doi:10.12741/ebrasilis.v11i1.748
e-ISSN 1983-0572
Publication of the project Entomologistas do Brasil
www.ebras.bio.br

Taxonomy and Systematic/Taxonomia e Sistemática

New records of Ephemeroptera (Insecta) from Roraima State, Northern Brazil

Registered on ZooBank: urn:lsid:zoobank.org:pub:A957A091-97A4-479F-BE04-9E89AF5357EA

Jaime de Liege Gama Neto[1]✉, Mahedy Araujo Bastos Passos[2], Jenisson Araujo Cruz[1] & Nazareno Trajano de Souza[1]

1. Universidade Estadual de Roraima (UERR). 2. Centro Estadual de Educação Profissional Prof. Antônio de Lima Pinho (CEEP/RR).

EntomoBrasilis 11 (1): 33-40 (2018)

Abstract. The aim of this work is to present new records and distributional notes of Ephemeroptera species on Roraima states. *Farrodes maculatus* Domínguez, Molineri & Peters, 1996, *Hermanellopsis incertans* (Spieth, 1943) and *Thraulodes marreroi* Chacón, Segnini & Domínguez, 1999 are recorded for the first time in Brazil. Family Coryphoridae, *Callibaetis cruentus* Cruz, Salles & Hamada, 2014, *Callibaetis gelidus* Cruz, Salles & Hamada, 2014, *Campylocia demoulini* Gonçalves & Salles, 2017, *Coryphorus aquilus* Peters, 1981, *Fittkaulus cururuensis* Savage, 1986, *Fittkaulus maculatus* Savage & Peters, 1978, *Miroculis fittkaui* Savage & Peters, 1983, and *Simothraulopsis sabalo* Kluge, 2007 are recorded for the first time in Roraima. The number of known species of Ephemeroptera in Roraima, after our study, has increased from 74 to 86.

Keywords: Aquatic insects; Faunal inventory; Geographic distribution; Neotropical region; Taxonomy.

Novos registros de Ephemeroptera (Insecta) do Estado de Roraima, norte do Brasil

Resumo. O objetivo deste trabalho é apresentar novos registros de espécies e notas sobre a distribuição geográfica de Ephemeroptera no Estado de Roraima. As espécies *Farrodes maculatus* Domínguez, Molineri & Peters, 1996, *Hermanellopsis incertans* (Spieth, 1943) e *Thraulodes marreroi* Chacón, Segnini & Domínguez, 1999 são registradas pela primeira vez no Brasil. A família Coryphoridae e as espécies *Callibaetis cruentus* Cruz, Salles & Hamada, 2014, *Callibaetis gelidus* Cruz, Salles & Hamada, 2014, *Campylocia demoulini* Gonçalves & Salles, 2017, *Coryphorus aquilus* Peters, 1981, *Fittkaulus cururuensis* Savage, 1986, *Fittkaulus maculatus* Savage & Peters, 1978, *Miroculis fittkaui* Savage & Peters, 1983 and *Simothraulopsis sabalo* Kluge, 2007 são registradas pela primeira vez no estado de Roraima. O número de espécies de Ephemeroptera com registros de ocorrência em Roraima é elevado de 74 a 86.

Palavras-Chave: Distribuição geográfica; Insetos aquáticos; Inventário de fauna; Região Neotropical; Taxonomia.

Ephemeroptera comprise an abundant and diverse order of hemimetabolous aquatic insects with approximately 375 genera and 3,200 species grouped in 37 families worldwide (Barber-James *et al*. 2013). There are about 80 genera and 351 species of Ephemeroptera in Brazil, representing 10 families (Santos 2017).

Roraima is the northernmost state in Brazil and its Ephemeroptera fauna is poorly known due to the paucity of studies on this taxonomic group in the state. The first and most significant Ephemeroptera inventory for Roraima state was conducted by Falcão *et al*. (2011), where they recorded 32 species of Baetidae. After that study, only a few taxonomic studies on Ephemeroptera were made in Roraima, providing new records and describing species (Gama Neto & Hamada 2013, 2014; Boldrini & Barroso 2015; Gama Neto & Passos 2016, 2017; Boldrini & Lima 2017; Molineri & Salles 2017; Raimundi *et al*. 2017). At present, Roraima states has 74 mayfly species belonging the families Baetidae, Caenidae, Leptohyphidae, Leptophlebiidae, Oligoneuriidae and Polymitarcyidae. Baetidae and Leptophlebiidae are the most species-rich families including approximately 78% of the mayfly species in Roraima (Santos 2017).

The aim of the present study is to provide new records and distributional notes for mayflies from Brazil and Roraima state, northern Brazil, based in collections made in the Alto Alegre, Mucajaí and Normandia municipalities.

MATERIAL AND METHODS

Mayflies were collected from September/2014 to December/2015 in three municipalities of the Roraima state, Brazil (Figure 1). Adult mayflies were collected with light-traps and nymphs were captured with aquatic entomological net. Specimens were preserved in 70% ethanol. For species identification, wings and male genital structures were examined under stereomicroscope. Nymphs' mouthparts, legs and gills were mounted on glass

Edited by:
William Costa Rodrigues
Article History:
Received: 16.x.2017
Accepted: 02.ii.2018

✉ **Corresponding author:**
Jaime de Liege Gama Neto
jaimebio@hotmail.com
No ORCID record

Funding agencies:
Without funding declared

slides with Berlese liquid using a modified version of the Young & Duncan (1994) temporary mounting technique. Whenever necessary, the genitalia also was removed and mounted on slides containing Berlese liquid and examined with a microscope for better visualization of its morphology.

Photographs of the species were taken using a Fuji FinePix s-4000 digital camera coupled to stereomicroscope Olympus SZ51 or to microscope Nikon Eclipse E-200. A series of digital images of different focal depths from each subject was stacked using the software CombineZP to produce enhanced quality final images. All collected specimens are deposited in the entomology collection of the Museu Integrado de Roraima (MIRR).

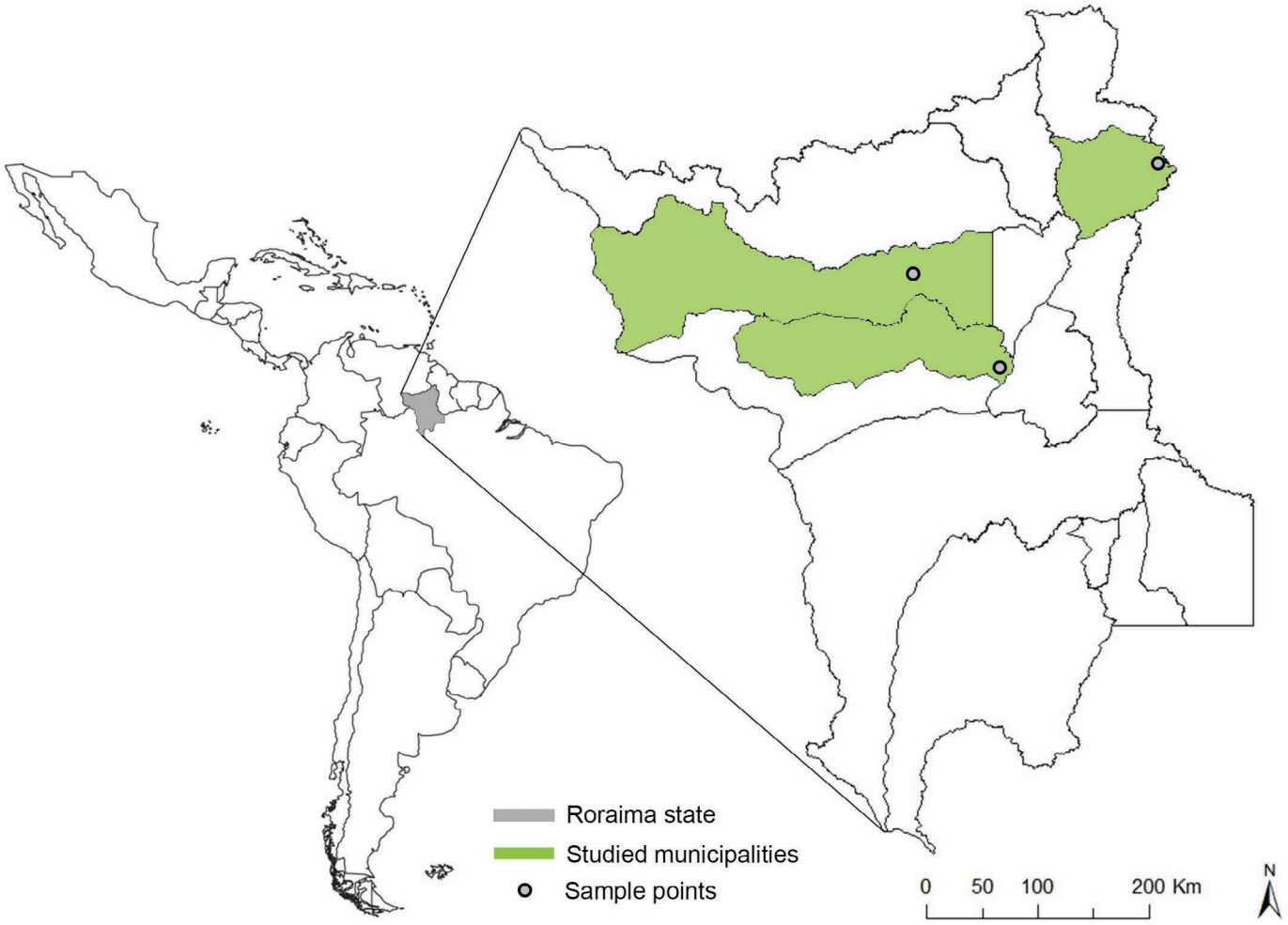


Figure 1. Map on left showing Brazil highlighting Roraima state (gray). The right map showing Roraima studied municipalities (green) and the sampled sites (black circle).

RESULTS

The new records of mayfly species from Roraima are proved below, together species' diagnosis and geographical distribution data.

Species list

Family Baetidae Leach, 1815

Callibaetis cruentus Cruz, Salles & Hamada, 2014

Callibaetis cruentus Cruz *et al.* 2014: 13

Male imago. 1) Dorsal portion of turbinate eyes oval; 2) forewing hyaline with black bands transversally, medially with transverse band complete; 3) marginal intercalary veins paired, except between veins ICu2 and A; 4) hind wing hyaline with brown marks basally, medially and apically; 5) costal process of hind wing compound; 6) abdominal sterna with many reddish spots, laterally with reddish brown spot, medially one brown mark and submedially with two light black marks; 7) forceps segment I cylindrical.

Previous distribution. Brazil: Amazonas state (Cruz *et al.* 2014).

Examined Material: 02 female imago (MIRR-EPH 0011), Brazil, Alto Alegre municipality, Vicinal do Barro, 03°67'36" N, 061°01'48.7" W, Sítio Riacho Doce, 23.VIII.2014, J.L. Gama Neto and M.A.B. Passos col.

Remarks. Its find in this study represents the first record of this species in Roraima state.

Callibaetis gelidus Cruz, Salles & Hamada, 2014

Callibaetis gelidus Cruz *et al.* 2014: 23

Diagnosis. Male imago. 1) Dorsal portion of turbinate eyes circular, apical third with constriction, base is wider than apex in lateral view; 2) forewing hyaline, except C, Sc, R1 areas; 3) marginal intercalary veins paired, except between veins MP and A; 4) hind wing hyaline, sometimes with one brown mark near costal process; 5) hind wing with costal process compound; 6) abdominal sterna with one brown mark submedially; 7) forceps segment I cylindrical.

Previous distribution. Brazil: Amazonas and Rondônia state (Cruz *et al.* 2014).

Examined Material: 02 male imago (MIRR-EPH 0012), Brazil, Alto Alegre municipality, Vicinal do Barro, 03°67'36" N, 061°01'48.7" W, Sítio Riacho Doce, 23.VIII.2014, J.L. Gama Neto and M.A.B. Passos col.

Remarks. Its find in this study represents the first record of this species in Roraima state.

Family Coryphoridae Molineri, Peters & Cardoso, 2001

Coryphorus aquilus Peters, 1981 (Figure 2)

Coryphorus aquilus Peters 1981: 211; Molineri *et al.* 2002: 120; Molineri *et al.* 2011: 43.

Diagnosis. 1) Absence of intercalaries in the cubital field of forewings; 2) setae presente on posterior margin of forewing; 3) male with large, fused, distally broadened penes and short desclerotized forceps; 4) Styliger plate produced distally, about as long as wide; 5) eyes undivided, separated, greatly enlarged.

Previous distribution. Colombia, Brazil (Amapá, Amazonas, Mato Grosso and Pará states), French Guyana and Venezuela (Peters 1981; McCafferty & Wang 2000; Molineri *et al.* 2001; Molineri & Peters 2002; Domínguez *et al.* 2006; Molineri *et al.* 2011; Shimano *et al.* 2011; Belmont *et al.* 2015).

Examined Material: 02 male imago (MIRR-EPH 0013), Brazil, Mucajaí municipality, Vicinal Embrapa, 02°24'78" N, 060°58'41.8" W, 31.X.2015, J.A. Cruz col.

Remarks. Its find in this study represents the first record of both family and species in Roraima state.

Family Euthyplociidae Lestage, 1921

Campylocia demoulini Gonçalves & Salles, 2017 (Figures 3 and 4)

Campylocia demoulini Gonçalves *et al.* 2017: 11; Boldrini & Kroslow 2017: 1.

Diagnosis. Imago: 1) Forewings usually with one ICu vein; 2) Abdominal colour pattern with two pairs of dropshaped spots, one on medioapical region on terga II-IX and one on medial region, narrower and more subtle, on terga II-VIII; 3) Styliger plate semi-rounded; 4) Penes wide with distal half strongly curved outwards.

Previous distribution. Brazil (Amazonas, Pará, Distrito Federal, Mato Grosso, and Tocantins states), Ecuador and Surinam (Boldrini & Kroslow 2017; Gonçalves *et al.* 2017)

Examined material. 25 males and 10 females imagos (MIRR-EPH 0014), Brazil, Roraima state, Mucajai municipality, Vicinal Sem Terra, 02°19'11.9" N, 060°55'25.8" W, 17.X.2015, J.L. Gama Neto, M.A.B. Passos and J.A. Cruz col.

Remarks. Its find in this study represents the first record of this species from Roraima states.

Family Leptophlebiidae Banks, 1900

Farrodes maculatus Domínguez, Molineri & Peters, 1996 (Figures 5 and 6)

Thraulus maculatus Needham & Murphy 1924: 45; Ulmer 1943: 28; Traver 1947: 149.

Homothraulus maculatus Traver 1960: 73; Peters & Tsui 1972: 565; Hubbard 1982a: 265.

Diagnosis. 1) Forewings with dark pigments, including a dark macula at fork of vein MA; 2) vein MP of fore wings forked asimmetrically to vein MP2 attached to MP1 by a crossvein; 3) Apex of hind wing obtuse, broadly rounded; 4) Mesonotun wich heavy brownish black wash forming marks on anterolateral margins, anterolateral sutures dark brown but not heavely with brownish black; 5) lateral subposteriormargins just anterior to lateral subposterior humps washed lightly to heavely with brownish black; 6) terga 3-5 wich small median dark marks.

Previous distribution. Argentina (Domínguez 1999).

Examined material. 06 males imago (MIRR-EPH 0015), Brazil, Mucajaí municipality, Vicinal Embrapa, 02°24'08.7" N; 060°58'41.8" W, 31.X.2015, J.A. Cruz col.

Remarks. Its find in this study represents the first record of this species from Brazil.

Fittkaulus cururuensis Savage, 1986 (Figures 7-9)

Fittkaulus cururuensis Savage 1986: 268; Domínguez *et al.* 2002: 462; Boldrini *et al.* 2009: 220.

Diagnosis. Nymphs: 1) labrum with anteromedian emargination without denticles; 2) apex of galea-lacinia with one large, pectinate setae and one large, nonpectinate, curved setae; 3) coxae II and III with brown mark; 4) tergum yellow washed with brown, terga II-VII with sublateral yellow mark, terga VIII with median area yellow, posterior 2/3 of terga IX yellow. Female imagos: 1) fore wing without a dark macula at fork of vein MA; 2) coxae I and II, or II and III with brown mark; 3) abdominal sterna 1-2 with small posteromedian brownish black marks.

Previous distribution. Brazil (Espírito Santo, Mato Grosso, Pará, and Pernambuco states) (Savage 1986; Boldrini *et al.* 2009; Lima *et al.* 2012).

Examined material. 04 female imagos (01 reared) and 03 nymphs (MIRR-EPH 0016), Brazil, Mucajaí municipality, Vicinal Tamandaré, 02°28'51.6" N, 060°55'33.8" W, 18.IX.2015, J.L. Gama Neto, M.A.B. Passos and J.A. Cruz col.

Remarks. Its find in this study represents the first record of this species from Roraima states.

Fittkaulus maculatus Savage & Peters, 1978 (Figure 10)

Fittkaulus maculatus Hubbard 1982a: 264; Savage 1986: 262; Domínguez *et al.* 2002: 462.

Diagnosis. 1) Nymphs: anteromedian emargination of labrum well developed with 6 very small apically flattened denticles; 2) Abdominal terga with brownish black markings as Fig. xx; 3) Metanotum with a median longitudinal mark that widens anteriorly, mark often appears as a distinct triangle.

Previous distribution. Brazil (Pará and Bahia states), Surinam (Savage & Peters 1978; Da-Silva 1992).

Examined material: 02 nymphs (MIRR-EPH 0017), Brazil, Mucajaí municipality, Vicinal Tamandaré, 02°28'51.6" N, 060°55'33.8" W, 18.IX.2015, J.L. Gama Neto, M.A.B. Passos and J.A. Cruz col.

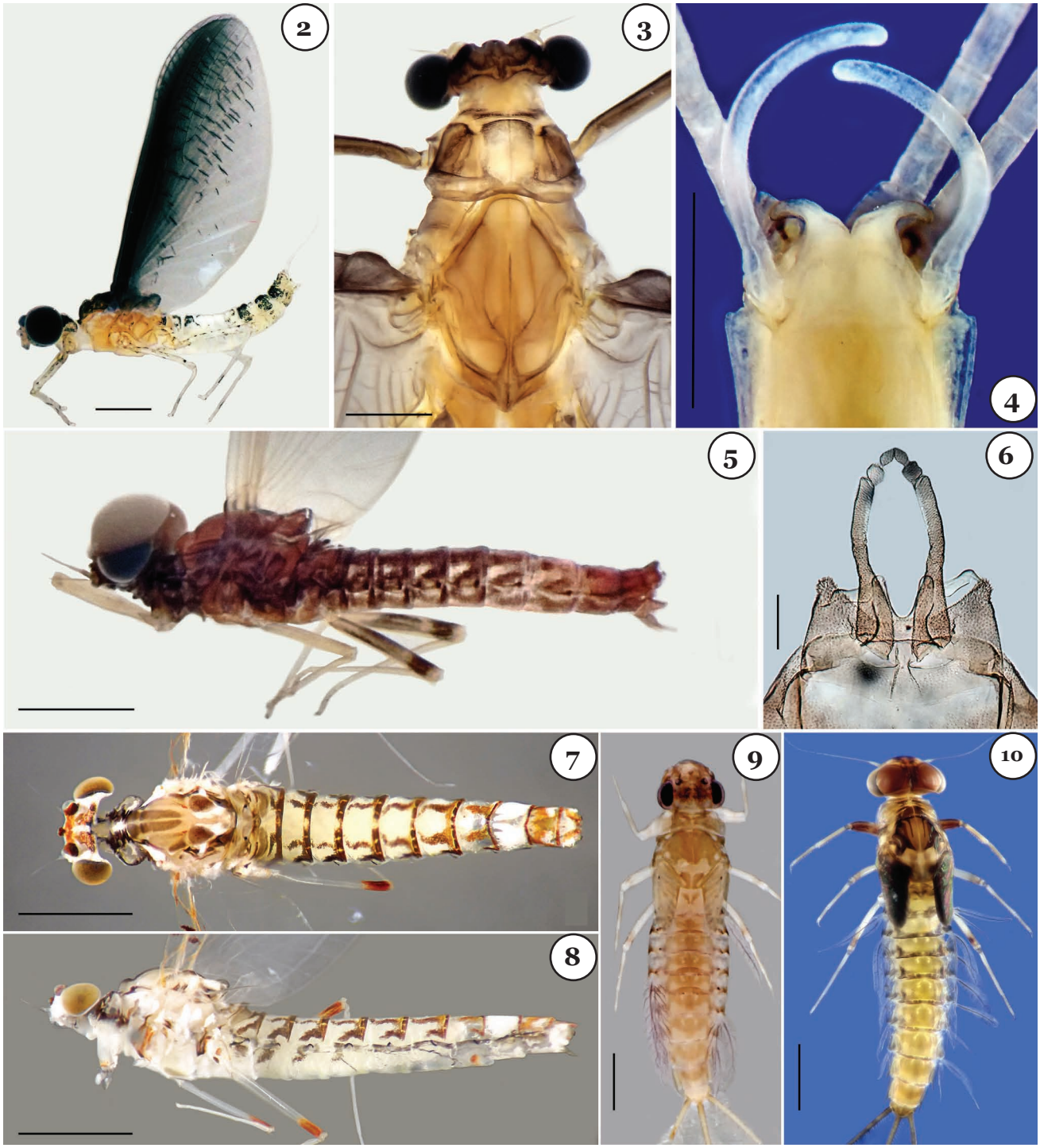
Remarks. Its find in this study represents the first record of this species from Roraima states.

Hermanellopsis incertans (Spieth, 1943) (Figures 11 and 12)

Hermanella incertans Spieth, 1943: 9; Traver, 1947: 159; Demoulin, 1966: 11.

Hermanella (*Hermanellopsis*) *incertans* Demoulin, 1955: 8.

Hermanellopsis incertans Edmunds, Jensen & Berner, 1976: 223; Hubbard,1982b: 264; Savage, 1983: 128; Savage & Peters, 1983: 579.



Figures 2-10. Ephemeroptera species: 2. *Coryphorus aquilus* male imago (Left lateral view). 3-4. *Campylocia demoulini* male imago: 3. Thorax (Dorsal view); 4. Genitalia (Ventral view). 5-6. *Farrodes maculatus* male imago: 5. left lateral view; 6. Genitalia (Ventral view). 7-9. *Fittkaulus cururuensis* female imago: 7. Dorsal view; 8. Left lateral view. 9. *Fittkaulus cururuensis* nymph (dorsal view). 10: *Fittkaulus maculatus* nymph (dorsal view) (Scales = 1 mm, except Figure 6 = 0.1 mm).

Diagnosis. 1) Upper portion of male eyes with 25-31 facets in longest row; and 2) vein MP2 of fore wings joined at base to veins MP1 and CuA by cross veins; 3) Posteromedian margin of male styliger plate gently rounded with a median notch and submedian projections; and (5) Penes long and narrow.

Previous distribution. Guyana and Surinam (Domínguez *et al.* 2006).

Examined material: 10 male imago (MIRR-EPH 0018), Brazil, Normandia municipality, Maú River, 03°57'07.6" N, 059°31'23.2" W, 05.X.2015, N.T. Souza col.

Remarks. Its find in this study represents the first record of this species from Brazil.

Miroculis (Miroculis) fittkaui Savage & Peters, 1983 (Figures 13 and 14)

Miroculis (*Miroculis*) *fittkaui* Savage 1983: 130; Savage 1987: 103.

Diagnosis. 1) Membrane of wings hyaline to very light brown, fore wings with darker brown clouds around cros veins; 2) ratio of femora to tibiae of male prothoracic legs 0.56-0.61; length of male protoracic tibiae 1.9-2.2mm; 3) median area of abdominal tergum VI with a brownish-black V-shaped mark, with open end of V directed posteriorly; 4) basal 1/3-1/2 of inner margin of forceps segment I abruptly narrows apically, distal 1/4 of inner margin developed; 5) styliger plate posteromedian margin gently rounded with a shallow median identation; and 6) penes tubular, scavated apically, 0.9-1.3 length of forceps segment I.

Previous distribution. Brazil (Espírito Santo, Pará, and Pernambuco states), Surinam and Venezuela (Savage & Peters 1983; Domínguez *et al*. 2006; Lima *et al*. 2012).

Examined material: 01 male imago (MIRR-EPH 0019), Brazil, Mucajai municipality, Vicinal rufina, 02°25'49.8" N, 60°52'15.5" W, 02.X.2015, J.A. Cruz coll.

Remarks. Its find in this study represents the first record of this species from Roraima.

Simothraulopsis (Maculognathus) sabalo Kluge, 2007 (Figures 15 and 16)

Simothraulopsis (Maculognathus) sabalo Kluge 2007: 389

Simothraulopsis sabalo Nascimento *et al*. 2017: 23.

Diagnosis. 1) thorax orangish yellow, abdomen orangish brown; 2) forewing with two costal cross veins basal to bulla; 3) hind wing with costal projection forming an acute angle, located approximately 2/3 distance from base to apex of wing; 4) abdominal segments I-V with translucent white basal bands;

Figures 11-18. Figures on left showing Ephemeroptera male imago habitus (left lateral view) and figures on right showing the species genitalia (ventral view): 11 and 12. *Hermanellopsis incertans*. 13 and 14. *Miroculis fittkaui*. 15 and 16. *Simothraulopsis sabalo*. 17 and 18. *Thraulodes marreroi* (Scales: Figures 11, 13, 15 and 17 = 1 mm; Figures 12, 14, 16 and 18 = 0,1mm).

5) forceps basal region of segment I with a small concavity; 6) penis projection spine-like, of median size (approximately half of the total length of penis lobes) and anteriorly directed; 7) penis lobes fused on basal 1/2; 8) ventral region of penis lobes without a well-marked sclerotized region.

Previous distribution. Brazil (Amazonas and Pernambuco states), Peru (Kluge 2007; Lima *et al.* 2012; Nascimento *et al.* 2017).

Examined material. 10 male imago (MIRR-EPH 0020), Brazil, Normandia municipality, Maú River, 03°57'07.63" N, 059°31'23.2" W, 0 5.X.2015, Nascimento col.

Remarks. Its find in this study represents the first record of this species from Roraima.

Thraulodes marreroi Chacón, Segnini & Domínguez, 1999 (Figures 17 and 18)

Thraulodes marreroi Chacón *et al.* 1999: 255.

Diagnosis. 1) fore wings no crossveins basal to bulla; 2) main longitudinal veins yellowish; 3) abdominal color pattern as in Figures 17 and 18, central area of terga II-IV tinged with reddish; 4) femora I with apical 1/5 covered with a tricolored spot; 5) penes long and stout, spine long and narrow; apicolateral area forming a small "ear"; external margin forming a small lateral pouch; recurved fold slightly angulated.

Previous distribution. Venezuela (Chacón *et al.* 1999).

Examined material: 04 male imago (MIRR-EPH 0021), Brazil, Roraima State, Normandia municipality, Maú River, 03°57'07.6" N, 059°31'23.2" W, 05.X.2015, J.L. Gama Neto col.

Remarks. Its find in this study represents the first record of this species from Brazil.

Family Leptohyphidae Edmunds & Traver, 1954

Tricorythodes sp.

Tricorythodes Ulmer, 1920: 51; Needham *et al.*, 1935: 630; Traver, 1958: 501; Allen, 1967: 369; Allen & Brusca, 1973: 94; Allen, 1977: 431; Allen & Murvosh, 1987: 36; Wiersema & McCafferty, 2000: 353; Molineri, 2002: 305.

Examined material. 09 male imago, (MIRR-EH 0022), Brazil, Mucajai municipality, Vicinal Embrapa 02°24'8.7" N, 60°58'41.8" W, 31.X.2015, J.A. Cruz coll.

Remarks. Its find in this study represents the first record of the genus in Roraima state. The caught specimens shows no similarity to any described species, and it could be a new species. The species description was not possible because only adults were analyzed, and the association with nymphs is essential for recognition of the species.

DISCUSSION

We found 74 Ephemeroptera species in Roraima State through literature review, including members of Baetidae, Caenidae, Euthyplociidae, Leptohyphidae, Leptophlebiidae and Oligoneuriidae families (Gama Neto & Passos 2017; Raimundi *et al.* 2017; Santos *et al.* 2017). In our study, besides these families, we found the family Coryphoridae which is recorded for the first time in Roraima.

Three species are recorded for the first time in Brazil, before they were known only from Argentina (*Farrodes maculatus*), Guyana and Surinam (*Hermanellopsis incertans*), and Venezuela (*Thraulodes marreroi*), referenced only in their original description. The find of *F. maculatus* in Roraima considerably extends its distribution further north in South America.

We observed variations in the *Thraulodes marreroi* species from Roraima states. In general, specimens collected in Roraima have forceps segments III clearly shorter than forceps segments II, and penes apicolateral area apparently not forming an "ear", while *T. marreroi* specimens from Venezuela have subequal forceps segments II and III, and penis apicolateral area forming a pronunciated "ear". We consider it as populational variation because no more relevant differences were found.

The species *Callibaetis cruentus*, *Callibaetis gelidus*, *Campylocia demoulini*, *Coryphorus aquilus*, *Fittkaulus cururuensis*, *Fittkaulus maculatus* and *Miroculis fittkaui*, previously recorded only in Amazonas (*C. cruentus*, *C. gelidus*, *C. demoulini*, and *C. aquilus*), Amapá (*C. aquilus*), Bahia (*F. maculatus*), Distrito Federal (*C. demoulini*), Espírito Santo (*F. cururuensis and M. fittkaui*), Mato Grosso (*C. demoulini*, *C. aquilus*, and *F. cururuensis*), Pará (*C. demoulini*, *C. aquilus*, *F. cururuensis, F. maculatus, and M. fittkaui*), Pernambuco (*F. cururuensis, M. fittkaui*), Rondônia (*C. gelidus*) and Tocantins states (*C. demoulini*) (Savage & Peters 1978, 1983; Savage 1986; Da-Silva 1992; Boldrini *et al.* 2009, Lima *et al.* 2012; Cruz *et al.* 2014; Gonçalves *et al.* 2017; Santos *et al.* 2017) have their known distributions extended to the far north in Brazil. In addition, the species *Coryphorus aquilus, Miroculis fittkaui* and *Thraulodes marreroi* are filling the existing gap in their species' distributions, showing continuity between Brazil and Venezuela.

After our study, the number of known Ephemeroptera species in Roraima has increased from 74 to 86.

ACKNOWLEDGEMENTS

We are grateful to Dra. Maria Marleny Chacón by to analyse images of *Thraulodes marreroi* from Roraima, giving suggestions about intraspecific variations.

REFERENCES

Allen, R.K., 1965. A review of the subfamilies of Ephemerellidae (Ephemeroptera). Journal of the Kansas Entomological Society, 38: 262-266.

Allen, R.K., 1977. A new species of *Tricorythodes* with notes (Ephemeroptera: Tricorythidae). Journal of the Kansas Entomological Society, 50: 431-435.

Allen, R.K. & R.C. Brusca, 1973. New species of Leptohyphinae from Mexico and Central America (Ephemeroptera: Tricorythidae). Canadian Entomologist, 105: 83-95. DOI: https://doi.org/10.4039/ent10583-1.

Allen, R.K. & C.M. Murvosh, 1987. Mayflies (Ephemeroptera: Tricorythidae) of the southwestern United States and northern Mexico. Annals of the Entomological Society of America, 80: 35-40. DOI: https://doi.org/10.1093/aesa/80.1.35.

Barber-James, H., M. Sartori, J.L. Gattolliat & J. Webb, 2013. World checklist of freshwater Ephemeroptera species. Available on: <http://fada.biodiversity.be/group/show/35>, [Access in: 4.ix.2017].

Banks, N., 1900. New genera and species of Neartic neuropteroid insects. Transactions of the American Entomological Society, 26: 239-251.

Belmont, E.L.L., Cruz, P.V. & N. Hamada, 2015. A new species of *Tricorythopsis* Traver, 1958 (Leptohyphidae) and occurrence of Pannota (Insecta: Ephemeroptera) species in Amapá state, Brazil. Zootaxa, 4007: 104-112. DOI: https://doi.org/10.11646/zootaxa.4007.1.7.

Boldrini, R., F.F. Salles & H.R.S. Cabette, 2009. Contribution to the taxonomy of the *Terpides* lineage (Ephemeroptera: Leptophlebiidae). Annalles de Limnologie - International Journal of Limnology, 45: 219-229. DOI: https://doi.org/10.1051/limn/2009029.

Boldrini, R. & P.C.S. Barroso, 2015. The male imago of *Paramaka incognita* Domínguez, Grillet, Nieto, Molineri & Guerrero,

2014 (Ephemeroptera: Leptophlebiidae). Zootaxa, 3957: 231-234. DOI: https://doi.org/10.11646/zootaxa.3957.2.7.

Boldrini, R. & L.R.C. Lima, 2017. New species and stages description of *Ulmeritoides* Traver, 1959 (Ephemeroptera: Leptophlebiidae) from Roraima State, Northern Brazil. Zootaxa, 4282: 385-394. DOI: https://doi.org/10.11646/zootaxa.4282.2.11.

Boldrini, R. & T.K. Kroslow, 2017. New records of Ephemeroptera (Insecta) from Tocantins state, northern Brazil. Check List, 13: 1-5. DOI: https://doi.org/10.15560/13.2.2067.

Chacón, M.M., S. Segnini & E. Domínguez, 1999. Three New Species of *Thraulodes* (Ephemeroptera: Leptophlebiidae: Atalophlebiinae) from Venezuela. Aquatic Insects, 21: 249-257. DOI: https://doi.org/10.1076/aqin.21.4.249.4504.

Cruz, P.V., F.F. Salles & N. Hamada, 2014. *Callibaetis* Eaton (Ephemeroptera: Baetidae) from Brazil. Journal of Natural History, 1-70. DOI: https:// doi.org/10.1080/00222933.2013.791883

Da-Silva, E.R, 1992. Description of the nymph of *Homoeoneuria (Notochora) fittkaui* Pescador & Peters, 1980 from northeastern Brazil (Ephemeroptera, Oligoneuriidae, Oligoneuriinae). Revista Brasileira de Entomologia, 36: 693-696.

Demoulin, G., 1955. Une mission biologique belge au Brésil. Éphéméroptères. Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, 31: 1-32.

Demoulin, G, 1966. Contribution à l'étude des Éphéméroptères du Surinam. - Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, 42: 1-22.

Domínguez, E., 1999. Systematics, cladistics and biogeography of the American genus *Farrodes* (Ephemeroptera, Leptophlebiidae, Atalophlebiinae). Zoological Journal of the Linnean Society, 126: 155-189. DOI: https://doi.org/10.1111/j.1096-3642.1999.tb00152.x.

Domínguez, E., C. Molineri & W.L. Peters, 1996. Ephemeroptera from Central and South America: New species of the *Farrodes bimaculatus* group with a key for the males. Studies on Neotropical Fauna and Environment, 31: 87-101. DOI: https://doi.org/10.1076/snfe.31.2.87.13325.

Domínguez, E., M.C. Zúñiga & C. Molineri, 2002. Estado actual del conocimiento y distribución del Orden Ephemeroptera (Insecta) en la región amazónica. Caldasia, 24: 459-469.

Domínguez, E., Molineri, C., Pescador, M.L., Hubbard, M.D. & C. Nieto, 2006. Ephemeroptera of South-America. Aquatic Biodiversity in Latin America (ABLA) (Vol. 2). Pensoft, Sofia-Moscow, 646 p.

Edmunds, G.F.Jr. & J.R. Traver, 1954. An outline of a reclassification of the Ephemeroptera. Proceedings of the Entomological Society of Washington, 56: 236-240.

Edmunds, G.F.Jr., S.L. Jensen & L. Berner, 1976. Mayflies of North and Central America. University of Minnesota Press, Minneapolis, 330 p.

Falcão, J.N., F.F. Salles & N. Hamada, 2011. Baetidae (Insecta, Ephemeroptera) ocorrentes em Roraima, Brasil: novos registros em chaves para gêneros e espécies no estágio ninfal. Revista Brasileira de Entomologia, 55: 516-548. DOI: https://doi.org/10.1590/s0085-56262011005000048.

Gama Neto, J.L. & N. Hamada, 2013. A new species of *Miroculis* Edmunds, 1963 (Ephemeroptera, Leptophlebiidae) from northern Brazil. Zootaxa, 3734: 597-600. DOI: https://doi.org/10.11646/zootaxa.3734.5.9.

Gama Neto, J.L. & N. Hamada, 2014. Leptophlebiidae (Ephemeroptera) of the serra do Tepequém, Roraima State, Brazil: new records and description of two new species. Zootaxa, 3900: 279-286. DOI: https://doi.org/10.11646/zootaxa.3900.2.8.

Gama Neto, J.L. & M.A.B. Passos, 2016. Leptophlebiidae (Ephemeroptera) from Roraima State, Brazil: description of two new species of *Ulmeritoides* Domínguez, 1991. Zootaxa, 4178: 295-300. DOI: https://doi.org/10.11646/zootaxa.4178.2.8.

Gama Neto, J.L. & M.A.B. Passos, 2017. A new species of *Campylocia* Needham & Murphy, 1924 (Ephemeroptera, Euthyplociidae) from Northern Brazil. Zootaxa, 4244: 296-300. DOI: https://doi.org/10.11646/zootaxa.4244.2.10.

Gonçalves, I.C., D.M. Takiya, F.F. Salles, J.G. Peters & J.L. Nessimian, 2017. Integrative taxonomic revision of *Campylocia* (mayflies: Ephemeroptera, Euthyplociidae). Systematics and Biodiversity, 1-18. DOI: https://doi.org/10.1080/14772000.2017.1291543.

Hubbard, M.D., 1982a. Catálogo abreviado de Ephemeroptera da América do Sul. Papéis Avulsos de Zoologia, 34: 257-282.

Hubbard, M.D., 1982b. Catalog of the Ephemeroptera: Family-Group Taxa, Aquatic Insects 4: 49-53.

Kluge, N.J., 2007. A new taxon Hermanellonota or subtribe Hermanellini subtr. n. (Ephemeroptera, Leptophlebiidae, Hagenulini), with description of three new species from Peruvian Amazonia. Russian Entomological Journal, 16: 127-137.

Lestage, J.A, 1921. Ephemeroptera, p. 162-273 *In*: Rousseau, E. (Ed.). Les larves et nymphes aquatiques des insectes d'Europe (Morphologie, Biologie, Systematique). Office de Publicité, Anc. Établiss. J. Lebègue & Cie. Éditeurs. Bruxelles, 1,966 p.

Lima, L.R.C., F.F. Salles & U. Pinheiro, 2012. Ephemeroptera (Insecta) from Pernambuco State, northeastern Brazil. Revista Brasileira de Entomologia, 56: 304-314. DOI: https://doi.org/10.1590/s0085-56262012005000043.

Lima, L.R.C.; F.F. Salles & U. Pinheiro, 2015. New records of mayflies (Ephemeroptera: Insecta) from Pernambuco state, northeasthern Brazil. Check List, 11: 1652. DOI: https://doi.org/10.15560/11.3.1652.

McCafferty, W.P. & T.Q. Wang, 2000. Phylogenetic systematics of the major lineages of pannote mayflies (Ephemeroptera: Pannota). Transactions of the American Entomological Society, 126: 9-101.

Molineri, C., 2002. Cladistic analysis of the South American species of *Tricorythodes* (Ephemeroptera: Leptohyphidae) with the description of new species and stages. Aquatic Insects, 24: 273-308. DOI: https://doi.org/10.1076/aqin.24.4.273.8236.

Molineri, C. & J. Peters, 2002. A new Family Coryphoridae (Ephemeroptera: Ephemerelloidea), and description of winged and egg stages of *Coryphorus*. Insecta Mundi, 15: 117-122.

Molineri, C. & F.F. Salles, 2017. Review of selected species of Campsurus Eaton 1868 (Ephemeroptera: Polymitarcyidae), with description of eleven new species and a key to male imagos of the genus. Zootaxa, 4300: 301-354. DOI: https://doi.org/10.11646/zootaxa.4300.3.1

Molineri, C., Peters, J.G. & M.C.Z. Cardoso, 2001. A new family, Coryphoridae (Ephemeroptera: Ephemerelloidea), and description of the winged and egg stages of *Coryphorus*. Insecta Mundi, 15: 117-122.

Molineri, C., M. E. Grillet, C. Nieto, E. Dominguez & E. Guerrero, 2011. New species and records for the mayfly families Caenidae, Leptohyphidae and Coryphoridae (Ephemeroptera, Pannota) from Venezuelan Guayana's Uplands. Zootaxa, 2750: 39-50.

Nascimento, J.M.C., F.F. Salles & N. Hamada, 2017. Systematics of *Simothraulopsis* Demoulin, 1966 (Ephemeroptera: Leptophlebiidae). Zootaxa, 4285: 001-081. DOI: https://doi.org/10.11646/zootaxa.4285.1.1.

Needham, J.G. & H.E. Murphy, 1924. Neotropical mayflies. - Bulletin of the Lloyd Library Number 24. Entomological Series, 4: 1-79.

Needham, J.G., J.R. Traver & Y.C. Hsu, 1935. The Biology of Mayflies. Comstock, New York.

Peters, W.L, 1981. *Coryphorus aquilus*, a new genus and species of Tricorythidae from Amazon Basin (Ephemeroptera). Aquatic insects, 3: 209-217.

Peters, W.L. & P.T.P. Tsui, 1972. A new name for a specific homonym in *Thraulus* (Ephemeroptera: Leptophlebiidae).

Oriental Insects, 6: 565. DOI: https://doi.org/10.1080/00305316.1972.10434197.

Raimundi, E.A., J.M.C. Nascimento, P.C.S. Barroso, N. Hamada & R. Boldrini, 2017. Three new species of *Miroculis* from the Serra da Mocidade National Park, Roraima State, Brazil, with new records and checklist of the Leptophlebiidae (Ephemeroptera). Zootaxa, 4317: 573-583. DOI: https://doi.org/10.11646/zootaxa.4317.3.8.

Santos, A.P.M., 2017. Trichoptera in Catálogo Taxonômico da Fauna do Brasil. PNUD. Available on: <http://fauna.jbrj.gov.br/fauna/faunadobrasil/278>. [Accessed in: 30.viii.2017].

Savage, H.M., 1983. Wing evolution within *Miroculis* and related genera (Ephemeroptera: Leptophlebiidae) from northern South America. Zeitschrift für zoologische Systematik and Evolutions forschung, 21: 124-142. DOI: https://doi.org/10.1111/j.1439-0469.1983.tb00281.x.

Savage, H.M., 1986. Systematics of the *Terpides* lineage from the Neotropics: Definition of the *Terpides* lineage, methods, and revision of *Fittkaulus* Savage & Peters. Spixiana, 9: 255-270.

Savage, H.M., 1987. Two new species of *Miroculis* from Cerro de la Neblina, Venezuela with new distribution records for *Miroculis fittkaui* and *Microphlebia surinamensis* (Ephemeroptera: Leptophlebiidae). Aquatic Insects, 9: 97-108. DOI: https://doi.org/10.1080/01650428709361279.

Savage, H.M. & W.L. Peters, 1978. *Fittkaulus maculatus* a new genus and species from northern Brazil (Leptophlebiidae: Ephemeroptera). Acta Amazonica, 8: 293-298. DOI: https://doi.org/10.1590/1809-43921978082293.

Savage, H.M. & W.L. Peters, 1983. Systematics of *Miroculis* and related genera from northern South America. Transactions of the American Entomological Society, 108: 491-600.

Shimano, Y., Salles, F.F. & H.S.R. Cabette, 2011. Ephemeroptera (Insecta) ocorrentes no Leste do estado do Mato Grosso, Brasil. Biota Neotropica, 11: 239-254. DOI: https://doi.org/10.1590/s1676-06032011000400021.

Spieth, H.T., 1943. Taxonomic studies on the Ephemeroptera. III. Some interesting Ephemerids from Surinam and other Neotropical localities. American Museum Novitates, 1244: 1-13.

Traver, J.R., 1947. Notes on Neotropical mayflies. Part II. Family Baetidae, subfamily Leptophlebiinae. Revista de Entomologia, 18: 149-160.

Traver, J.R., 1958. The subfamily Leptohyphinae (Ephemeroptera: Tricorythidae). Part I. Annals of the Entomological Society of America, 51: 491-503. DOI: https://doi.org/10.1093/aesa/51.5.491.

Traver, J.R, 1960. Uruguayan mayflies. Family Leptophlebiidae: Part III. Revista de la Sociedad Uruguaya de Entomologia, 4: 73-85.

Ulmer, G., 1920. Neue Ephemeropteren. Archiv für Naturgeschichte, 85: 1-80.

Ulmer, G., 1943. Alte und neue Eintagsfliegen (Ephemeropteren) aus Süd- und Mittelamerika. Stettiner Entomologische Zeitung, 104: 14-46.

Wiersema, N.A. & W.P. McCafferty, 2000. Generic Revision of the North and Central American Leptohyphidae (Ephemeroptera: Pannota). Transactions of the American Entomological Society, 126: 337-371.

Young D.G. & M.A. Duncan, 1994. Guide to the identification and geographic distribution of *Lutzomyia* sand flies in Mexico, the West Indies, Central and South America (Diptera: Psychodidae). Memoirs of the American Entomological Institute. Gainesville: Associated Publishers American Entomological Institute. 881 p. DOI: https://doi.org/10.21236/ada285737.

****

Suggestion citation:

Gama Neto, J.L., M.A.B. Passos, J.A. Cruz & N.T. Souza, 2018. New records of Ephemeroptera (Insecta) from Roraima State, Northern Brazil. EntomoBrasilis, 11 (1): 33-40.
Available on: doi:10.12741/ebrasilis.v11i1.748