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Ephemeroptera from the Venezuelan Guayanas' Uplands: Families Leptophlebiidae, Euthyplociidae and Oligoneuriidae

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Abstract

As a continuation of a series of papers to improve the knowledge of the Ephemeroptera fauna of the Venezuelan Guayana's Uplands, an update of the families Leptophlebiidae, Euthyplociidae and Oligoneuriidae in the region is presented. As a result, *Paramaka incognita* sp. nov. is described, the female of *Askola emmerichi* is described for the first time, and the genera *Askola*, *Hydrosmilodon* and *Leentvaaria*, the subgenus *Miroculis* (*Atroari*) and the species *Miroculis* (*M.*) *marauiae* are recorded for the first time for Venezuela.

Key words: *Askola*, *Hagenulopsis*, *Paramaka*, *Simothraulopsis*, *Fittkauneuria*

Resumen

Como una continuación de una serie de publicaciones destinadas a mejorar el conocimiento de la fauna de Ephemeroptera de las tierras altas del escudo Guayanés venezolano se presentan nuevos datos de las familias Leptophlebiidae, Euthyplociidae y Oligoneuriidae para esa región. Como resultado, se describe *Paramaka incognita* n. sp., se describe por primera vez la hembra imago de *Askola emmerichi* y los géneros *Askola* y *Hydrosmilodon*, el subgénero *Miroculis* (*Atroari*) y la especie *Miroculis* (*M.*) *marauiae* son registrados por primera vez para Venezuela.

Introduction

The first important contribution to the knowledge of the order Ephemeroptera in Venezuela was done by Traver, in 1943. Since then, only isolated contributions to the mayfly fauna of Venezuela have been published (for details see Segnini *et al.* 2003, and Chacon *et al.*, 2009). Recently, an important collecting effort in the Guyana's Uplands (Gran Sabana region, Bolívar state) was carried out. As a result, new taxa and records of the families Baetidae (Nieto *et al.*, 2011), Caenidae, Leptohiphidae and Coryphoridae (Molineri *et al.*, 2011) have been published, improving greatly the knowledge of the group in this interesting region, describing three new species, and recording for the first time one family, seven genera and 13 species. Previous to these two publications, only eight species, 9 genera and six families were recorded for the region (Chacón *et al.*, 2009). Among the material collected, there were also several taxa belonging to the families Leptophlebiidae, Euthyplociidae and Oligoneuriidae. The new information available for these families is provided here, to complement the information of this order in the region.

Material and methods

Imagos were collected using light traps, along the margins of numerous rivers flowing through the eastern part of the Canaima National Park, Gran Sabana region (Bolívar state), southern Venezuela (06° 15' 00" N, 62° 50' 18" W; see Fig. 1: Nieto *et al.*, 2011). Nymphs were also collected in the same localities, from all submerged substrates of each river by manually picking the specimens or using a D-net. The Gran Sabana is an undulating plain grass-dominated upland savanna covering close to 18 000 km², with altitudes ranging from 750 to 1 450 m (Huber 1995). Most of the Gran Sabana uplands have a humid submontane climate, with average annual temperatures ranging between 18 °C and 24°C, average annual rainfall between 2 000 and 3 000 mm, and a short dry season occurring from December to March. This area is drained by tributaries of the Orinoco river (Venezuelan part of the igneous metamorphic Guyana Shield), most of them black-water rivers, with very acidic and low mineral waters (Huber 1995). The specimens were studied with the standard methodology for the group (Molineri *et al.*, 2011; Nieto *et al.*, 2011). Collectors are abbreviated as follows: EG (Edmundo Guerrero), María-Eugenia Grillet (MEG) and Ana-María Oliveira Pes (AMO). The specimens are deposited in: 1) MLBV, the Invertebrate Collection of Laboratorio de Biología de Vectores (Instituto de Zoología y Ecología Tropical, Universidad Central de Venezuela, Caracas) and 2) IBN (Instituto de Biodiversidad Neotropical, Tucumán).

Results

Family Leptophlebiidae

This is one of the most diverse families of Ephemeroptera in South America, with more than 40 genera recorded for the area (Domínguez *et al.*, 2006). In this study, we registered nine genera from the different localities.

Askola Peters

This genus has been known for a long time from the type species, and was restricted to Southeastern Brazil. In 2009, Domínguez *et al.* reviewed the genus and described three new species, from central and northern Brazil and Southern Colombia, one of them, *A. emmerichi*, was known only from male imagos. Among the Venezuelan material studied, we found the female imago and subimago of this species, which we describe for the first time here.

Askola emmerichi Domínguez, Molineri and Mariano (Figs. 1–3)

Askola emmerichi Domínguez *et al.* 2009: 31; Nascimento *et al.* 2011: 200.

Material. Venezuela, Estado Bolívar: 2 female imagos and 1 female subimago from Maremán-Parú stream, 5°44'49"N–61°24'06"W, 1308 m, 27/VI/2007 (EG, MEG, AMO cols.). One female imago and one subimago deposited at MLBV, one female imago at IBN.

Discussion. This species was described recently (Domínguez *et al.* 2009) from the border of Colombia-Brazil, based only on male imagos. The female imago is described here for the first time, constituting the first record of the species for Venezuela. The female imagos were associated with the male imagos of this species because they present a very similar coloration (except that the blackish markings on the abdomen are somewhat wider). They can be separated from the female imagos of the other species of the genus mainly by the wing and abdominal coloration.

Description. Female imago (in alcohol). Length: body, 6.3–6.5 mm; fore wing, 7.1–7.3 mm. General coloration (Figs. 1–2) thorax yellowish orange, abdomen yellowish with wide V-shaped black markings dorsally. Head (Fig. 2) yellowish with black stripes around lateral and posterior margin of median ocellus and on posterior margin of head. Eyes black. Ocelli whitish, surrounded with black. Antennae yellowish. Thorax. Pronotum and

metanotum yellowish white, heavily washed with black. Mesonotum yellowish orange with lateral margins of scutum and central area of scutellum, with the exception of its apex, blackish. Pleurae and sternae yellowish white, except sclerites close to base of legs darker. Legs I and III broken-off and missing. Leg II with segments yellowish white, tarsi and claws broken-off and missing. Wings (Fig. 2). Membrane hyaline, except base of Costal area yellowish and grayish spots around cross veins as in Fig. 2; longitudinal veins yellowish, cross veins blackish bordered with grayish; five costal cross veins from bulla to costal brace. Abdomen yellowish white. Terga with variable wide V shaped black markings as in Fig. 1. Sterna without markings, except egg-guide yellowish orange, and its base grayish (Fig. 3). Caudal filaments yellowish white, with basal 1/6 of each segment blackish.



FIGURES 1–3. *Askola emmerichi*, female imago. 1, dorsal view; 2, lateral view; 3, egg guide, ventral view, detail.

Female subimago. Length: body, 4.8 mm; fore wing, 6.3 mm. Coloration similar to female imago, except that yellowish and yellowish orange coloration in this specimen is whitish.

Distribution. Brazilian-Colombian border, and Manaus, Brazil, Venezuela (**new country record**).

Ecology. Imagos of this species were collected along the stream margins, at night, and during the rainy season (June 2007). The specific stream flows through the savanna area (1308 m) and it is a bed-rock, uncovered, medium size stream (30 m wide), with very shallow (~30 cm) and acidic (pH = 5) waters.

***Farrodes* Peters**

This genus is widely distributed in the New World, from Texas at the North to Central Argentina. It is currently represented by 22 described species (Domínguez *et al.*, 2012) and certainly many new to be described. Besides the

nymphs of *F. caribbeanus*, there are several nymphs collected in different localities during this campaign. Nevertheless, most of the nymphs of this genus can not be assigned confidently to species if not reared. For this reason, although the genus is obviously widespread in this region, we will not include that material in this study.

***Farrodes caribbeanus* (Traver)**

Thraulius caribbeanus Traver, 1943: 79; Traver, 1960: 73; Hubbard, 1982: 267.

Farrodes caribbeanus Domínguez, 1999: 159.

Material. Venezuela, Edo Bolívar, Kavanayén stream, 5° 37' 27"N–61° 44' 37" W, 1355 m, 21/XI/2005, 25 nymphs. Small stream near Kavanayén locality, 5° 38' 08"N–61° 40' 47"W, 1355 m. 22/XI/2005, 2 nymphs. Idem, except date 19/III/2006, 1 nymph. EG, MEG, AMO cols. The specimens were deposited at the MLBV, the Invertebrate Collection of Laboratorio de Biología de Vectores (Instituto de Zoología y Ecología Tropical, Universidad Central de Venezuela, Caracas) and IBN (Instituto de Biodiversidad Neotropical, Tucumán, Argentina).

Discussion. This species was described from adults by Traver in the genus *Thraulius*, in 1943. Later, Domínguez (1999) described the nymphs for the first time and transferred the species to *Farrodes*, after a cladistic analysis was performed. This is one of the few nymphs of *Farrodes* that can be identified to species, by the following combination of characters: 1) abdominal terga yellow orange, with posterior 1/3 of segments II–VII blackish; 2) spines on dorsum of hind femora blunt; 3) spines on outer margin of tarsi III long, and 4) thick setae along outer margin of labial palps II. The species was recorded previously in Venezuela from Antimano, and Parque Nacional Henry Pittier Traver, 1943).

Distribution. Colombia, Venezuela, Panamá and Costa Rica.

Ecology. Nymphs of this species were collected from organic substrates such as macrophytes, leaves, and woody debris within the streams, during the rainy (November 2005) and dry (March 2006) seasons. The streams showed either partial or no cover vegetation. Overall, they were small size streams (2–9 m wide), with shallow (4–20 cm) and acidic waters (pH = 5), and with bottoms mainly composed of bed-rock.

Hagenulopsis Ulmer

This genus, distributed from Northern Argentina to Central America and the West Indies, is currently represented by 9 described species. The genus was recently reviewed (Domínguez *et al.*, 2009) and the relationships of this dipterous genus were studied (Domínguez, 2009). Only one species was represented in the studied collection.

***Hagenulopsis minuta* Spieth**

(Figs. 4–6)

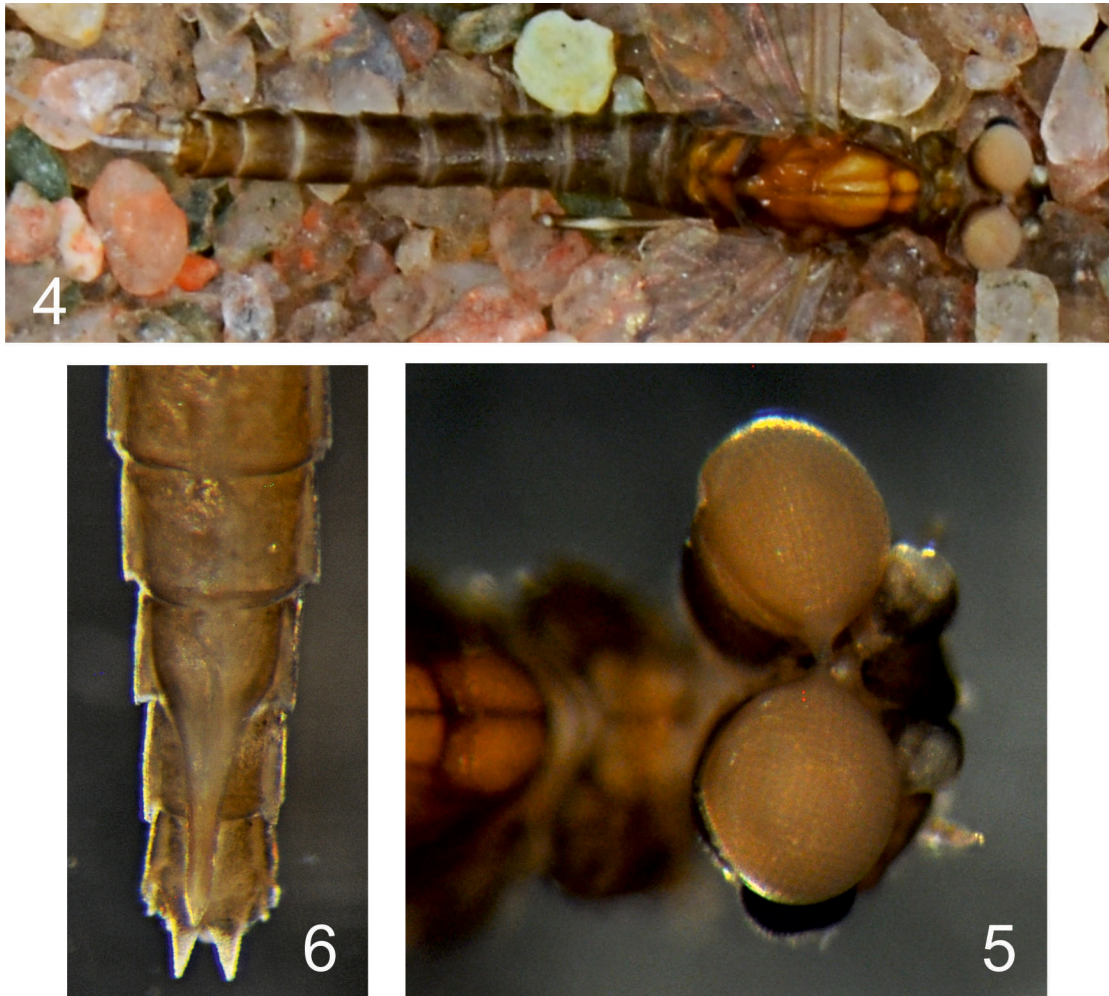
Hagenulopsis minutus Spieth, 1943: 10; Traver, 1946: 427.

Hagenulopsis minuta; Peters & Domínguez, 2001: 354; Domínguez, Molineri & Mariano, 2009: 43.

Material. Venezuela, Edo Bolívar, Aponwao river, 5° 51' 02"N–61° 27' 52" W, 1340 m, 20/XI/2005, 12 male and 17 female imagos. Small stream near Kavanayén locality, 5° 38' 08"N–61° 40' 47"W, 1355 m, 19/III/2005, 1 nymph. Kamoirán river, 5°37'12"N–61°21'47"W, 1313 m, 23/XI/2005, 1 male imago. Idem, except date 29/VI/2007, 9 nymphs. Mareman-Parú river, 5° 44' 49"N–61° 24' 06"W, 1308 m, 23/XI/2005, 1 nymph. Idem except date 19/III/2006, 2 nymphs. Idem, except date 26/VI/2007, 6 male and 11 female subimagos. Idem, except date 28/VI/2007, 6 male and 8 female imagos (Malaise trap). Kauí stream, 5° 28' 34"N–61° 16' 20"W, 1196 m, 20/III/2006, 3 nymphs. Pacheco stream, 5° 10' 29"N–61° 29' 51"W, 1144 m, 21/III/2006, 1 nymph. Soroape river, 5° 06' 29"N–61° 34' 40"W, 935 m, 25/XI/2005, 1 nymph. Small stream in the road to the Paují locality, 4° 36' 45"N–61° 05' 25"W, 942 m, 17/III/2006, 1 nymph. Stream close to the Paují locality, 4° 35' 11"N–61° 30' 53"W, 936 m, 17/III/2006, 1 nymph. Tarotá stream, 5°49'15"N–61°25'04"W, 1324 m, 27/VI/2007, 5 male and 11 female imagos.

Parupa river, 5°40'49"N–61°32'39"W, 1281 m, 19/III/2006, 13 nymphs. Collectors: EG, MEG and AMO. The specimens were deposited at the MLBV (Venezuela) and IBN (Argentina).

Discussion. This species was reviewed and re-described by Peters & Domínguez in 2001. It is a very characteristic species, due to the presence of a well developed eye bridge (Figs. 4–5) and its small size. The females of this genus also have an egg-guide (Fig. 6).



FIGURES 4–6. *Hagnulopsis minuta*. 4, male imago, dorsal view; 5, idem, detail of head, with eye bridge; 6 female imago, egg guide, ventral view.

Distribution. Brazil, Guyana, Surinam, Venezuela and north to Honduras.

Ecology. Imagos were collected along the stream margins, at night, during the rainy season (November 2005 and June 2007); whereas nymphs were collected during rainy and dry seasons (November 2005, March 2006 and June 2007). The rivers and streams flow across the altitude gradient of the Gran Sabana region (936 m–1355 m), and showed different riparian vegetation (varying from streams partially shaded to rivers not shaded at all). They ranged from small streams (2 m wide) to large rivers (50 m wide), with variable water depths (4.0–40 cm) and acidic waters (pH = 5). The bottoms of these waterbodies also were heterogeneous: rock-gravel-bottom, gravel-sandy bottom, and bed-rock-bottom.

Hydrosmilodon Flowers & Domínguez

The genus is constituted by 4 species, distributed from Mexico to Northern Argentina, and was not previously recorded from Venezuela ((Domínguez *et al.*, 2012). A single species was represented in the studied collection.

***Hydrosmilodon gilliesae* Thomas & Péru**

Hydrosmilodon gilliesae Thomas & Péru in Thomas *et al.*, 2004: 66 (nymph).

Material. Venezuela, Edo Bolívar, Kamá river, 5° 25' 11''N–61° 13' 05''W, 1035 m, 24/XI/2005, 3 nymphs. Tarotá stream, 5° 49' 15''N–61° 25' 04''W, 1324 m, 18/III/2006, 1 nymph. Parupa river, 5° 40' 49''N–61° 32' 39''W, 1281 m, 19/III/2006, 1 nymph. EG, AMO and MEG cols. Specimens were deposited at the MLBV (Venezuela) and IBN (Argentina).

Discussion. *Hydrosmilodon gilliesae* was described from the French Guiana in 2004, based solely on nymphs, and the imago remains unknown until now. The nymphs collected in this study correspond with the original description by Thomas & Péru. The nymphs can be separated from the other species of the genus by: 1) subapical denticle of the tarsal claw much larger than the other denticles; 2) gills narrow on abdominal segments I–VII, well developed and tapered to a terminal filament on I–VI, and with main trachea not branched.

Distribution. Brazil, French Guyana, Venezuela (**new country record**).

Ecology. Nymphs were collected from the submerged substrates within the rivers during the rainy (November 2005) and dry (March 2006) seasons. These three sampled rivers varied in their water sizes (12 m–40 m wide), and riparian vegetation (from partially shaded to non-shaded). They were mostly rocky rivers, with acidic waters (pH=5).

***Leentvaaria* Demoulin**

This genus, belonging to the *Hermanella-Traverella* complex is only known from nymphs, described from Surinam. Its phylogenetic relationships were studied by Domínguez *et al.* (2001). The genus was recorded from Brazil, French Guiana and Surinam.

***Leentvaaria palpalis* Demoulin**

Demoulin, 1966: 14; Domínguez *et al.*, 2001: 314.

Material. Venezuela, Edo Bolívar, Kamá river 5° 25' 11''N–61° 13' 05''W, 1035 m, 20/III/2006, 1 nymph. Yuruaní river, 5° 05' 32''N–61° 05' 47''W, 880 m, 25/XI/2005, 1 nymph. Parupa river, 5° 40' 49''N–61° 32' 39''W, 1281 m, 19/III/2006, 4 nymphs. Collectors: MEG, EG and AMO. Specimens were deposited at the MLBV (Venezuela) and IBN (Argentina).

Discussion. This species was described only from nymphs, that are very unusual and easy to recognize for the very long labial palpi, which also present a basal prominence on segment I. Apparently, due to the scarce number of nymphs collected, this species is not very common in the region. This is the first time it is collected in Venezuela.

Distribution. Surinam, Brazil, Venezuela (**new country record**).

Ecology. Nymphs were collected from the submerged substrates within the rivers during the rainy (November 2005) and dry (March 2006) seasons. Rivers were large water courses (30 m–70 m wide), non-shaded, with bottom of rocks and gravels and acidic waters (pH=5).

***Miroculis* Edmunds**

The genus at present is constituted by 16 species, distributed in four subgenera. The genus has been recorded from Argentina, Brazil, Colombia, Ecuador, French Guiana, Surinam, Venezuela, Cuba and Trinidad. Of the four subgenera, only two are found in the studied collection.

Miroculis (Atroari) sp.

Material. Venezuela, Edo Bolívar, Pacheco stream, 5° 10' 29''N–61° 29' 51''W, 1144 m, 21/III/2006. 1 male nymph. EG, AMO and MEG cols. Specimens were deposited at the MLBV (Venezuela) and IBN (Argentina).

Discussion. *Miroculis (Atroari) nebulosus* was described from Cerro de La Neblina, by Savage 1987. Later, Peters *et al.* (2007) when described the female and nymph, transferred this species to the subgenus *Miroculis (Miroculis)*. As a consequence, the subgenus *Miroculis (Atroari)* was restricted to three species from Brazil and Colombia. This new record re-establish the Venezuelan distribution of this subgenus. The male nymph studied here is assigned tentatively to this subgenus because it presents: 1) upper portion of eyes with medium sized facets; 2) posterolateral spines developed beyond posterior margin of terga on abdominal segments V–IX. As several species of this genus are described solely from adults, and the nymphs of this subgenus are not very well characterized, we prefer not to name this species until its adult is known.

Distribution. The subgenus is distributed in Brazil, Colombia and Venezuela (**new country record**).

Ecology. Individuals were collected during the dry season, in a non-shaded medium sized stream (23 m wide), having a bed-rock bottom and acidic waters (pH=5).

***Miroculis (Miroculis) marauiae* Savage & Peters**

Miroculis (Miroculis) marauiae Savage & Peters, 1983: 517.

Material. Venezuela, Edo Bolívar, Kavanayén stream, 5° 37' 27''N–61° 44' 37''W, 1355 m, 21/XI/2005, 1 male imago. Kamoirán river, 5° 37' 12''N–61° 21' 47''W, 1313 m, 29/VI/2007, 4 nymphs. Soroape rivers, 5° 06' 29''N–61° 34' 40''W, 935 m. 21/III/2006, 2 nymphs. Kaku-Parú stream, 4° 54' 00''N–61° 05' 25''W, 913 m, 25/XI/2005, 3 nymphs. Idem, except date 29/VI/2007, 1 nymph. Tarotá stream, 5° 49' 15''N–61° 25' 04''W, 1324 m, 18/III/2006, 1 nymph. Idem, except date 27/VI/2007, 4 nymphs, 2 male imagos. Parupa river, 5° 40' 49''N–61° 32' 39''W, 1281 m, 19/III/2006, 9 nymphs. Idem, except date 29/VI/2007, 3 nymphs. Collectors: EG, MEG and AMO. Specimens were deposited at the MLBV (Venezuela) and IBN (Argentina).

Discussion. *Miroculis (Miroculis) marauiae* was described originally from Northern Brazil (Amazonas state). The imagos of this species can be characterized by: 1) Upper portion of eyes on narrow, dorsally directed stalks, with 8 to 9 facets in longest row; 2) fore and hind wings without maculae around cross-veins; and 3) length of penes 0.8–1.1 times length of segment I of forceps. In the nymph, the abdominal gills are small and slender, with posterolateral lobes from medium-sized to reduced. In this study imagos and nymphs of this species were collected at elevations from 900 up to 1355 m.

Distribution. Brazil and Venezuela (**new country record**).

Ecology. Imagos and nymphs were collected in water currents with acidic waters (pH = 5) that ranged from small streams (12 m wide) to medium rivers (30 m wide). They also varied in their riparian vegetation (from partially shaded to non-shaded) and bottom (from bed-rock bottom to gravel-bottom rivers). Collections corresponded to dry (March 2006) and rainy season (November 2005, March 2006 and June 2007).

***Paramaka* Savage & Domínguez**

The genus was established for the species *Paramaka convexa* from Surinam (Savage & Domínguez, 1992). Later, in 2003, Blanco Belmonte *et al.* described the nymph of the genus. In 2005, Sartori described *P. antonni* based on nymphs from Guyana. Mariano (2011) described another species, *P. pearljam*, from nymphs and male imagos from Central-western Brazil. The nymphs of these two species presented a labrum not as expanded, nor curved as in *P. convexa*, suggesting that this could be a specific character. This is confirmed with the different degree of development presented in the new species described below, plus some allometric variation in this character throughout the nymphal development. Furthermore, the new species described here presents gills only on segments I–VI, without the thin and pointed projection usually present in *P. convexa* and *P. antonii* (but see variations in *P. convexa* below). Another difference between the new species described here and the other species known is the strong development of posterolateral projections on segments VII–IX. This development can be related to the total loss of gills on segment VII.

Paramaka convexa (Spieth)

Paramaka convexa; Savage & Domínguez, 1992: 244; Blanco-Belmonte *et al.*, 2003: 119; Sartori, 2005: 237.

Material. Venezuela, Edo Bolívar, Kamá river 5°25'11"N–61°13'05"W, 1035 m, 24/XI/2005, 4 nymphs. Soroape river, 5°06'29"N–61°34'40"W, 935 m, 25/XI/2005, 1 nymph. Idem, except date 21/III/2006, 42 nymphs. Yuruani river, 5°05'32"N–61°05'47"W, 880 m, 25/XI/2005, 3 nymphs. Small stream in the road to the Paují locality, 4°36'45"N–61°05'25"W, 942 m, 17/III/2006, 42 nymphs. Specimens were deposited at the MLBV (Venezuela) and IBN (Argentina).

Discussion. This species was known only from adults, until Blanco-Belmonte *et al.* (2003) described the nymph. According to them, gills were present on abdominal segments I–VI were platelike, biramous, with dorsal portion of gills III–VI frequently terminating in a small finger-like filament; gills on abdominal segment VII vestigial. The nymphs collected in the Guayana's uplands also present the variation in the small finger-like filament of the gills. Some of the nymphs present the filaments, while other do not.

Distribution. Brazil, French Guiana, Surinam, Venezuela.

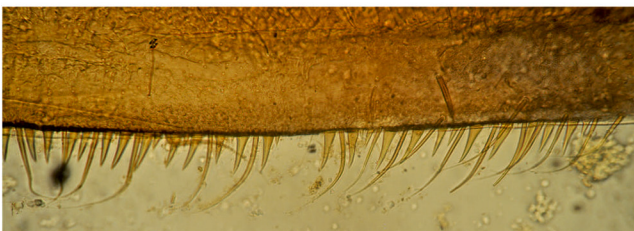
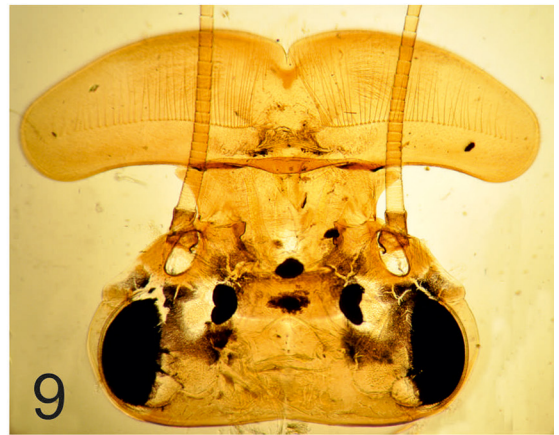
Ecology. Nymphs were mostly collected in large rocky open rivers (55–150 m wide) but also in a small rocky partially shaded stream (10 m wide). Collections corresponded to dry (March 2006) and rainy seasons (November 2005 and June 2007).

Paramaka incognita sp. nov.

(Figs. 7–22)

Mature nymph (Fig. 7–8). In alcohol. Body length: 8.2–9.5 mm. General coloration orange-brown. Head: orange-brown with whitish marks between eyes and lateral ocelli. Blackish line between base of median ocellus and apex of lateral ones, ocelli black. Upper portion of male eyes orange-brown, lower portion black. Eyes of female black. Antennae: scape and pedicel brown, flagellum yellowish-orange. Mouthparts (Figs. 9–12): clypeus, labrum (Fig. 9), incisors, prostheca, base of molars and central area of mandible (Fig. 10) and setae of maxillae (Fig. 11) orange-brown, remaining parts lighter, except base of mandible, maxillae and labium (Fig. 12) washed with black. Thorax (Fig. 8): terga orange-brown, with anterior margin of pronotum and base and inner margins of wingpads blackish; pleura and sterna yellowish-white. Legs: dark orange-brown with apex of femora and base and apex of tarsi yellowish white. Claws yellowish white with denticles orangish, with very small accessory denticles near apex of claw (Fig. 13). Abdomen (Fig. 8): terga yellowish-orange, darker posteriorly; posterolateral angles washed with black, posterior margin of each segment bordered with a row of triangular spines and setae (Fig. 15). Sterna yellowish-white, with blackish lines along lateral margins of segments VIII–IX. Gills oval, grayish (Fig. 7–8), present on segments I–VI, smaller posteriorly, without thin and pointed projection. Posterolateral projections strong, clearly diverging from the abdomen and present on segments VII–IX (Fig. 14). Caudal filaments orangish, except basal segments (Fig. 7).

Female imago. In alcohol. Length: body, 11.2–11.3 mm; fore wings, 13.0–13.2 mm; hind wings, 1.7–1.8 mm. General coloration (Figs. 16–17) yellowish-white, with brown markings. Head: whitish, with brownish marks between ocelli, posterior margin of head and between eyes and posterior margins of lateral ocelli; ocelli white, with inner margins black. Eyes black. Antennae: scape and pedicel brownish [flagellum broken-off and missing]. Thorax: pronotum whitish with lateral margins and central area tinged with black. Mesonotum with central area light orange-brown, surrounded with white towards the margins, posterior margins blackish. Metanotum yellowish, with central longitudinal stripe darker. Pleura and sterna mainly blackish-brown, with membranous areas yellowish-white. Wings: membranes hyaline. Base of fore wings with a brown spot; veins C, Sc and R₁ brownish, lighter apically; other veins translucent white. Hind wings with a basal brown spot; veins C, Sc and R₁ brown up to costal projection, remaining of this veins and rest of veins translucent. Legs: in leg I, coxa and trochanter yellowish white, washed with black, femur yellowish with base, apex and margins brownish, that surround the oval yellowish area; tibia brownish, tarsus I yellowish. Coxae and trochanters of legs II and III yellowish, heavily washed with brown. [Remaining parts of legs broken-off and missing]. Abdomen (Figs. 16–17): terga I–VI and X light brown, with medial area darker, and posterior margin of each segment darker; terga VII–VIII yellowish, heavily washed with black, especially in the postero-central area; terga IX yellowish. Sterna yellowish, with strong brown lateral marks on segments VII–IX. IX abdominal sternite widely cleft apically (Fig. 17). [Caudal filaments broken-off and missing].



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FIGURES 7–15. *Paramaka incognita*, sp. nov., male nymph. 7, habitus, d.v.; 8, idem, detail; 9, clypeus and labrum, d.v.; 10, mandible, d.v.; 11, maxilla, d.v.; 12, labium, v.v.; 13, tarsal claw; 14, abdomen, detail, v.v.; 15, abdominal terga, posterior margin detail, d.v. d.v.= dorsal view; v.v.= ventral view.



FIGURES 16–19. *Paramaka incognita*, sp. nov. female adults, habitus. 16, imago, d.v.; 17, idem, v.v.; 18, subimago, d.v.; 19, idem, v.v. d.v.= dorsal view; v.v.= ventral view.



FIGURES 20–21. *Paramaka incognita*, sp. nov. male subimago, habitus. 20, dorsal view; 21, ventral view. 22 subimaginal male genitalia, ventral view.

Female subimago. In alcohol. Length: body, 10.3–11.1 mm; fore wings, 12.5–13.0 mm; hind wings, 1.5–1.6 mm. General coloration (Figs. 18–19) similar to male subimago, except head and abdomen as in female imago, but colors duller.

Male subimago. In alcohol. Length: body, 10.1–10.5 mm; fore wings, 10.8–11.3 mm; hind wings, 1.4–1.5 mm. General coloration (Figs. 20–21) yellowish-white, with brown marks. Head: whitish, with thin stripes in front and lateral of ocelli. Upper portion of eyes orange-yellow, lower portion black. Ocelli white, with inner margins black.

Antennae: scape and pedicel brown [flagellum broken-off and missing]. Thorax as in female imago, but paler. Wings as in female imago, but membrane translucent white, and coloration of C, Sc and R₁ of both wings fainter. Legs: mainly brownish-black, except femora yellowish-white, with base and apex brownish-black, this darker area more extended on posterior legs. Abdomen (Figs. 20–21): terga I–V translucent white, terga I almost completely tinged with black, terga II–V with oval posterolateral marks and posterior margins black; terga VI–X yellowish, terga VI with black markings similar to anterior terga, terga VII–IX with anterior ¾ of each segment washed with brown, and posterior margins black; tergum X with central area washed with black, lateral areas yellowish. Sterna whitish, sternum I almost completely washed with black, sterna II–VI translucent, sterna VII–VIII with broad lateral stripes that cover around 1/3 of segment width. Genitalia (Fig. 22): Styliiger plate more diffusely tinged than precedent sterna. Forceps whitish, tinged with black, especially segments I and II. Penes white, with ventral spines yellowish. Caudal filaments black.

Variations. In the nymphs, there is a gradual darkening from the young to the more mature nymphs, especially on the male eyes upper portion, legs, abdomen and caudal filaments.

Material. Holotype, male nymph. Venezuela, Edo Bolívar. Tarotá stream, 5°49'15"N–61°25'04"W, 1324 m, 18/III/2006. Collectors: MEG, EG and AMO. Paratypes: 21 nymphs, same data as holotype; 1 female imago, 3 male and 2 female subimagos, 38 nymphs, except date: 27/VI/2007. 1 nymph, Maraupan stream, 05°12'36"N–61°05'38"W, 1194 m, 20/III/2006. 9 nymphs, Pacheco stream, 5°10'29"N–61°29'51"W, 1144 m, 21/III/2006. The association of nymph and adult was made by similar color pattern of specimens from the same locality. Holotype and half of paratypes were deposited at the MLBV (Venezuela), whereas the other paratypes were placed at the IBN (Argentina).



FIGURES 23–26. collection sites of *Paramaka incognita*, sp. nov. 23, Tarotá; 24, Maraupan; 25–26, Pacheco (different aspects).

Etymology. *Incognita*, from the Latin, *incognitus*, unknown, strange. Because was difficult to determine, due to the absence of male imagos, and some unusual nymphal characters.

Discussion: The nymphs of this species can be separated from the other species of the genus by the following combination of characters: 1) Gills oval, without terminal filaments, present on abdominal segments I–VI (Figs. 7–8); 2) claws with very small accessory denticles near apex of claw (Fig. 13); 3) posterolateral projections strong, clearly diverging from the abdomen and present on segments VII–IX (Fig. 14); and 4) posterior margin of each abdominal tergite bordered with a row of triangular spines and setae (Fig. 15). The female of this species is the first known for the genus. It may be characterized mainly based on the abdominal coloration, shown in figures 16–17.

Ecology. Imagos and nymphs of this new species were collected during the dry (March 2006) and rainy (June 2007) season. They were found in small to medium size streams (7–54 m wide) of acidic waters (pH = 5) flowing through the savanna area (1144–1324 m), having a bottom mainly composed of bed-rock, and a water channel partially or totally uncovered (Figs. 23–26).

Simothraulopsis Demoulin

This genus, currently represented by five species, is widely distributed in Northern South America. It is related to the genera *Farrodes* and *Homothraulus*. While *Farrodes* is widely distributed in the Americas, *Homothraulus* has only been collected in Northeastern Argentina, Uruguay and Southeastern Brazil (Paraná basin). It appears then that *Simothraulopsis* present a vicariant distribution with its sister group *Homothraulus*.

***Simothraulopsis demerara* (Traver)**

Thraulus demerara Traver, 1947: 150; 1960b: 73.

Simothraulopsis demerara; Domínguez *et al.*, 1997: 146.

Simothraulopsis surinamensis Demoulin, 1966: 18 (nymph).

Material. Venezuela, Edo Bolívar, Kavanayén stream, 5°37'27"N–61°44'37"W, 1355 m, 21/XI/2005, 1 female subimago, 1 nymph. Small stream near Kavanayén locality, 5°38'08"N–61°40'47"W, 1355 m, 19/III/2005, 2 nymphs. Maremán-Parú stream, 5°44'49"N–61°24'06"W, 1308 m, 27/VI/2007, 1 male imago, 2 nymphs. Kamá river, 5°25'11"N–61°13'05"W, 1035 m, 20/III/2006, 12 nymphs. Kauí stream, 5°28'34"N–61°16'20"W, 1196 m, 24/XI/2005, 2 nymphs. Maraupan stream, 5°12'36"N–61°05'38"W, 1194 m, 20/III/2006. Pacheco stream, 5°10'29"N–61°29'51"W, 1144 m, 21/III/2006, 4 nymphs. Soroape river, 5°06'29"N–61°34'40"W, 935 m, 21/III/2006, 1 nymph. Kako-Parú stream, 4°54'00"N–61°05'25"W, 913 m, 25/XI/2005, 1 nymph. *Idem*, except date 28/VI/2007, 1 male subimago. Small stream in the road to the Paují locality, 4°36'45"N–61°05'25"W, 942 m, 17/III/2006, 3 nymphs. Tarotá stream, 5°49'15"N–61°25'04"W, 1324 m, 18/III/2006, 8 nymphs. *Idem*, except date 27/VI/2007, 2 male imagos, 15 nymphs. Parupá river, 5°40'49"N–61°32'39"W, 1281 m, 29/VI/2007, 7 nymphs. Specimens were deposited at the MLBV (Venezuela) and IBN (Argentina).

Discussion. *Simothraulopsis demerara* was originally known from Surinam and Guyana (Traver, 1947). Later, Domínguez *et al.* (1997) studied material from several other countries (Brazil, Colombia, French Guiana and Venezuela), extending its distribution. This species appears to be fairly common in the area here studied. There are some variations in the nymphs coloration collected, that could represent a different species. Nevertheless, as there are no imagos available from the different variations, we preferred not to describe them as different species. The imagos can be separated from the other species of the genus by the following combination of characters: 1) forceps sockets not fused; 2) femora with subapical brown bands. In the nymphs: 1) Posterolateral projections on abdominal segments VIII–IX; 2) femora with subapical brown bands.

Ecology. Imagos and nymphs were collected in both (dry and rainy) seasons. They were sampled in the whole size gradients of rivers we studied in the Gran Sabana region, which was, from the small sandy stream to the large rocky rivers. Consequently, they showed different riparian vegetation (varying from streams partially shaded to rivers not shaded at all) but acidic waters (pH = 5).

Euthyplociidae

This is a small family of Ephemeroptera, with only three genera registered for South and Central America, and the remaining genera of the family distributed in the Ethiopian and Oriental region (Domínguez *et al.*, 2006). Among its species are found the largest specimens of the order.

Campylocia Needham & Murphy

The genus *Campylocia* is distributed in the lowlands of Central and South America, while the other two genera of the family registered for the region are extended mainly in relation with the Andes (Domínguez *et al.*, 2006).

Campylocia anceps (Eaton)

Campylocia anceps; Needham & Murphy, 1924: 27; Gros & Lestage, 1926: 162; Ulmer, 1932: 207; Ulmer, 1942: 101; Spieth, 1943: 1; Traver, 1944: 10; Demoulin, 1952: 13; Kimmins, 1960: 307; Berner & Thew, 1961: 329; Hubbard, 1982: 262; Pereira & Da-Silva, 1990: 2.

Currently there are three species described for the genus, being *C. anceps* the most widely distributed, and the two others (*C. bocainensis* and *C. dochmia*) only registered from Brazil.

Material. Venezuela, Edo Bolívar, Maremán-Parú, 5°44'49"N–61°24'06"W, 1308 m, 19/III/2006, 1 nymph. Maraupan stream, 05°12'36"N–61°05'38"W, 1194 m, 20/III/2006, 2 nymphs. Pacheco stream, 5°10'29"N–61°29'51"W, 1144 m, 21/III/2006, 4 nymphs. Kaku-Parú stream, 4°54'00"N–61°05'25"W, 913 m, 29/VI/2007, 1 male imago, 1 female imago. Small stream in the road to the Paují locality, 4°36'45"N–61°05'25"W, 942 m, 17/III/2006, 10 nymphs. Tarota stream, 5°49'15"N–61°25'04"W, 1324 m, 27/VI/2007, 1 male and 1 female imago. Parupa river, 5°40'49"N–61°32'39"W, 1281 m, 28/VI/2007, 7 nymphs. Specimens were deposited at the MLBV (Venezuela) and IBN (Argentina).

Discussion. The specimens studied here correspond to the widely distributed species *C. anceps*. This species can be characterized in the imagos because the penes lobes are widely divergent along medial line, and do not present median lobes. In the nymphs, the abdominal gills are light colored, with fringes darker, while the antennae is $\frac{3}{4}$ to subequal in length to the mandibular tusks. Within the material studied, there is some variation in the length of the antennae and the coloration of the gills. Nevertheless, we consider the variation is within the normal limits of the species.

Distribution. Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Surinam, Venezuela and Costa Rica.

Ecology. Imagos and nymphs were collected in both (dry and rainy) seasons. They were found in a diversity of streams of acidic waters (pH = 5), varying from small sandy streams to large rocky rivers.

Oligoneuriidae

This is a relatively small family of Ephemeroptera, with a Pantropical distribution. It is presently represented in South America by five genera (Domínguez *et al.*, 2012).

Fittkauneria adusta Pescador & Edmunds

Fittkauneria adusta Pescador & Edmunds 1994: 268.

The genus was described for two species, one of them known from nymphs and male imagos, and the other only from nymphs. The species collected in this study is known only from nymphs.

Material. Venezuela, Edo Bolívar, Kamoirán river, 5°37'12"N–61°21'47"W, 1313 m, 23/XI/2005, 1 nymph. Tarotá stream, 5°49'15"N–61°25'04"W, 1324 m, 27/VI/2007, 3 nymphs. Specimens were deposited at the MLBV (Venezuela) and IBN (Argentina).

Discussion. The nymphs of *F. adusta* can be characterized by the abdominal gills, in which the dorsal lamellae is ovate, and the ventral tuft is vestigial. From the distribution of its two species, it appears that the genus is restricted to northern Amazonia and Venezuelan highlands.

Distribution. Brazil and Venezuela.

Ecology. Individuals were collected during the rainy season, in partially shaded small and medium size streams, both having a rock-bottom and acidic waters (pH=5).

Conclusion

Chacon *et al.*, 2009 published the most recent list of mayfly species from Venezuela, indicating the states and bioregions of the country (MARN, 2001) where they were recorded. The Guayana bioregion encompasses two states: Amazonas and Bolívar. Ten species were recorded from Amazonas state: *Campylocia anceps*, *Tricorythopsis volsellus*, *Farrodes longispinus*, *Farrodes tepui*, *Hagenulopsis minuta*, *Microphlebia surinamensis*, *Miroculis (M.) bicoloratus*, *Miroculis (M.) fittkai*, *Miroculis (M.) nebulosus* and *Fittkaunuria carina*. Interesting enough, five species were recorded from Bolívar state, none of them so far found in Amazonas: *Massartella devani*, *Massartella venezuelensis*, *Paramaka convexa*, *Simotraulopsis demerara* and *Fittkaunuria adusta*.

Within the studied collection from the Guyana's Uplands, in a series of three multi-authored papers (Molineri *et al.*, 2011; Nieto *et al.*, 2011, and the present one), we were able to collect again some of the species recorded from Bolívar state, to extend the distribution of some species previously collected from Amazonas state, to present new country records for several taxa and also to describe new species and unknown stages of known species. Following, we detail our findings:

Species previously recorded from Bolívar State and included in the studied collection:

Paramaka convexa, *Simotraulopsis demerara*, *Fittkaunuria adusta*.

Species previously recorded only from Amazonas State and found in the studied collection (Bolívar State):

Campylocia anceps, *Tricorythopsis volsellus*, *Hagenulopsis minuta*.

Species previously recorded from Venezuela, but not for Guayana's Uplands:

Farrodes caribbeanus,

New country records for Venezuela:

Baetidae:

Genera: *Cryptonympha*, *Harpagobaetis*, *Spiritiops*, *Zelus*.

Species: *Baetodes proiectus*, *Camelobaetidius billi*, *Camelobaetidius janae*, *Camelobaetidius leentvaari*, *Camelobaetidius mathuriae*, *Cryptonympha copiosa*, *Harpagobaetis gulosus*, *Spiritiops silvudus*, *Zelus principalis*.

Coryphoridae:

Coryphorus aquilus (new family, genus and species record)

Leptohyphidae:

Amanahyphes saguassu, *Tricorythopsis yucupe*.

Leptophlebiidae:

Askola emmerichi (new genus and species record), *Hydrosmilodon gilliesae* (new genus and species record), *Leentvaaria palpalis* (new genus and species record), *Miroculis (Atroari)* (new subgenus record), *Miroculis (Miroculis) marauiae* (new species record).

New stages described:

Tricorythopsis yucupe: adults described for the first time

Askola emmerichi: female imago described for the first time

New species described:

Caenidae: *Caenis teipunensis*

Leptohyphidae: *Macunahyphes pemonensis*

Leptophlebiidae: *Paramaka incognita*

Besides these species, Derka *et al.* (2009) described *Massartella hirsuta*, and Nieto & Derka (2011, 2012) described *Parakari auyanensis*, *P. churiensis* and *Spiritiops tepuensis* from the same region. In this way, from the original five species recorded from Bolívar State in 2009, the number of species there rose to more than 30. This clearly indicates that Venezuela has an important diversity yet to be discovered.

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