos et al. 2017
	Thraulodes sp1.	-	BA (Curaça)	Mariano & Costa 2014; Campos et al. 2017
	Thraulodes sp2.	-	BA (Catolés)	Campos et al. 2017
	Thraulodes sp3.	-	BA (Rio de Contas)	Campos et al. 2017
***Ulmeritoides* Traver, 1959**	*U. angelus* Souto, Da-Silva, Nessimian & Gonçalves	-	MG, BA (Catolés; Piatã)	Campos et al. 2017
	*U. flavopedes (*Spieth, 1943)	P8, P9, P35, P38, P39	MT, PE, RR, BA (Barreiras)	Lima et al. 2016
	Ulmeritoides sp. nov.	P1, P2, P3	-	-
***Ulmeritus* Traver, 1956**	*Ul. saopaulensis* (Traver, 1946)	-	MG, SP, BA (Maracás)	Campos et al. 2017

Figure 2. A - Parque Estadual da Serra do Conduru (P42); B - Cachoeira Acaba Vidas (P7); C - Riacho da Mandiroba (P38); D - Rio Mucugezinho (P30).

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Author Contributions

Sabrina Santos Costa: the author contributed in field collection, in the identifications and preparation of the manuscript.

Maria Adonay Melo Nogueira: the author contributed in field collection, in the identifications and preparation of the manuscript.

Edineusa Pereira dos Santos: the author contributed in field collection, in the identifications and preparation of the manuscript.

Everlin Almeida: the author contributed in field collection, in the identifications and preparation of the manuscript.

Francine Novais Souza: the author contributed in field collection, in the identifications and preparation of the manuscript.

Michelle Maria Lima de Sousa: the author contributed in field collection, in the identifications and preparation of the manuscript.

Vinicius de Assis Silva: the author contributed in field collection, in the identifications and preparation of the manuscript.

Rodolfo Mariano: the author contributed in field collection, in the identifications and preparation of the manuscript.

Conflicts of interest

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

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