

## New, additional and historical records of Leptophlebiidae (Insecta, Ephemeroptera) from Colombia

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### ABSTRACT

In the Neotropical region, especially South America, Leptophlebiidae achieves its higher diversity, with 45 genera and almost 250 species. In Colombia, the diversity about this family is underestimated, with only 22 species reported so far. In order to contribute to the current knowledge of the Leptophlebiidae in Colombia we examined the adults of this family deposited at the Colección Entomológica del Programa de Biología, Universidad de Caldas. In addition to the historical records herein presented, nine species are registered for the first time from the country (*Farrodes savagei*, *F. tepui*, *F. xingu*, *Hagenulopsis minuta*, *Terpides contamanensis*, *T. echinovarioris*, *T. ornatodermis*, *Tikuna atramentum*, and *Ulmeritoides flavopedes*). Besides that, additional records are presented for 12 species of the following genera: *Askola*, *Farrodes*, *Simothraulopsis*, *Tikuna*, *Ulmeritoides*, *Hydrosmilodon*, *Terpides*, *Choroterpes*, *Paramaka*, and *Hagenulopsis*. With these additional and new records, we update the list of Leptophlebiidae from Colombia to 33 species and 14 genera.

### Introduction

Leptophlebiidae is one of the most diversified groups of mayflies (Ephemeroptera), both taxonomically and ecologically, with more than 640 species and 140 genera distributed worldwide (Sartori and Brittain, 2015). The family represents an important component of freshwater ecosystems, especially in the Southern Hemisphere (Savage, 1987b).

Historically, the family was divided in two subfamilies, Leptophlebiinae Banks and Atalophlebiinae Peters (Peters, 1980). While Leptophlebiinae was represented by few genera and species mostly restricted to the Northern Hemisphere, Atalophlebiinae included more than 100 described genera and more than 500 species and presents a gondwanan distribution with some taxa spreading to the north (O'Donnell and Jockusch, 2008). Nowadays, however, the family is divided into eight subfamilies, due to the split of both Leptophlebiinae (in Leptophlebiinae s.s., Habrophlebiinae, and Calliarciyinae) and Atalophlebiinae (in Atalophlebiinae s.s., Terpidinae, Castanophlebiinae, Choroterpinae, and Hagenulinae) (Kluge, 2009; Godunko et al., 2015; Monjardim et al., 2020).

The Neotropics, especially South America, is where Leptophlebiidae achieves its higher diversity. In this region, more than 45 genera and

240 species are reported, belonging to Atalophlebiinae, Choroterpinae, Hagenulinae, and to the endemic Terpidinae (Domínguez et al., 2006; Kluge, 2015; Zúñiga et al., 2015; Salles and Boldrini, 2019; Monjardim et al., 2020; Salles et al., 2020a). Nevertheless, the average of new species published every year is still high and many taxa remain to be described from the region.

Colombia is recognized as one of the most biodiversity rich countries in the Neotropic (Andrade, 2011). A huge variety of ecosystems, such as “tropical forests in the Amazon and Choco, mountain habitats like the Sierra Nevada and Andes, the grasslands of the plains and badlands, and islands like Gorgona in the Pacific and San Martin in the Caribbean”, is the main reason for such biodiversity. Unfortunately, given the high rates of biodiversity loss, some areas in the country are among the most hotspots for biodiversity in the World (Myers et al., 2000; Poveda et al., 2010).

Concerning mayflies it is clear that the diversity in Colombia is underestimated. Currently, only 120 species are known: 32 species for Baetidae, eight for Caenidae, one for Coryphoridae, three for Ephemerae, two for Euthyplociidae, 28 for Leptohyphidae, 22 for Leptophlebiidae, three for Oligoneuriidae, and 21 for Polymitarcyidae (Dias and Marulanda, 2019; Domínguez et al., 2019; Molineri et al., 2019;

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Salles et al., 2020b). These numbers, especially for Leptophlebiidae and Baetidae, are far from the actual number. In South American countries where the mayfly components have been studied more often, such as Brazil and Argentina, the number of species of this families surpasses one hundred and many species remain to be described.

Based on material collected by L.G. Dias team in the last years and deposited at the Entomological Collection of the Biology program of the Caldas University - CEBUC, our aim is to increase the knowledge of Leptophlebiidae from Colombia by presenting new and additional records of the family from the country.

## Material & Methods

### Identification

We examined and mounted the male genitalia and wings of imagos in permanent slides using Euparal®. For the identification of the collected insects taxonomic keys and original descriptions were used (Walker, 1853; Eaton, 1883, 1892; Needham and Murphy, 1924; Spieth, 1943; Traver, 1943, 1947; Traver and Edmunds, 1967; Savage and Peters, 1983; Flowers, 1987; Savage, 1987a; Domínguez et al., 1996; Domínguez, 1999; Domínguez and Zúñiga, 2003; Peters et al., 2008; Kluge, 2009, 2015; Zúñiga et al., 2015; Salles et al., 2018).

### Occurrence maps

We made the maps of occurrence in South America with the software ESRI® ArcMap 10.0, using a digital model of the elevation with countries delimitation in the Neotropic. Records from the literature were obtained from the following publications: Needham and Murphy (1924); Traver and Edmunds (1967); Savage and Peters (1983); Zúñiga et al. (1997); Mosquera et al. (2001); Domínguez and Zúñiga (2003); Zúñiga et al. (2004); Peters et al. (2008); Domínguez and Zúñiga (2009); Domínguez et al. (2009); Salinas-Jiménez et al. (2013); Zúñiga et al. (2014, 2015); Roza and Salinas-Jiménez (2016); Salinas-Jiménez et al. (2017, 2018); Salles et al. (2018).

### Images

We took pictures of specimens deposited in alcohol using LEICA M205 A and LEICA M205 C stereo microscopes with LEICA MC170 HD digital cameras. Pictures of living specimens in the field were taken with a Nikon d800 camera, 105mm macro lens, a SB-5000 Nikon flash, and a small acrylic aquarium. Post-processing of pictures were made in Adobe Lightroom® and the final plates were prepared in Adobe Illustrator® and Adobe Photoshop®.

### Deposition

We deposited the material in the Colección Entomológica del Programa de Biología, Universidad de Caldas (CEBUC), Manizales, Colombia, and at the Museu de Entomologia, Universidade Federal de Viçosa (UFVB), Viçosa, Brazil. In the case of Terpidinae, all specimens are temporarily deposited at the UFVB.

## Results

Based on the specimens available at the CEBUC, we identified 21 species of Leptophlebiidae. Eleven of them (belonging to the genera *Askola* Peters, 1969; *Farrodes* Peters, 1971; *Simothraulopsis* Demoulin, 1966; *Tikuna* Savage, Flowers & Porras, 2005; *Ulmeritoides* Traver, 1959;

*Hydrosmilodon* Flowers & Domínguez, 1992; *Terpides* Demoulin, 1966; and *Hagenulopsis* Ulmer, 1920), were already reported from Colombia and, thus, represent additional records for the country. *Farrodes savagei* Domínguez, 1999; *F. tepui* Domínguez, Molineri & Peters, 1996; *F. xingu* Domínguez, Molineri & Peters, 1996; *Terpides contamanensis* Kluge, 2015; *T. echinovar* Kluge, 2015; *T. ornatoderms* Kluge, 2015; *Tikuna atramentum* (Traver, 1947); *Hagenulopsis minuta* Spieth, 1943; and *Ulmeritoides flavopedes* (Spieth, 1943) represent new records for the country. We also present records for a new species of *Choroterpes* Eaton, 1881 and a new species of *Paramaka* Savage & Domínguez, 1992. With these new and additional records, we update the total number of Leptophlebiidae known from Colombia to 33 species and 14 genera. Importantly, given the diversity of *Thraulodes* in Colombia, the new species of this genus that were found in CEBUC will be treated elsewhere (Hernández in prep.).

A complete list of the species of Leptophlebiidae reported from Colombia is presented below. For species reported for the first time from the country, the specific name is succeeded by an asterisk (\*).

### Hagenulinae

*Askola emmerichi* Domínguez et al., 2009 (Figs. 1A and 2B)

**Previous distribution:** COLOMBIA: Amazonas department (Domínguez et al., 2009: 31); Venezuela: Bolivar state (Domínguez et al., 2014: 302); BRAZIL: Amazonas state (Nascimento et al., 2011: 200), Roraima state (Santos and Boldrini, 2016: 2), Bahia state (Lima et al., 2016: 216; Costa et al., 2018: 4), Pernambuco state (Campos et al., 2019: 36), Maranhão state (Nascimento et al., 2020: 581).

Additional records from Colombia: 2 male imagos, Putumayo department, Puerto Asís, Quebrada La Ventura (0°37'15.8"N 76°34'33.6"W), 19/xii/2015, light trap night, deposited at CEBUC; 88 male and 5 female imagos, Putumayo department, Puerto Asís, Quebrada Agua Negra (0°31'36.3"N 76°31'38.3"W), 17, 19 and 20/xii/2015, light trap night, deposited at CEBUC; 3 male imagos, Amazonas department, Leticia, 2017, light trap, deposited at CEBUC.

*Atopophlebia caldasi* Salles, Marulanda & Dias, 2018 (Figs. 1B, 2B and 3D)

**Previous distribution:** COLOMBIA, Caldas department, Norcasia and Samaná (Salles et al., 2018: 140).

Additional records from Colombia: 1 nymph, Tolima department, San Sebastián de Mariquita, Cataratas de Medina stream (5°14'41.09"N 74°53'06.97"W), 14/ii/2020, deposited at UFVB.

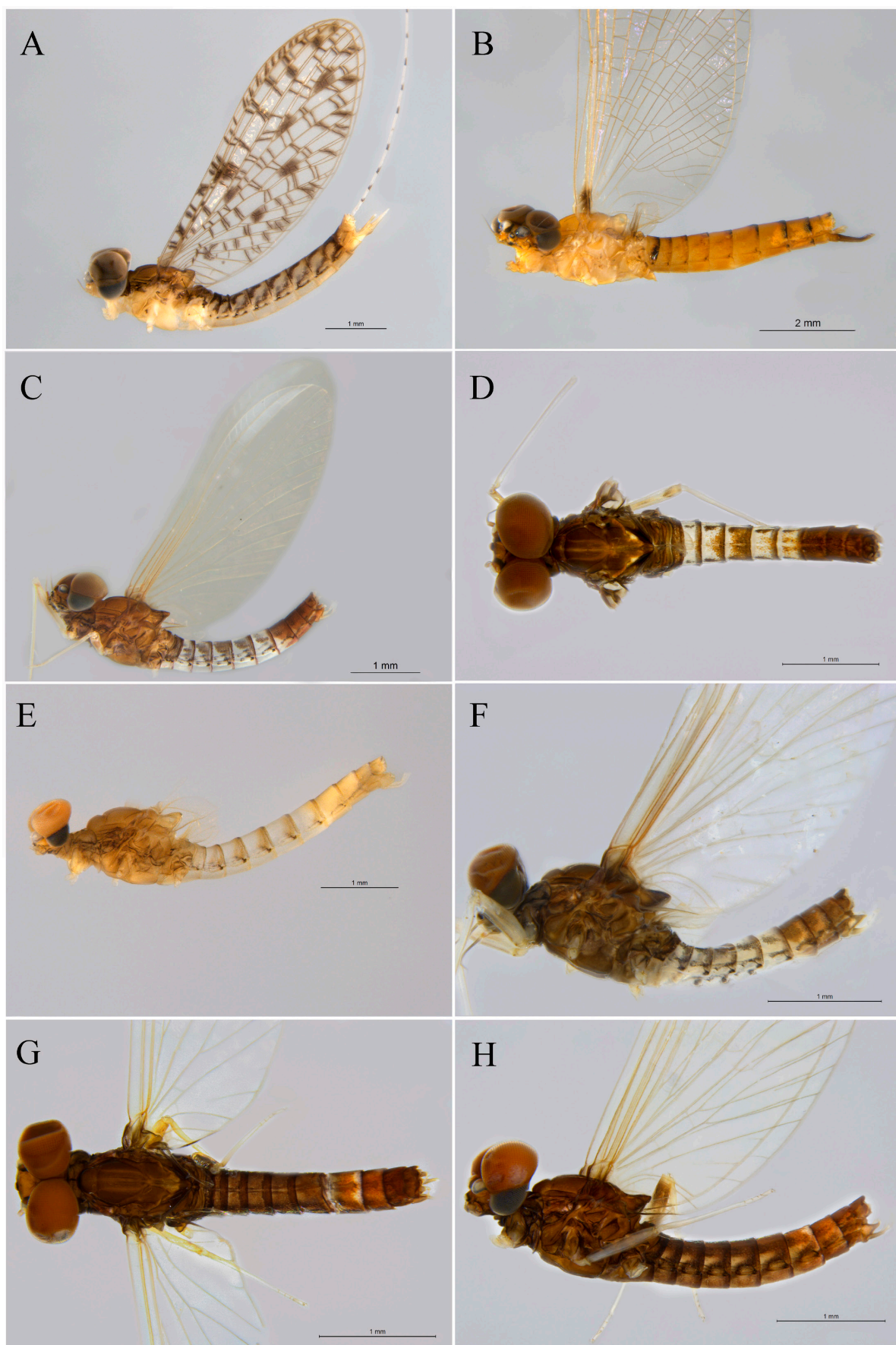
*Atopophlebia fortunensis* Flowers, 1987 (Fig. 2B)

**Previous distribution:** COLOMBIA, Valle del Cauca department, Pavas (Zúñiga et al., 1997; Mosquera et al., 2001); COSTA RICA: Cartago Province; (Flowers, 1987: 205); PANAMA: Chiriquí and Bocas del Toro Provinces (Flowers, 1980: 164, 1987:205).

Additional records from Colombia: none.

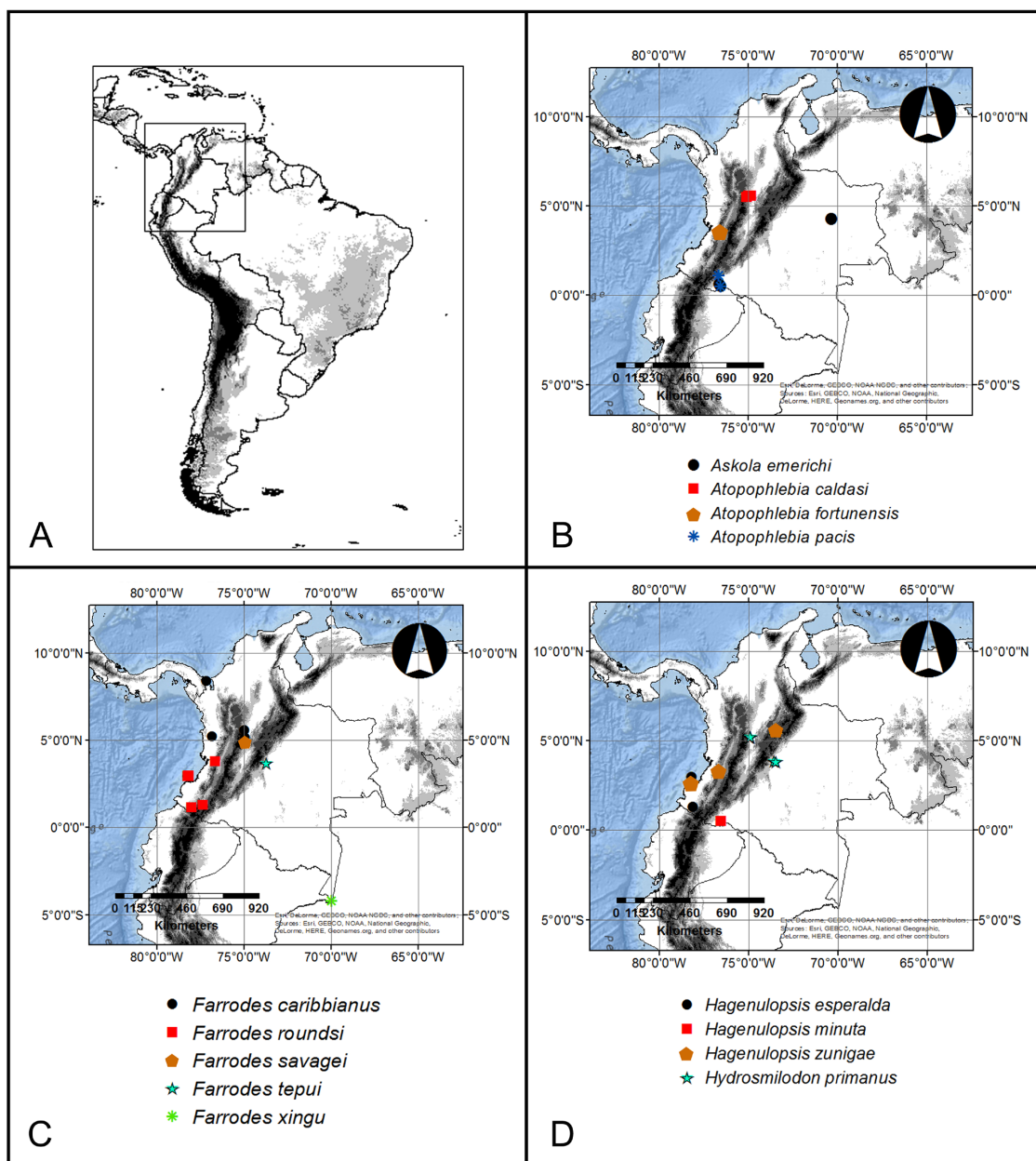
*Atopophlebia pacis* Salles, Marulanda & Dias, 2018 (Fig. 2B)

**Previous distribution:** COLOMBIA, Putumayo department, Mocoa and Puerto Asís (Salles et al., 2018: 139).



**Figure 1.** Habits of male imagos of Leptophlebiidae species: A) lateral view of *Askola emmerichi*; B) lateral view of *Atopophlebia caldasí*; C) lateral view of *Farrodes caribbeanus*; and D) dorsal view of *Farrodes caribbeanus*; E) lateral view of *F. roundsi*; F) lateral view of *F. savagei*; G) dorsal view of *F. tepui*; and H) lateral view of *F. tepui*.





**Figure 2.** Maps of South America with detail of Colombia showing the distribution of the species of Leptophlebiidae: A) map of South America with detail of Colombia; B) *Askola emerichi* and *Atopophlebia* spp.; C) *Farrodes* spp.; D) *Hagenulopsis* spp. and *Hydrosmilodon primanus*.

Additional records from Colombia: none.

*Farrodes caribbianus* (Traver, 1943) (Figs. 1C–D and 2C)

**Previous distribution:** COLOMBIA, Choco department, Acandí (Zúñiga et al., 2004: 36; Roza and Salinas-Jiménez, 2016: 8), Cauca department, Parque Nacional Natural Gorgona (Zúñiga et al., 2014: 234); COSTA RICA: Guanacaste Province (Domínguez, 1999: 159; Chacón et al., 2009: 726); VENEZUELA: Bolivar state (Domínguez, 1999: 159; Chacón et al., 2009: 726; Domínguez et al., 2014: 304); PANAMA: Canal de Panama (Domínguez, 1999: 159); NICARAGUA: Río San Juan department (Meyer et al., 2008: 140).

Additional records from Colombia: 3 male imagos, Tolima department, Armero Guayabal, Quebrada Santo Domingo - Granja Universidad del

Tolima (5°00'06.0"N 74°54'08.0"W), 19/v/2017, light trap, deposited at CEBUC; 2 male imagos, Tolima department, Mariquita, Villa de los Caballeros (5°09'21.42"N 74°53'58.32"W), 21/v/2017, light trap, deposited at CEBUC; 2 male imagos, Tolima department, Mariquita, Villa de los Caballeros (5°09'21.42"N 74°53'58.32"W), 21/v/2017, light trap, deposited at UFVB.

*Farrodes roundsi* (Traver, 1947) (Figs. 1E and 2C)

**Previous distribution:** COLOMBIA: Nariño and Valle del Cauca departments (Zúñiga et al., 2004: 36), Pasto department, Reserva Natural La Planada (Domínguez and Zúñiga, 2009: 74), Cauca department, Parque Nacional Natural Gorgona (Zúñiga et al., 2014: 227; Zúñiga et al., 2015: 294); COSTA RICA: Guanacaste Province



(Domínguez, 1999: 161); PANAMA: Chiriquí Province (Domínguez, 1999: 161).

Additional records from Colombia: 1 male imago, Nariño, Reserva Natural Río Nambi (1°18'00"N 74°04'58.79"W), 01/iii/2013, light trap, deposited at CEBUC.

*Farrodes savagei*\* Domínguez, 1999 (Figs. 1F and 2C)

**Previous distribution:** VENEZUELA: Zulia state (Domínguez, 1999: 164; Chacón et al., 2009: 726); NICARAGUA: Reserva de la Biosfera Bosawas (Meyer et al., 2008: 140).

New record from Colombia: 2 male imagos, Tolima department, Armero Guayabal, Quebrada Santo Domingo - Granja Universidad del Tolima (5°00'18.15"N 74°54'24.78"W), 19/xi/2017, light trap, deposited at UFVB; 1 male and 1 female imagos, same data, deposited at CEBUC.

*Farrodes tepui*\* Domínguez, Molineri & Peters, 1996 (Figs. 1G–H and 2C)

**Previous distribution:** BRAZIL: Pernambuco (Lima et al., 2012: 309) and Bahia states (Lima et al., 2016: 217); VENEZUELA: Amazonas state (Domínguez et al., 1996: 98); FRENCH GUIANA: Amazonas state (Chacón et al., 2009: 726).

New record from Colombia: 3 male and 4 female imagos, Meta department, San Martín, Caño Camoa (3°41'24.72"N 73°41'59.41"W), 04/i/2015, light trap, deposited at UFVB; 4 male and 4 female imagos, same data, deposited at CEBUC.

*Farrodes xingu*\* Domínguez, Molineri & Peters, 1996 (Figs. 2C and 4A–B)

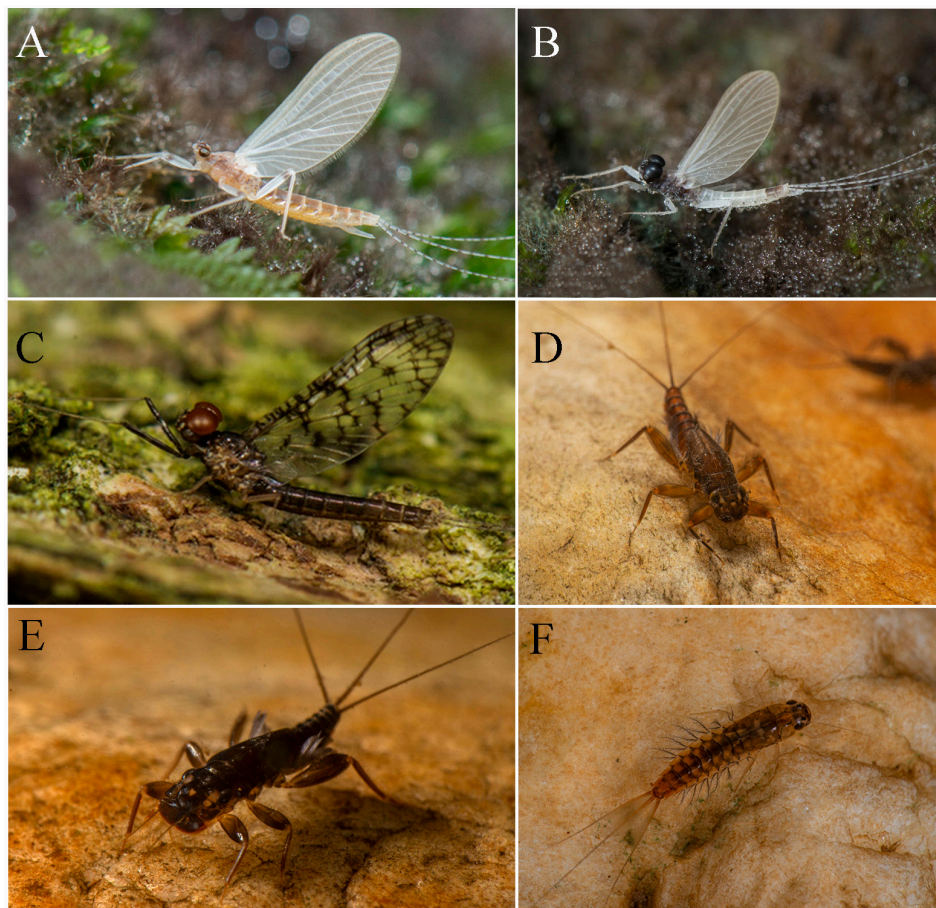
**Previous distribution:** BRAZIL: Pará state (Domínguez et al., 1996: 97), Mato Grosso state (Santos et al., 2019: 203); and Maranhão state (Nascimento et al., 2020: 581).

New record from Colombia: 10 male and 4 female imagos, Amazonas department, Leticia, Quebrada La Arenosa (4°12'11.39"S 69°56'09.26"W), 28/ix/2014, light trap, deposited at UFVB; 11 male and 5 female imagos, same data, deposited at CEBUC.

*Hagenulopsis esmeralda* Domínguez et al., 2009 (Figs. 2D and 3A–B)

**Previous distribution:** COLOMBIA: Cauca department, Parque Nacional Natural Gorgona (Zúñiga et al., 2014: 226; 2015: 294); ECUADOR: Esmeralda Province (Domínguez et al., 2009: 40).

Additional record from Colombia: 2 male imagos, Nariño department, Reserva Natural Río Nambi (1°18'00"N 74°04'58.79"W), 01/iii/2013, light trap, deposited at CEBUC.



**Figure 3.** Habits of living specimens of Leptophlebiidae in the field: A) female lateral view of *Hagenulopsis esmeralda*; B) male lateral view of *Hagenulopsis esmeralda*; C) lateral view of *Terpides contamanensis*; D) dorsal view of the nymph of *Atopophlebia caldasi*; E) dorsal view of the nymph of *Hydrosmilodon primanus*; F) dorsal view of the nymph of *Terpides echinovaris*.

*Hagenulopsis minuta*\* (Spieth, 1943) (Figs. 2D and 4C–D)

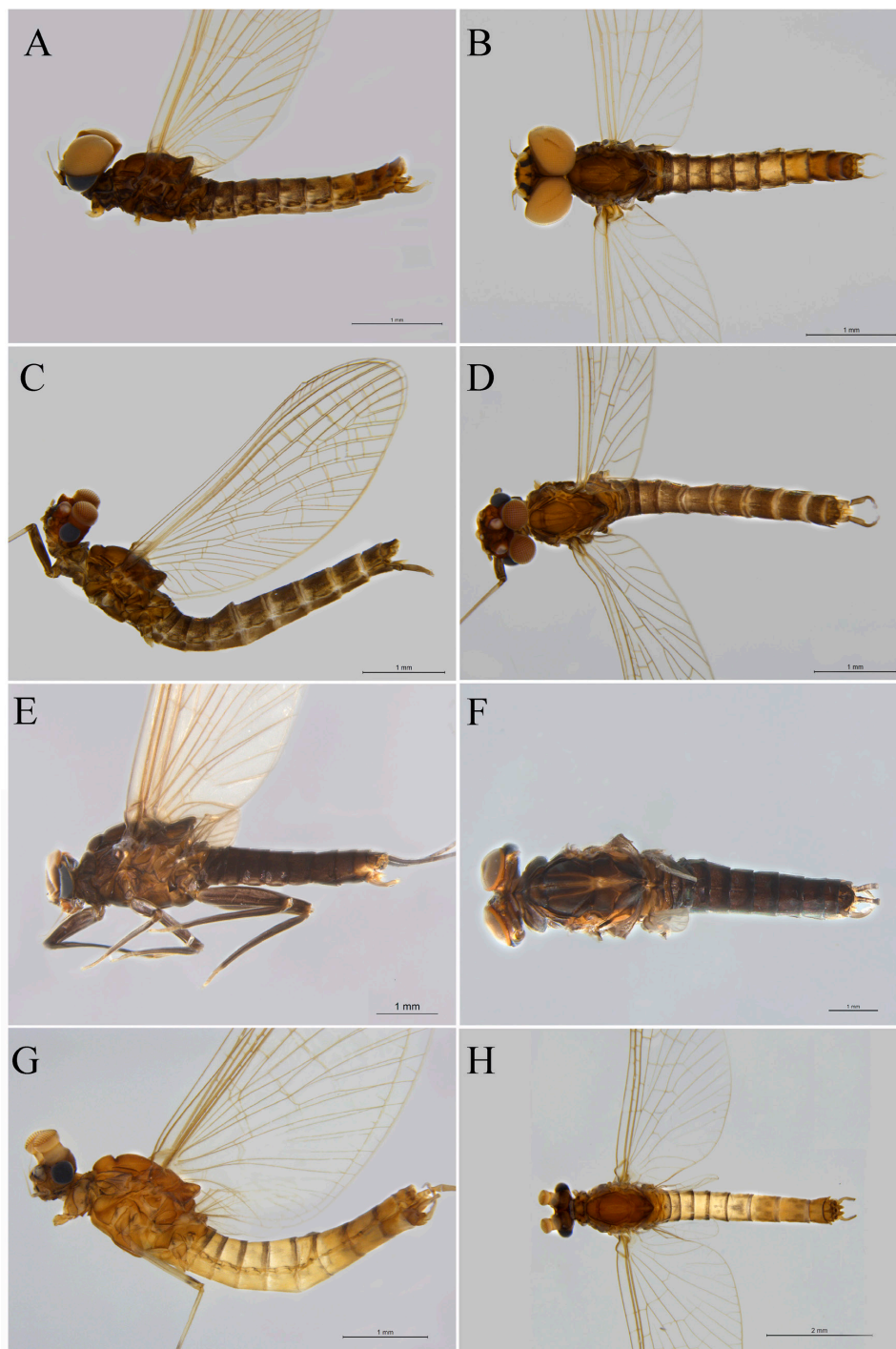
**Previous distribution:** BRAZIL: Roraima (Gama Neto and Hamada, 2014: 279), and Bahia states (Lima et al., 2016: 217); SURINAME: Rio Marowijne (Peters and Domínguez, 2001: 354); VENEZUELA: Amazonas state (Peters and Domínguez, 2001: 354; Chacón et al., 2009: 726).

New record from Colombia: 6 male imagos, Putumayo department, Puerto Asís, Quebrada Agua Negra (0°31'36.3"N 76°31'38.3"W), 20/xii/2015,

light trap, deposited at UFVB; 15 male imagos, same data: deposited at CEBUC; 60 male and 4 female imagos, same data, deposited at CEBUC.

*Hagenulopsis zunigae* Domínguez et al., 2009 (Fig. 2D)

**Previous distribution:** COLOMBIA: Valle del Cauca department, Parque Nacional Natural Farallones de Cali, Boyaca department, Arcabuco (Domínguez et al., 2009: 41), Cauca department, Parque Nacional Natural Gorgona (Zúñiga et al., 2014: 235).



**Figure 4.** Habits of male imagos of Leptophlebiidae species: A) lateral view of *Farrodes xingu*; B) dorsal view of *Farrodes xingu*; C) lateral view of *Hagenulopsis minuta*; D) dorsal view of *Hagenulopsis minuta*; E) lateral view of *Hydrosmilodon primanus*; F) dorsal view of *Hydrosmilodon primanus*; G) lateral view of *Miroculis (Miroculis) chiribiquete*; H) dorsal view of *Miroculis (Miroculis) chiribiquete*.



Additional records from Colombia: none.

*Hydrosmilodon primanus* (Eaton, 1892) (Figs. 2D, 3E, and 4E–F)

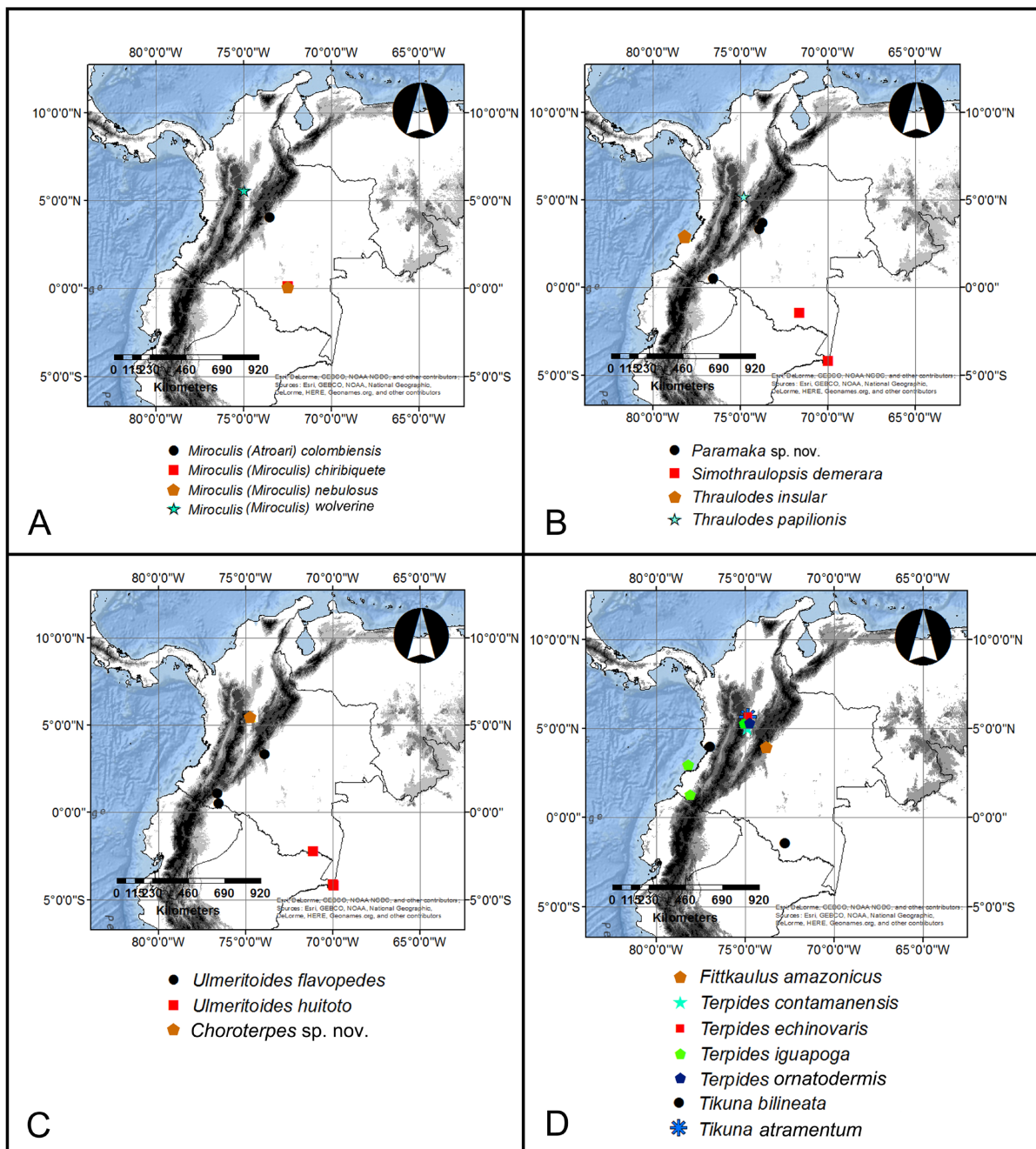
**Previous distribution:** COLOMBIA: Tolima department, Mariquita (Salinas-Jiménez et al., 2013: 364), Meta department, Acacías (Salinas-Jiménez et al., 2017: 273); COSTA RICA: Guanacaste Province (Flowers and Domínguez, 1992: 660); MEXICO: Veracruz city and Tabasco state (McCafferty, 2011: 325); PANAMA: Bocas del Toro Province (Flowers and Domínguez, 1992: 660); HONDURAS: Comayagua, El Paraiso, Intibuca and Atlantida states (Flowers and Domínguez, 1992: 660).

Additional records from Colombia: 10 male and 5 female imagos, Tolima department, San Sebastián de Mariquita, Cataratas de Medina (5°14'41.09"N 74°53'06.97"W), 19/i/2016, light trap, deposited at CEBUC; 1 male imago and 10 nymphs, Caldas, Norcasia, Rio Manso, 15/ii/2020, light trap, male imago and 5 nymphs deposited at CEBUC, 5 nymphs at UFVB.

*Miroculis (Atroari) colombiensis* Savage & Peters, 1983 (Fig. 5A)

**Previous distribution:** COLOMBIA: Meta department, Puerto Lopez (Savage & Peters, 1983: 558).

Additional records from Colombia: none.



**Figure 5.** Maps of South America with detail of Colombia showing the distribution of the species of Leptophlebiidae: A) *Miroculis* spp.; B) *Paramaka* sp. nov., *Simothraulopsis demerara* and *Thraulodes* spp.; C) *Ulmeritoides* spp. and *Choroterpes* sp. nov.; D) *Terpidea* spp.



*Miroculis (Miroculis) chiribiquete* Peters, Domínguez & Dereser, 2008 (Figs. 4G–H and 5A)

**Previous distribution:** COLOMBIA: Caquetá department, Puerto Abeja (Peters et al., 2008: 296).

Additional records from Colombia: none.

*Miroculis (Miroculis) nebulosus* Savage, 1987 (Fig. 5A)

**Previous distribution:** COLOMBIA: Caquetá department, Puerto Abeja (Peters et al., 2008: 301); VENEZUELA: Amazonas state (Savage, 1987a: 104; Chacón et al., 2009: 727).

Additional records from Colombia: none.

*Miroculis (Miroculis) wolverine* Costa, Almeida & Salles, 2019 (Fig. 5A)

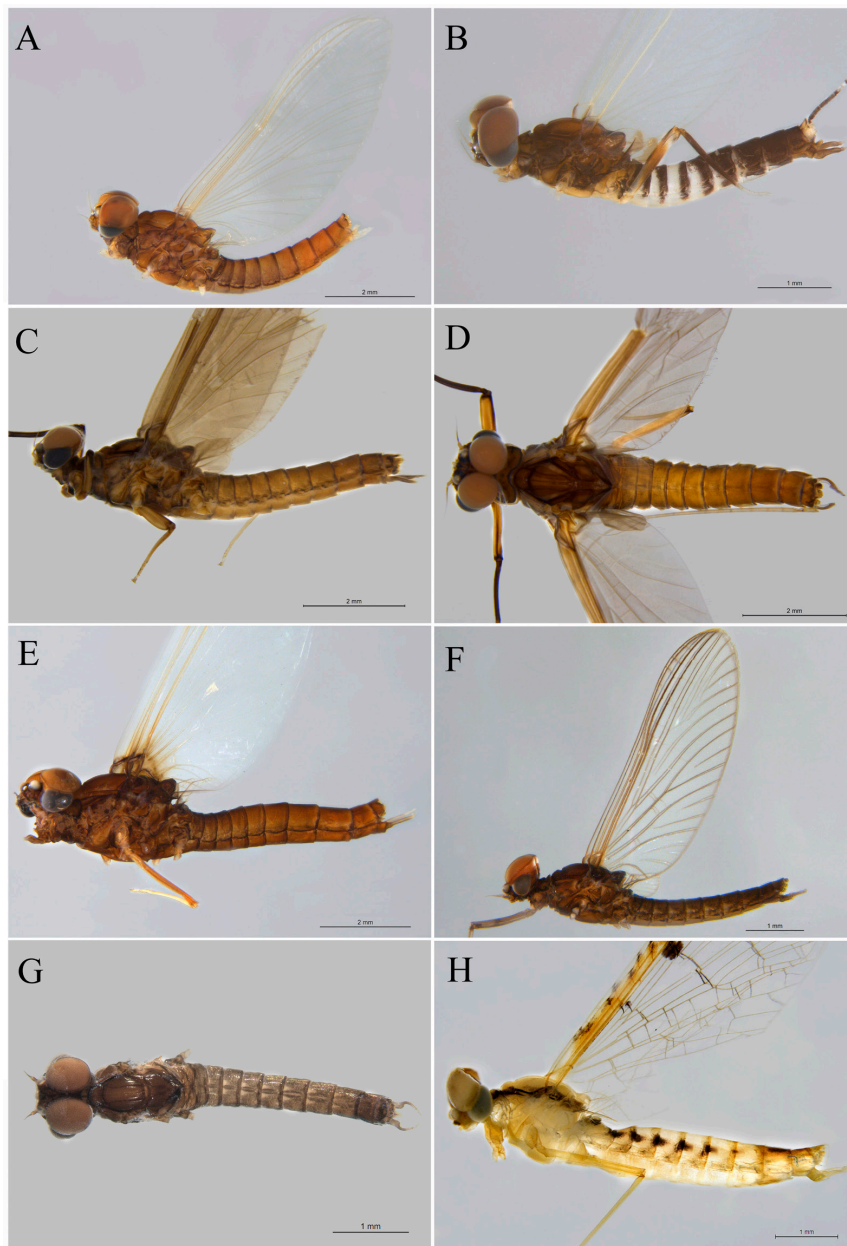
**Previous distribution:** COLOMBIA: Caldas department, Norcasia (Costa et al., 2019: 288).

Additional records from Colombia: none.

*Paramaka* sp. nov.\* (Figs. 5B and 6A)

**Previous distribution:** none.

New records from Colombia: 1 male and 2 female imagos, Putumayo department, Puerto Asís, Quebrada Agua Negra (0°31'36.3"N 76°31'38.3"W), 17 and 20/xii/2015, light trap day, deposited at CEBUC; 1 male imago,



**Figure 6.** Habits of male imagos of Leptophlebiidae species: A) lateral view of *Paramaka* sp. nov.; B) lateral view of *Simothraulopsis demerara*; C) lateral view of *Ulmeritoides huitoto*; D) dorsal view of *Ulmeritoides huitoto*; E) lateral view of *Ulmeritoides flavopedes*; F) lateral view of *Choroterpes* sp. nov.; G) dorsal view of *Choroterpes* sp. nov.; H) lateral view of *Tikuna atramentum*.

Meta department, San Juan de Arama, Finca la Esmeralda (3°20'47.21"N 73°53'21.87"W), 16-17/v/2015, light trap, deposited at CEBUC; 15 male and 10 female imagos, Meta department, San Martín, Caño Camoa (3°41'24.72"N 73°41'59.41"W), 04/i/2015, light trap, deposited at CEBUC.

*Simothraulopsis demerara* (Traver 1947) (Figs. 5B and 6B)

**Previous distribution:** COLOMBIA: Amazonas department (Zúñiga et al., 2004: 36); BRITISH GUIANA: Demerara River; SURINAME: Brokopondo District; VENEZUELA: Bolívar state (Domínguez et al., 2014: 313), Morichal District (Chacón et al., 2009: 728); FRENCH GUIANA: Sinnamary River; BRAZIL: Amazonas and Pará states (Domínguez et al., 1997: 146), Tocantins state (Boldrini and Krolow, 2017: 3), Roraima state (Gama Neto and Hamada, 2014: 285; Raimundi et al., 2017: 581), Pernambuco state (Lima et al., 2015: 5), Bahia state (Campos et al., 2016: 310; Lima et al., 2016: 217; Costa et al., 2018: 1), Maranhão state (Nascimento et al., 2020: 584), São Paulo state (Mariano and Polegatto, 2011: 594), Espírito Santo state (Salles et al., 2010: 306), and Paraná state (Faria and Salles, 2019: 376).

Additional records from Colombia: 13 male and 4 female imagos, Amazonas department, Leticia, Reserva Natural Ágape, Quebrada La Arenosa (4°11'26.81"S 69°56'11.94"W), 28/ix/2014, light trap, deposited at CEBUC.

*Thraulodes colombiae* (Walker, 1853)

**Previous distribution:** COLOMBIA (Walker, 1853: 537).

Additional records from Colombia: none.

*Thraulodes insular* Domínguez, Molineri & Zúñiga, 2015 (Fig. 5B)

**Previous distribution:** COLOMBIA: Cauca department, Parque Nacional Natural Gorgona (Zúñiga et al., 2015: 288).

Additional records from Colombia: none.

*Thraulodes laetus* (Eaton, 1883)

**Previous distribution:** COLOMBIA (Eaton, 1883: 110).

Additional records from Colombia: none.

*Thraulodes papilionis* Traver & Edmunds, 1967 (Fig. 5B)

**Previous distribution:** COLOMBIA: Tolima department, Honda (Traver and Edmunds, 1967: 374).

Additional records from Colombia: none.

*Ulmeritoides huitoto* Domínguez & Zúñiga, 2003 (Figs. 5C and 6C–D)

**Previous distribution:** COLOMBIA: Amazonas department, Leticia (Domínguez and Zúñiga, 2003: 123).

Additional records from Colombia: 1 male and 1 female imagos, Amazonas department, Leticia, (2°14'43.03"S 71°05'49.27"W), 2017, light trap, deposited at CEBUC; 1 female imago and 2 female subimagos,

Amazonas department, Leticia (4°12'21.75"S 69°55'03.31"W), 28/ix/2014, light trap, deposited at UFVB.

*Ulmeritoides flavopedes*\* (Spieth, 1943) (Figs. 5C and 6E)

**Previous distribution:** SURINAME: Marowijne District (Domínguez, 1995: 19); BRAZIL: Mato Grosso state (Shimano et al., 2010: 304), Pernambuco state (Lima et al., 2015: 5), Tocantins state (Boldrini and Krolow, 2017: 3), Pará state (Shimano et al., 2018: 141), Maranhão state (Nascimento et al., 2020: 588).

New records from Colombia: 1 male imago, Meta department, San Juan de Arama, Finca la Esmeralda (3°20'47.21"N 73°53'21.87"W), 16-17/v/2015, light trap, deposited at CEBUC; 44 male and 4 female imagos, Putumayo department, Mocoa, Fin del Mundo (1°05'48.70"N 76°36'12.13"W), vii/2018, light trap, deposited at CEBUC; 1 male imago, Putumayo department, Puerto Asís, Quebrada Agua Negra (0°31'36.3"N 76°31'38.3"W), 20/xii/2015, light trap day, deposited at CEBUC.

### Choroerpininae

*Choroerpes* sp. nov.\* (Figs. 5C and 6F–G)

**Previous distribution:** none.

New record from Colombia: 4 male imagos, Caldas department, Norcasia, Reserva Natural Río Manso, Afluente Río Manso, (5°39'25.80"N 74°51'44.66"W), 04-05/iv/2017, light trap, deposited at CEBUC.

### Terpidinae

*Fittkaulus amazonicus* Kluge, 2009 (Fig. 5D)

**Previous distribution:** COLOMBIA: Meta department, Acácias, Vereda La Esmeralda, Caño Seco stream (Salinas-Jiménez et al., 2018: 98); PERU: Loreto Region (Kluge, 2009: 248), Maynas Province (Kluge, 2015: 181).

Additional records from Colombia: none.

*Terpides contamanensis*\* Kluge, 2015 (Figs. 3C and 5D)

**Previous distribution:** PERU: Loreto Region (Kluge, 2015: 175).

New records from Colombia: 2 female imagos, Caldas department, Norcasia, Reserva Natural Río Manso, Afluente Río Manso, (5°39'25.80"N 74°51'44.66"W), 05/iv/2017, light trap, deposited at UFVB; 1 male and 1 female imagos, Tolima department, Mariquita, Quebrada Granja Universidad del Tolima (5°00'06.2"N 74°54'07.4"W), 04/xi/2017, light trap, deposited at UFVB.

*Terpides echinvaris*\* Kluge, 2015 (Figs. 3F and 5D)

**Previous distribution:** PERU: Satipo Province (Kluge, 2015: 167).

New record from Colombia: 3 male imagos, Caldas department, Norcasia, Reserva Natural Río Manso, Afluente Río Manso, (5°39'25.80"N 74°51'44.66"W), 05/iv/2017, light trap, deposited at UFVB.

*Terpides iguapoga* Molineri, Domínguez & Zúñiga, 2015 (Fig. 5D)

**Previous distribution:** COLOMBIA: Cauca department, Parque Nacional Natural Gorgona (Zúñiga et al., 2015: 283).

Additional records from Colombia: 1 male and 1 female imagos, Nariño department (Reserva Natural Nambi) (1°18'00"N 74°04'58.79"W), iii/2013, light trap, deposited at UFVB; 1 male and 1 female imagos, Caldas department, Samaná (Parque Nacional Natural Selva de Florencia), Río San Antonio (5°30'31.7"N 75°02'24.3"W), 20/x/2017, light trap, deposited at UFVB.

*Terpides ornatodermis*\* Kluge, 2015 (Fig. 5D)

**Previous distribution:** PERU: Satipo Province (Kluge, 2015: 157).

New record from Colombia: 1 male subimago, Tolima department, Mariquita, Villa de los Caballeros (5°09'21.42"N 74°53'58.32"W), 21/v/2017, reared, deposited at UFVB.

*Tikuna atramentum*\* (Traver, 1947) (Figs. 5D and 6H)

**Previous distribution:** COSTA RICA: San Jose Province (Traver, 1947: 156), Guanacaste Province (Savage, et al., 2005: 4; Flowers and Ávila, 2006: 133).

New record from Colombia: 5 male and 1 female imagos, Caldas department, Norcasia, Reserva Natural Río Manso, Afluente Río Manso, (5°39'25.80"N 74°51'44.66"W), 05/iv/2017, light trap, deposited at UFVB.

*Tikuna bilineata* (Needham & Murphy, 1924) (Fig. 5D)

**Previous distribution:** COLOMBIA: Amazonas department, La Chorrera (Needham and Murphy, 1924: 48); SURINAME: Surinam River (Traver, 1947: 156); PERU and SURINAME (Hubbard, 1982: 264); BRAZIL: Pará state; ECUADOR: Pastaza Province; SURINAME: Wijne District and VENEZUELA: Zulia state (Peters et al., 2005: 52; Chacón et al., 2009: 728); PERU: Madre de Dios department, Ucayali Province, and Maynas Province (Sweeney et al., 2009: 315; Kluge, 2015: 182); BRAZIL: Mato Grosso and Pará states (Boldrini et al., 2009: 225; Shimano et al., 2011: 250; Brasil et al., 2013: 262; Shimano et al., 2013: 36), Espírito Santo state (Angeli et al., 2015: 202), Tocantins state (Boldrini and Krolow, 2017: 3), Goiás state (Raimundi, 2019: 40), and Maranhão state (Nascimento et al., 2020: 587).

Additional records from Colombia: 1 male imago, Caldas department, Norcasia, Reserva Natural Río Manso, Afluente Río Manso, (5°39'25.80"N 74°51'44.66"W), 05/iv/2017, light trap, deposited at UFVB; 1 female imago, Valle del Cauca department, Bajo Calima, Buenaventura, Quebrada La Larga (3°59'47"N 76°58'28"W), 12/xii/2017, light trap, deposited at UFVB.

## Discussion

As expected, Hagenulinae is the most species-rich subfamily in Colombia, currently represented by 10 genera and 25 species. Among them, *Farrodos* (five species), *Miroculis* (four) and *Thraulodes* (four) stand out as the most diverse, closely followed by *Atopophlebia* and *Hagenulopsis* (three species each). In the case of *Thraulodes*, however, it should be noted, as previously stated, that additional species will be

treated elsewhere. Terpidinae is represented by its three genera and seven species, while Choroterpinae is represented by a single new species of *Choroterpes*. Unidentified species of this genus have been previously reported from Colombia based on nymphs (Peters et al., 2005; Gutiérrez and Reinoso-Flórez, 2010; García et al., 2013), and for the first time adults were found. These are the only records of the world-widely distributed Choroterpinae in South America. The absence of Atalophlebiinae in Colombia, at least among the previous and new records, was somewhat expected. Members of this subfamily include cold-adapted mayflies (Santos et al., 2018; Monjardim et al., 2020) that, in South America, are mostly restricted to Patagonia and some marginal areas along the southern portion of South American Transition Zone (Molineri et al., 2020) (the only exception is the genus *Massartella* Lestage, found in Brazil and Venezuela). It is very unlikely, therefore, that even additional collections in the Paramo, an area poorly represented at the CEBUC, would lead to the discovery of some Atalophlebiinae in the country.

Of the 33 species of Leptophlebiidae treated in this work, 14 are registered only to Colombia while 19 are present in other countries, such as Brazil (eight), Peru (five), Costa Rica (five), and Panama (four). Given the current distribution of these species, the fauna of Leptophlebiidae in Colombia seems to be a mosaic of elements from distinct biogeographic dominions (see Morrone, 2014). Some endemic, such as *Atopophlebia fortunensis*, *Farrodos caribbeanus*, and *Hydrosmilodon primanus* (from the Pacific Dominion) or *Askola emmerichi*, *Ulmeritoides flavopedes*, and *Hagenulopsis minuta* (from the Boreal Brazilian Dominion). While others are present in more than one biogeographic dominion. For example, *Fittkaulus amazonicus* (northwestern portion of the South Brazilian dominion and Boreal Brazilian), and *Terpides contamanensis* and *Terpides echinovarioris* (northwestern portion of the South Brazilian Dominion and Pacific).

The new and additional records presented in this work contribute significantly to our understanding of the knowledge of the order Ephemeroptera from Colombia. Furthermore, this work highlights the richness of the different biogeographical regions of Colombia and confirms that diversity in this country is underestimated. Our results also demonstrate the importance of biological collections as a depository of biodiversity and suggest that the knowledge of Ephemeroptera in Colombia could expand with the increase in the sampling effort, since many regions of the country have not been studied.

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## Conflicts of interest

The authors declare no conflict of interest.



## Author contribution statement

LGD conceived the research, conducted the field work and take some imagens. FFS identified the species and elaborated the discussion. ICH obtained some imagens and produced the final plates, and included the world distribution of the lineages. JFM wrote the document and elaborated the maps. All authors critically reviewed the manuscript and approved the final version of this paper.

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