

ORIGINAL ARTICLE

## New species of Leptohiphidae (Insecta: Ephemeroptera) from Colombia with evidence of reproductive time segregation

CARLOS MOLINERI,<sup>1</sup> & MARÍA DEL CARMEN ZÚÑIGA<sup>2</sup>

<sup>1</sup>Facultad de Ciencias Naturales, Universidad Nacional de Tucumán, San Miguel de Tucumán, Argentina, and <sup>2</sup>Universidad del Valle, Escuela de Ingeniería en Recursos Naturales y del Ambiente, Apartado Aéreo 25360, Cali, Colombia

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### Abstract

Five new species of Leptohiphidae are described, four of them from nymphal and adult stages: *Leptohiphes albipennis*, *L. coconuco*, *L. nigripennis*, and *Tricorythodes trifasciatus*. *Tricorythopsis ticuna* is described from male imagines only. Two of the new species, *Leptohiphes albipennis* and *L. nigripennis*, represent a distinct group in the genus characterized by the presence of hind wings in the female and T-shaped penes in the male. Both species, very closely related, differ markedly in swarm time activity. SEM photographs of the eggs of *L. nigripennis* are presented.

### Resumen

Se describen cinco especies nuevas de Leptohiphidae, cuatro de ellas a partir de los estados ninfal y adulto: *Leptohiphes albipennis*, *L. coconuco*, *L. nigripennis* y *Tricorythodes trifasciatus*. *Tricorythopsis ticuna*, se describe sobre la base de imagos machos. Dos de las nuevas especies descritas aquí en *Leptohiphes* (*L. albipennis* y *L. nigripennis*) representan un grupo distintivo dentro del género, caracterizado por la presencia de alas posteriores en las hembras y por poseer penes en forma de T en los machos. Ambas especies, muy cercanamente emparentadas, difieren notablemente en el periodo de actividad reproductiva. Se presentan microfotografías de barrido para los huevos de *L. nigripennis*.

**Keywords:** Leptohiphidae, *Leptohiphes*, *Tricorythodes*, *Tricorythopsis*

### Introduction

The status of the knowledge of Colombian Ephemeroptera was recently reviewed by Zúñiga et al. (2004). Six species of the family Leptohiphidae were reported from Colombia: *Tricorythodes zunigae* Molineri (2002), *Haplohiphes aquilonius* Lugo-Ortiz & McCafferty and *H. mithras* (Traver) (Molineri, 2003a), *Lumahyphes yagua* Molineri (Molineri & Zúñiga, 2004), *Lumahyphes pijcha* Molineri (2004) and *Traverhyphes* (*Byrsahyphes*) *namus* (Allen) (Molineri, 2004). We herein describe five additional species in the genera *Leptohiphes*, *Tricorythodes* and *Tricorythopsis*.

### Material and methods

Material was preserved in 75% ethanol. Important body parts of adults and nymphs were mounted on microscope slides in Canada balsam and drawn with a

stereo-microscope camera lucida. Nymphal gills were dissected and figured in alcohol. Abdominal gills V of *Leptohiphes* nymphs are difficult to study without dissection, but the ventro-basal outgrowth that characterizes some species is nevertheless visible in intact nymphs. Eggs from *Leptohiphes nigripennis* sp. n. were removed from a mature nymph, dehydrated in a graded ethanol series, dried by critical point-method, and then mounted on SEM stubs and sputter coated with gold; eggs were observed and photographed with a JEOL 35CF scanning electron microscope at 25 kV. Methods and terms are as given in Molineri (2003b). Material is deposited in the following institutions: Museo de Entomología de la Universidad del Valle, Cali, Colombia (MEUV); Instituto-Fundación Miguel Lillo, Tucumán, Argentina (IFML); and Florida A & M University, Tallahassee, Florida, USA (FAMU). Collectors are abbreviated as follows: B = J. V. Ballesteros, C = A. J. Cardozo-Zúñiga,

CC = C.A. Cardona, D = E. Domínguez, E = J. Echeverri, M = C. Molineri and Z = M. del C. Zúñiga.

## Results

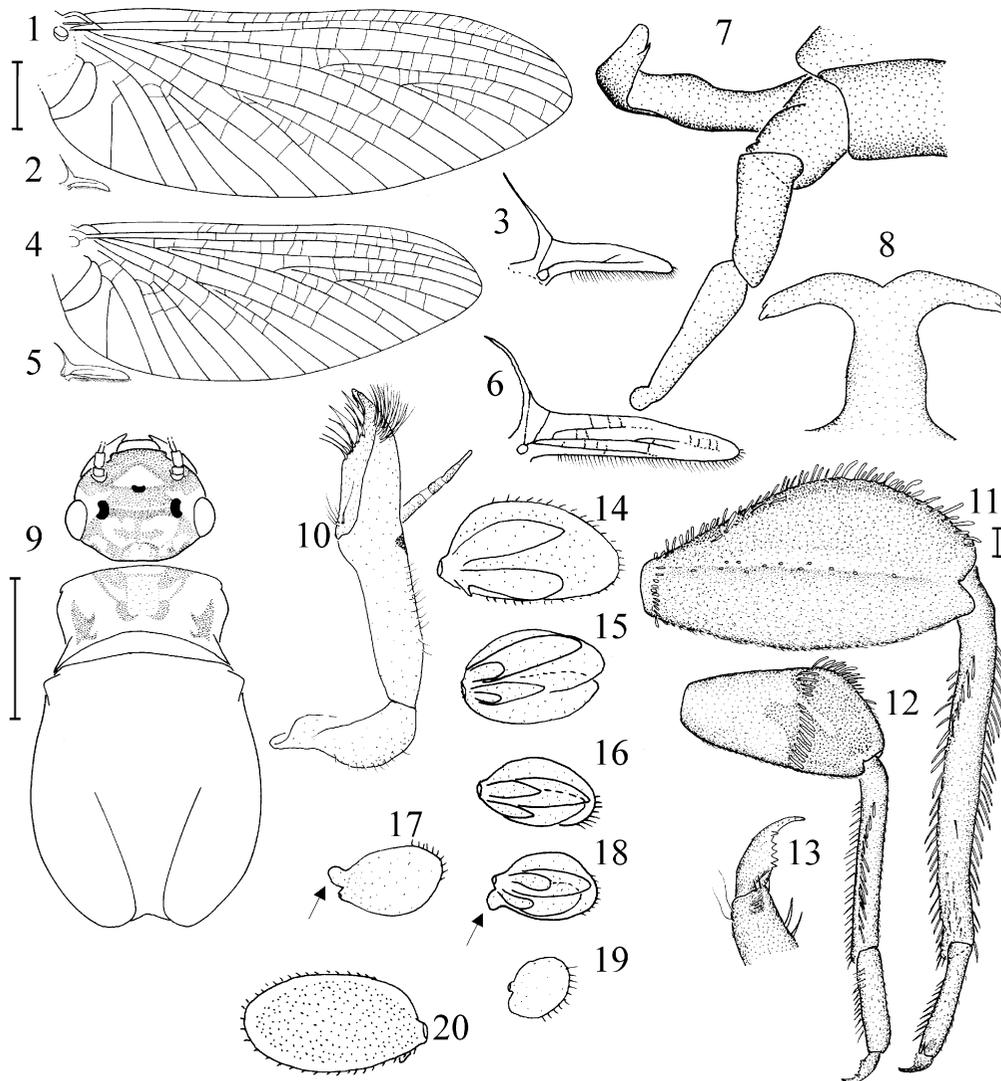
### *Leptohyphes albipennis* sp. n.

(Figures 1–20)

#### Male imago

Length: body, 4.4–5.2 mm; forewings, 5.7–6.4 mm; hind wings, 0.9–1.0 mm. General coloration whitish-brown. Head shaded with yellowish-brown dorsally. Thorax: pronotum shaded with gray, blackish on carinae and anterior margin; mesonotum yellowish-brown to orangish-brown; membranous

filaments of mesoscutellum translucent whitish-gray; mesopleurae, mesosternum and metathorax paler, shaded diffusely with gray. Legs: forelegs light yellowish-brown; middle and hind legs paler; all legs completely shaded with light gray. Wings (Figures 4–6): membrane of wings hyaline, lightly tinged with brown, shaded with gray basally; veins of C and Sc region brownish-yellow to grayish-yellow. Abdomen whitish-translucent except segments VIII–X whitish-yellow; abdominal segments shaded dorsally with gray and ventrally with yellow except on intersegmental membranes. Genitalia (Figure 7 and 8): penes T-shaped (Figure 8); styliger plate yellowish anteriorly and paler posteriorly with yellowish posterior margin; forceps and penes translucent yellowish-white. Caudal filaments translucent yellowish-white shaded with gray, pale at annulations.



Figures 1–20. *Leptohyphes albipennis*. Adult: (1) female forewing; (2) female hind wing; (3) same, enlarged; (4) male forewing; (5) male hind wing; (6) same, enlarged; (7) male genitalia l.v.; (8) penes detail v.v. Nymph: (9) head and thorax d.v. (color pattern on mesonotum omitted); (10) maxilla d.v.; (11) hind leg; (12) foreleg; (13) foretarsal claw detail; (14) gill II v.v.; (15) gill III v.v.; (16) gill IV v.v.; (17) gill V d.v.; (18) same v.v.; (19) gill VI; (20) gill II, d.v. Arrows indicate basal outgrowth on gill V. Scale bars: Figures 1–2, 4–5, 9 = 1 mm, Figures 11–12 = 0.1 mm.

*Female imago*

Length: body, 4.5–5.4 mm; forewings, 6.8–8.2 mm; hind wings, 0.6–0.7 mm. Head and thorax as in male except darker. Legs and wings as in male, except for usual sexual dimorphism (Figure 1); hind wings smaller with a larger costal projection (Figures 2 and 3). Abdomen as in male except tinged with brown on posterolateral corners of tergum IX and with posteromedian mark on tergum X. Ninth sternum whitish with yellowish posterior margin and anterolateral corners; apex slightly emarginated. Caudal filaments as in male.

*Mature nymphs*

Male length: body, 4.2 mm; mesonotum, 1.8–1.9 mm; hind femora, 1.0–1.1 mm; terminal filament, 4.5 mm; cerci, 4.0 mm. Female length: body, 5.2–6.2 mm; mesonotum, 1.9–2.1 mm; hind femora, 1.2–1.3 mm; terminal filament, 5.0 mm; cerci, 4.5 mm. General coloration light yellowish-brown with gray markings. Head shaded with black between ocelli, around antennae and behind eyes, occiput with gray markings as in Figure 9. Mouthparts whitish-yellow, maxillae as in Figure 10. Thorax: pronotum with gray markings as in Figure 9; mesonotum shaded with gray on anterolateral corners and between wingpads; wingpads whitish-yellow with blackish costal margin; pleurae and sterna paler, shaded with gray. Legs (Figures 11–13): forelegs whitish-yellow completely shaded with gray dorsally, except on anterobasal corner and mediolongitudinal line of femora (Figure 12); middle and hind legs yellowish shaded with gray except for mediolongitudinal line on femora (Figure 11); mediolongitudinal row of 10–15 spines on dorsum of middle and hind femora (Figure 11); tarsal claw with four marginal denticles and one submarginal subapical denticle (Figure 13). Abdomen yellowish-white shaded with gray dorsally, paler ventrally; thick setae on terga II–IX yellowish located near hind margin of each tergum, more numerous on terga III–VI, a pair of larger submedian setae on terga II–IX, similar setae delineating gill border on terga IV–VII. Gills (Figures 14–20): gills II operculate, oval; dorsal lamella yellowish-gray basally and paler apically with whitish margins; remaining gills translucent-whitish; dorsal lamella of gills V with a rounded ventro-basal outgrowth (Figures 17–18). Caudal filaments yellowish, with whorls of long spines at annulations.

*Life cycle association*

Imagines of both sexes were captured while mating. Nymphs and adults were associated by rearing.

*Type material*

Holotype male imago: Colombia, Cauca, Coconuco, río Grande, N 02° 20' 28"–W 76° 29' 59", 2350 m, 19–21.II.1999, luz 4:00–6:00 h, Z, D & M Cols. Allotype female imago: same data as holotype. Paratypes: 19 male imagines, 1 female imago and 12 nymphs, same data as holotype; 1 reared female subimago from Valle del Cauca, Las Brisas, río El Cerrito, N 03° 38' 31"–W 76° 11' 12", 1460 m, 22.II.1999, Z, D & M Cols; 5 nymphs, Cauca, Silvia, río Piendamó, N 02° 38' 05"–W 76° 23' 09", 2680 m, 16–17.II.1999, Z, D & M Cols. Additional (non-type) specimens: 5 male and 1 female imagines, 11 male and 5 female subimagines from Valle del Cauca, Municipio de Cali, Parque Nacional Natural Farallones de Cali, Peñas Blancas, río Pichindé, N 03° 25' 45"–W 76° 39' 27", 2000 m, 17–18.III.1999, Z, D & M Cols. Holotype and 5 male, 1 female, and 5 nymphal paratypes deposited in MEUV; 2 male and 2 nymphal paratypes in FAMU; remaining material in IFML.

*Etymology*

From Latin “albus” = white and “penna” = wing.

*Diagnosis*

*Leptohiphes albipennis* sp. n. can be distinguished from other species of the genus by the following combination of characters. In the imago: (1) membrane of wings almost hyaline; (2) veins brownish-yellow; (3) occiput completely shaded with black; (4) hind wings present in females (Figures 2 and 3); and (5) penes T-shaped (Figure 8). In the nymph: (1) occiput shaded gray as in Figure 9; (2) tarsal claw with four marginal denticles and one submarginal subapical denticle (Figure 13); (3) pronotum with gray shading as Figure 9; (4) operculate gills II shaded gray basally; (5) dorsal lamella of gills V with a rounded ventro-basal outgrowth (Figures 17 and 18); (6) femora shaded with gray as in Figures 11–12; (7) mediolongitudinal row of 10–15 spines on dorsum of middle and hind femora (Figure 11); and (8) femoral setae not inserted in conspicuously elevated sockets. In the key to species by Molineri (2003b), *L. albipennis* n. sp. will key to *L. tacajalo* from which it is easily distinguished by character (7).

*Biology and ecology*

The nuptial flight was observed near the stream, 2–3 m above the ground or water. Swarms were numerous and contained hundreds of males; each male moved in the usual up and down manner. Activity lasted until mid-morning, but extending to later in the morning when cloudy. All localities for

this species belong to the natural Andean region of Colombia. Three localities (Coconuco, Silvia and Las Brisas) correspond to mountain areas at the occidental side of the Central cordillera. One of the localities (Parque Nacional Natural Los Farallones de Cali) is located on the oriental side of the Occidental cordillera.

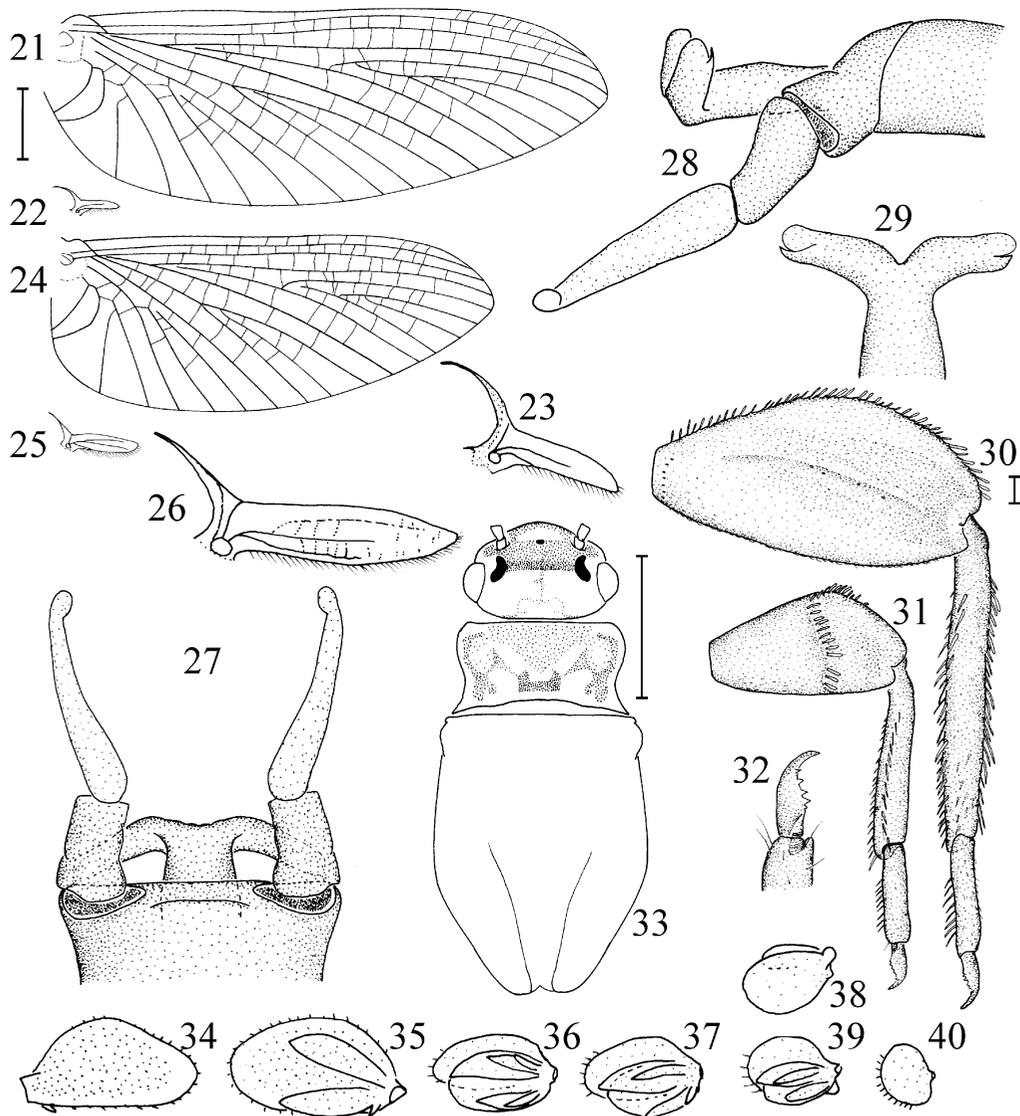
*Leptohyphes nigripennis* sp. n.

(Figures 21–42)

*Male imago*

Length: body, 4.3–4.7 mm; forewings, 6.0–6.2 mm; hind wings, 1.0–1.1 mm. General coloration

whitish-light brown. Head shaded black between ocelli and around antennae; occiput without dark marks. Thorax: pronotum translucent whitish, shaded with black; meso- and metanotum lightly shaded with gray; mesoscutellum brownish with membranous filaments translucent-whitish; thoracic pleurae and sterna paler, shaded with gray. Legs yellowish-white shaded with light brown dorsally on forefemora and with black on middle and hind femora, except on mediolongitudinal band of all femora; shading stronger on apex of all femora; tibiae and tarsi of all legs shaded gray. Wings (Figures 24–26): membrane of wings hyaline completely tinged blackish-gray, veins yellowish shaded with black. Abdomen translucent shaded with black dorsally and gray ventrally except on intersegmental membranes, shading darker on pair



Figures 21–40. *Leptohyphes nigripennis*. Adult: (21) female forewing; (22) female hind wing; (23) same, enlarged; (24) male forewing; (25) male hind wing; (26) same, enlarged; (27) male genitalia v.v.; (28) same l.v.; (29) penes detail v.v. Nymph: (30) hind leg; (31) foreleg; (32) foretarsal claw detail; (33) head and thorax d.v. (color pattern on mesonotum omitted); (34) gill II, d.v.; (35) gill II v.v.; (36) gill III v.v.; (37) gill IV v.v.; (38) gill V d.v.; (39) same v.v.; (40) gill VI v.v. Scale bars: Figures. 21–22, 24–25 = 1 mm, Figures. 30–31 = 0.1 mm.

of submedian longitudinal lines on terga II–VI; pleural folds translucent, with gray shading on spiracles, except spiracles on segment II completely black; tergum X yellowish-white with a mediolongitudinal black band. Genitalia (Figures 27–29): penes T-shaped (Figure 29); styliger plate and forceps whitish-yellow shaded with gray, penes translucent-whitish. Caudal filaments translucent whitish shaded with gray, pale at annulations.

#### Female imago

Length: body, 3.9–4.6 mm; forewings (Figure 21), 7.5–8.2 mm; hind wings, 0.65–0.75 mm. Head and thorax as in male but slightly darker. Hind wings present (Figures 22–23). Abdomen completely shaded with black except on tergum X and sternum IX. Ninth sternum whitish anteriorly, translucent yellowish posteriorly, apex entire and convex.

#### Mature nymphs

Male length: body, 3.7–4.0 mm; mesonotum, 1.5–1.6 mm; hind femora, 0.9–1.0 mm; terminal filament, 3.0 mm; cerci, 2.0 mm. Female length: body, 5.3–5.6 mm; mesonotum, 2.0 mm; hind femora, 1.3 mm; terminal filament, 4.0–4.2 mm; cerci, 3.0–3.5 mm. General coloration brownish with black markings. Head shaded black between ocelli and around antennae as in Figure 33. Mouthparts yellowish-light brown, maxillae similar to Figure 10. Thorax brownish with gray markings; wingpads (even unfolded) blackish; pleurae and sterna paler, shaded with gray. Legs (Figures 30 and 31) yellowish shaded with gray on distal 1/4 of femora; dorsum of middle and hind femora with mediolongitudinal row of 3–5 spines (Figure 30); tarsal claw with three

marginal denticles and one submarginal subapical denticle (Figure 32). Abdomen brownish completely shaded with gray, color darker on a mediolongitudinal band; terga with a few spines delineating gill border and with a pair of small submedian spines on posterior margin of terga III–IX. Gills (Figures 34–40): gills II operculate, oval, lamellae translucent-brown shaded with gray at base and with whitish margins: remaining gills translucent whitish: dorsal lamella of abdominal gills V with a rounded ventro-basal outgrowth (Figures 38 and 39). Caudal filaments light brown with blackish annuli and spines at annulations.

#### Egg

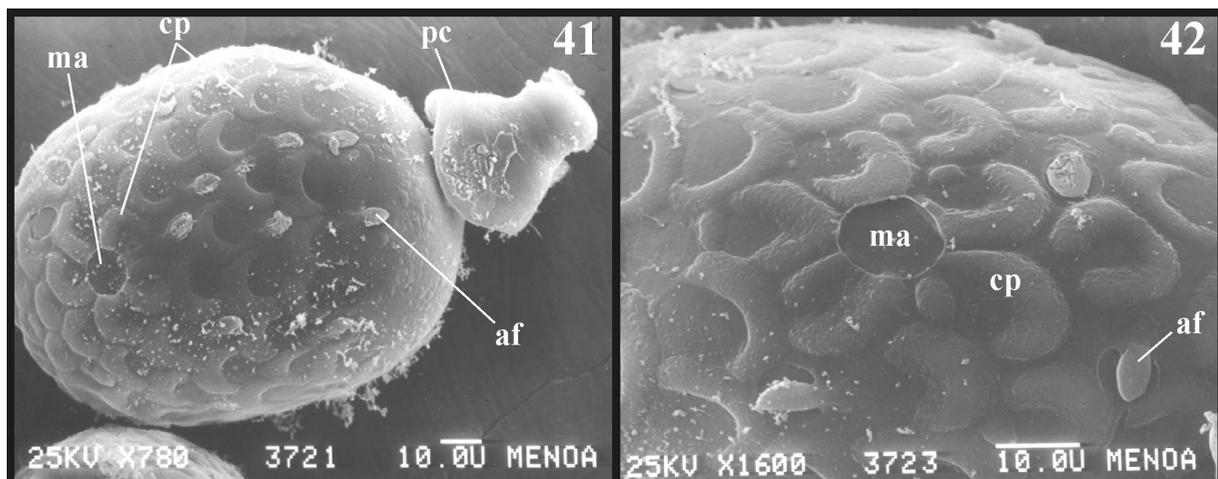
Translucent-yellowish with whitish polar caps (in alcohol). Polar cap semicircular or hood-shaped (Figure 41). Chorionic plates polygonal and touching each other on uncapped pole, but more isolated and croissant-shaped in capped pole. Adhesive filaments short and blunt (Figure 42). One circular and smooth micropylar area surrounded by 5–6 chorionic plates (Figure 42), one small micropyle located in the margin of this area.

#### Life cycle association

Imagos of both sexes were captured in a nuptial flight. Nymphs and adults were associated by the color pattern on wings and nymphal wingpads, legs and head.

#### Type material

Holotype male imago: Colombia, Cauca, Coconuco, río Grande, N 02° 20' 28"–W 76° 29' 59", 2350 m,



Figures 41–42. *Leptohiphes nigripennis*. Egg: (41) general view; (42) edtail of micropylar area and adhesive filaments. Abbreviations: af= adhesive filament; cp= chorionic plate; ma= micropylar area; pc= polar cap. Scale bars = 10  $\mu$ m.

19–21.II.1999, luz 18:00–21:00 h, Z, D & M Cols. Allotype female imago: same data as holotype. Paratypes: 60 male imagines, 24 female imagines and 150 nymphs, same data as holotype. Additional (non-type) specimens: 23 nymphs, Cauca, Silvia, Río Piendamó, N 02° 38' 05" – W 76° 23' 09", 2680 m, 16–17.II.1999, Z, D & M Cols. Holotype, allotype, and 20 male, 10 female, and 50 nymphal paratypes in MEUV; 10 male, 4 female, and 10 nymphal paratypes in FAMU; remaining material in IFML.

#### Etymology

From Latin “niger” = black and “penna” = wing.

#### Diagnosis

*Leptohyphes nigripennis* sp. n. can be distinguished from the other species of *Leptohyphes* by the following combination of characters. In the adult: (1) membrane of wings tinged blackish-gray; (2) wing veins yellowish shaded black; (3) occiput without dark marks; (4) hind wing present in female (Figures 22 and 23); and (5) penes T-shaped (Figures 27–29). In the nymph: (1) occiput without marks or slightly shaded as Figure 33; (2) tarsal claw with three marginal denticles and one submarginal subapical denticle (Figure 32); (3) pronotum shaded gray as Figure 33; (4) operculate gills II shaded gray basally; (5) dorsal lamella of gills V with a rounded ventro-basal outgrowth (Figure 38 and 39); (6) femora shaded gray as in Figures 30–31; (7) dorsum of middle and hind femora with mediolongitudinal row of 3–5 spines (Figure 30); and (8) femoral setae not inserted in conspicuously elevated sockets. Only *L. limiti* Wang et al. (1998), from Ecuador, presents a similar blackish tint in the wingpads; but *L. limiti* is characterized by the presence of 2–3 rows of pectinate setae on the dorsum of the labrum and elevated spine-bearing sockets on the femora. Scanning electron microscope photographs have been published for the eggs of three species of *Leptohyphes*: *L. cornutus* Allen and *L. eximius* Eaton by Molineri (2003b), and *L. guadaloupensis* by Hofmann et al. (1999). The eggs of *L. nigripennis* can be characterized by the presence of very short adhesive filaments, but otherwise are similar to the other species. In the key to species by Molineri (2003b), *L. nigripennis* n. sp. will key to *L. tacajalo* from which it is easily distinguished by the lack of extensive black pigments in the wingbuds.

#### Biology and ecology

Male imagines performed the nuptial flight shortly before dusk, as light intensity declined. Swarms were difficult to see because of the dark wings of this

species. General patterns of swarms and individual flight are as described for *L. albipennis*. This species was found only in the natural Andean region, in mountain zones on the occidental side of the Central cordillera.

#### *Leptohyphes coconuco* sp. n.

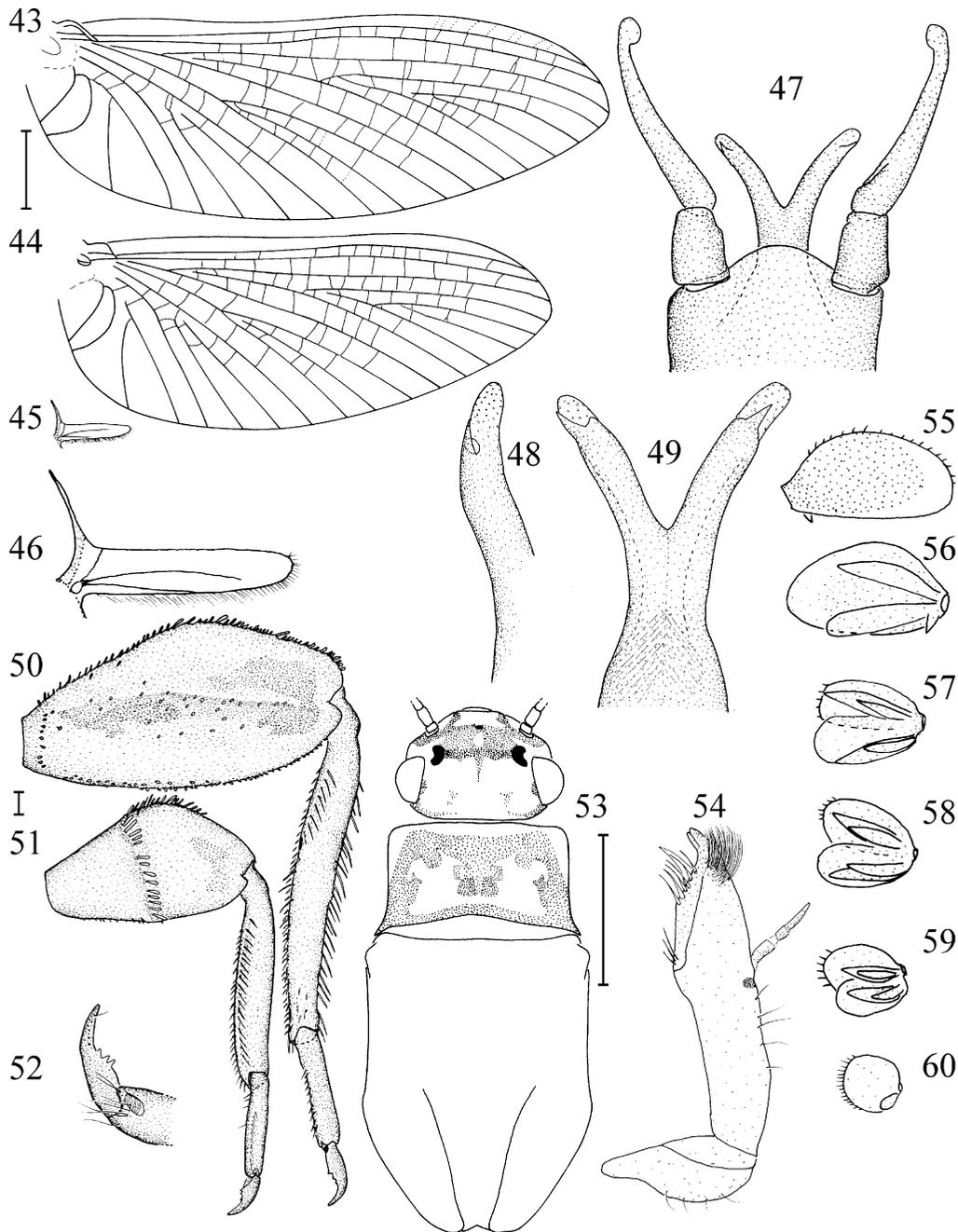
(Figures 43–60)

#### Male imago

Length: body, 3.7–5.0 mm; forewings, 5.8–6.4 mm; hind wings, 0.9–1.0 mm. General coloration light yellowish-brown. Head shaded with black between ocelli except oval longitudinal whitish mark posterior to median ocellus. Thorax: pronotum yellowish shaded with black except on sublateral sclerites; meso- and metanotum light yellowish-brown with blackish margins and sutures, darker on mesoscutellum and hind margin of metanotum; membranous filaments of mesoscutellum translucent-whitish; mesopleurae, mesosternum and metathorax paler, shaded with gray on sclerites. Legs light yellowish-brown; forefemora shaded slightly with gray, foretibiae and tarsi yellowish shaded with gray; middle and hind femora whitish-yellow shaded with grayish black on two dorsal marks, one subbasal and other subapical; tibiae and tarsi translucent whitish-yellow. Wings (Figures 44–46): membrane of wings hyaline lightly tinged with yellow, shaded with gray at base and on costal margin; longitudinal veins brownish-yellow, cross-veins yellowish. Abdomen translucent yellowish-white shaded with gray, shading darker on pair of submedian longitudinal lines on terga I–VI, on anterolateral corners and on median of tergum X; abdominal sterna light gray with circular median mark on each sternum; pleural folds whitish except shaded with gray on segments VII–IX. Genitalia (Figures 47–49): penes Y-shaped (Figures 47 and 49); styliiger plate whitish with yellowish margins; forceps paler, shaded with gray on basal half of second segment; penes whitish with yellowish lateral margins. Cerci yellowish-white shaded with gray except at annulations; terminal filament whitish-translucent.

#### Female imago

Length: body, 5.0 mm; forewings, 7.5 mm. Head and thorax as in male but darker; membranous filaments of mesoscutellum shaded gray on basal 1/3–1/2. Wings as in male except usual sexual dimorphism (Figure 43), hind wings absent. Abdomen as in male except submedian longitudinal lines on terga II–VI and mediolongitudinal band on terga VII–X darker. Ninth sternum whitish with



Figures 43–60. *Leptohiphes coconuco*. Adult: (43) female forewing; (44) male forewing; (45) male hind wing; (46) same, enlarged; (47) male genitalia v.v.; (48) penes detail l.v.; (49) same v.v. Nymph: (50) hind leg; (51) foreleg; (52) foretarsal claw detail; (53) head and thorax d.v. (color pattern on mesonotum omitted); (54) maxilla d.v.; (55) gill II, d.v.; (56) gill II v.v.; (57) gill III v.v.; (58) gill IV v.v.; (59) gill V v.v.; (60) gill VI v.v. Scale bars: Figures. 43–45, 53 = 1 mm, Figures. 50–51 = 0.1 mm.

anterolateral margins yellowish, apex with a small median notch. Caudal filaments whitish-translucent shaded with light gray. Eggs translucent-yellowish with whitish polar cap.

#### *Mature nymphs*

Length of male: body, 3.7–4.0 mm; mesonotum, 1.6 mm; hind femora, 1.1–1.2 mm; terminal fila-

ment, 4.0 mm; cerci, 3.5 mm. Female length: body, 4.5–4.8 mm; mesonotum, 1.8–2.0 mm; hind femora, 1.3–1.4 mm; terminal filament, 4.5 mm; cerci, 4.2 mm. General coloration light yellowish-brown with black markings. Head shaded black between ocelli and around antennae (Figure 53); occiput with a pair of small marks (Figure 53). Mouthparts yellowish shaded with gray on mandibles and base of maxillary palpi (Figure 54). Thorax with

blackish pattern on pronotum (Figure 53), on fore margin and sutures of mesonotum and on hind margin of metanotum; pleurae and sterna a paler gray. Legs (Figures 50–52) yellowish shaded with black on middle and hind coxae, and with subbasal and subapical blackish marks on dorsum of all femora (also ventrally on middle and hind femora) (Figures 50 and 51); tarsal claws with three marginal denticles and without submarginal subapical denticle (Figure 52). Abdomen shaded black dorsally, color darker on mediolongitudinal marks; long brownish spines on hind margins of terga III–IX, spines larger toward posterior segments, and with few spines delineating gill border on terga IV–VII; sterna shaded black on anteromedian circular marks. Gills (Figures 55–60): gills II operculate, oval, lamella translucent-yellowish with whitish margins, shaded gray at base; remaining gills translucent whitish, also shaded at base. Caudal filaments whitish-yellow with whorls of spines at annulations,

#### Life cycle association

Adults were captured while mating. Nymphs and adults from the same locality were associated by color pattern.

#### Type material

Holotype male imago: Colombia, Cauca, Coconuco, río Grande, N 02° 20' 28"–W 76° 29' 59", 2350 m, 19–21.II.1999, luz 4:00–6:00 h, Z, D & M Cols. Allotype female imago: same data as holotype. Paratypes: 77 male imagines, 1 female imago and 116 nymphs, same data as holotype. Holotype, allotype, 20 male and 30 nymphal paratypes in MEUV; 10 male and 10 nymphal paratypes in FAMU; remaining paratypes in IFML.

#### Etymology

Coconuco, name in apposition, for a now extinct ethnic group of the region.

#### Diagnosis

*Leptohyphes coconuco* sp. n. can be distinguished from the other species of the genus by the following combination of characters. In the imago: (1) membrane of wings almost hyaline; (2) veins brownish-yellow; (3) occiput whitish, almost without marks; (4) hind wings absent in female; (5) penes Y-shaped (Figures 47–49). In the nymph: (1) occiput whitish with small gray marks (Figure 53); (2) tarsal claw with three marginal denticles present and submarginal subapical denticle absent (Figure 52); (3) pronotum shaded as in Figure 53; (4) operculate

gill shaded gray at base; (5) femora shaded black as in Figures 50 and 51; (6) numerous spines on dorsum of middle and hind femora (Figure 50); (7) femoral setae not inserted in conspicuously elevated sockets. In the key to species by Molineri (2003b), *L. coconuco* n. sp. will key to *L. maculatus* from which it is easily distinguished by characters (5) and (6) listed above.

#### Biology and ecology

The time of swarming activity overlapped with *L. albipennis*, and males of both species were commonly caught in the same swarms. The locality record belongs to the occidental side of the Central cordillera, in the natural Andean region.

#### Genus *Leptohyphes* Eaton

Of the three new species of *Leptohyphes* collected in the Western Andes, two (*L. albipennis* and *L. nigripennis*) represent a group of species characterized by the presence of hind wings in females and T-shaped penes in the males. Nymphs of this group can be distinguished from other species of *Leptohyphes* because the dorsal lamella of abdominal gills V possesses a rounded ventro-basal outgrowth (Figures 17 and 18). This group of species was previously recognized but not named by Molineri (2003b) from additional material found throughout the Andes from Bolivia to Colombia. Here it is confirmed that *L. tacajalo* belongs to this group, since the paratype nymphs show the diagnostic outgrowth on gill V. The third, new species (*L. coconuco*) belongs to the *L. eximius*-group of species, characterized by dipterous females and Y-shaped penes in the males. This group is better represented in collections and almost all the species hitherto described in *Leptohyphes* pertain to it.

#### Biology and ecology

The three species described here were collected in the same area in Colombia, most commonly in the Grande River at Coconuco (Departamento del Cauca). There, they were sympatric, sharing the same microhabitats as nymphs, but differing in the hour of adult activity. The pair of closely related species (*L. albipennis* and *L. nigripennis*) did not overlap in time of swarming, as *L. albipennis* performed its nuptial flight in the morning and *L. nigripennis* just before dusk. The third species, *L. coconuco*, belonging to a different species-group, showed the same activity period as *L. albipennis* (the common activity period for the genus), but no spatial or behavioral differentiation between them was observed. Probably the large differences in penis structure avoid hybridization.

The Grande is a third-order stream, 4.5 m wide with a depth of 0.20–0.48 m; boulders, stones, and patches of gravel and sands form the substrate. Mean water volume is 3.9 m<sup>3</sup>/s and mean current speed is 1.04 m/s. Marginal vegetation consists of shrubs and grasses. Its source area is located in the Paramo, high-mountain tropical ecosystems (>3000 m) from the Andes of Peru, Ecuador, Colombia and Venezuela. The Paramo landscape is characterized by the abundance of grasses (mainly *Calamagrostis*) and unique shrubs of the genus *Espeletia* (Asteraceae). The rich organic matter soils are acid, and contribute (with lignin, tannins and humic acids) to the slight tint of the waters. Mean daily water temperature is 12°C and pH is 7.1. Organic matter as biochemical oxygen demand (BOD<sub>5-20°C</sub>) is 0.85 mg O<sub>2</sub>/l, chemical oxygen demand (COD) is 12.0 mg O<sub>2</sub>/l, and the water is always oxygen saturated. These conditions indicate a good capacity of stabilization of residual organic matter. Following the Water Pollution Index proposed by the National Sanitary Foundation of the United States of North America (Ott, 1981) and adapted to regional conditions (Behar et al., 1997), this stream presents a value of 78.9%. This corresponds to a good ecological quality without evident pollution, adequate for preservation of flora and fauna. Pollution indices for suspended matter, mineralization and organic matter are very low.

#### *Genus Tricorythodes Ulmer*

Only one species, *T. zunigae*, is known from Colombia from the Choco-Caribbean region (Molineri, 2002). The species described here, *T. trifasciatus*, is similar to *T. zunigae* and also belongs to the *santarita*-species group obtained in a previous cladistic analysis (Molineri, 2002). Wiersema and McCafferty (2000) established the genus *Asioplax* for this group of mayflies but we prefer the cladistic-based classification proposed by Molineri (2002) that consider *Tricorythodes* (sensu lato) as a unity.

#### *Tricorythodes trifasciatus* sp. n.

(Figures 61–76)

#### *Male imago*

Length: body, 2.5–3.0 mm; forewing, 2.7–3.2 mm. General coloration: thorax amber, abdomen whitish; three strong blackish transverse bands present dorsally: on pronotum, abdominal terga I–II and VIII–IX. Head cream. Thorax: pronotum heavily and completely shaded with black (Figure 62), prosternum shaded with gray; mesonotum bright yellowish-orange, shaded diffusely with gray medially

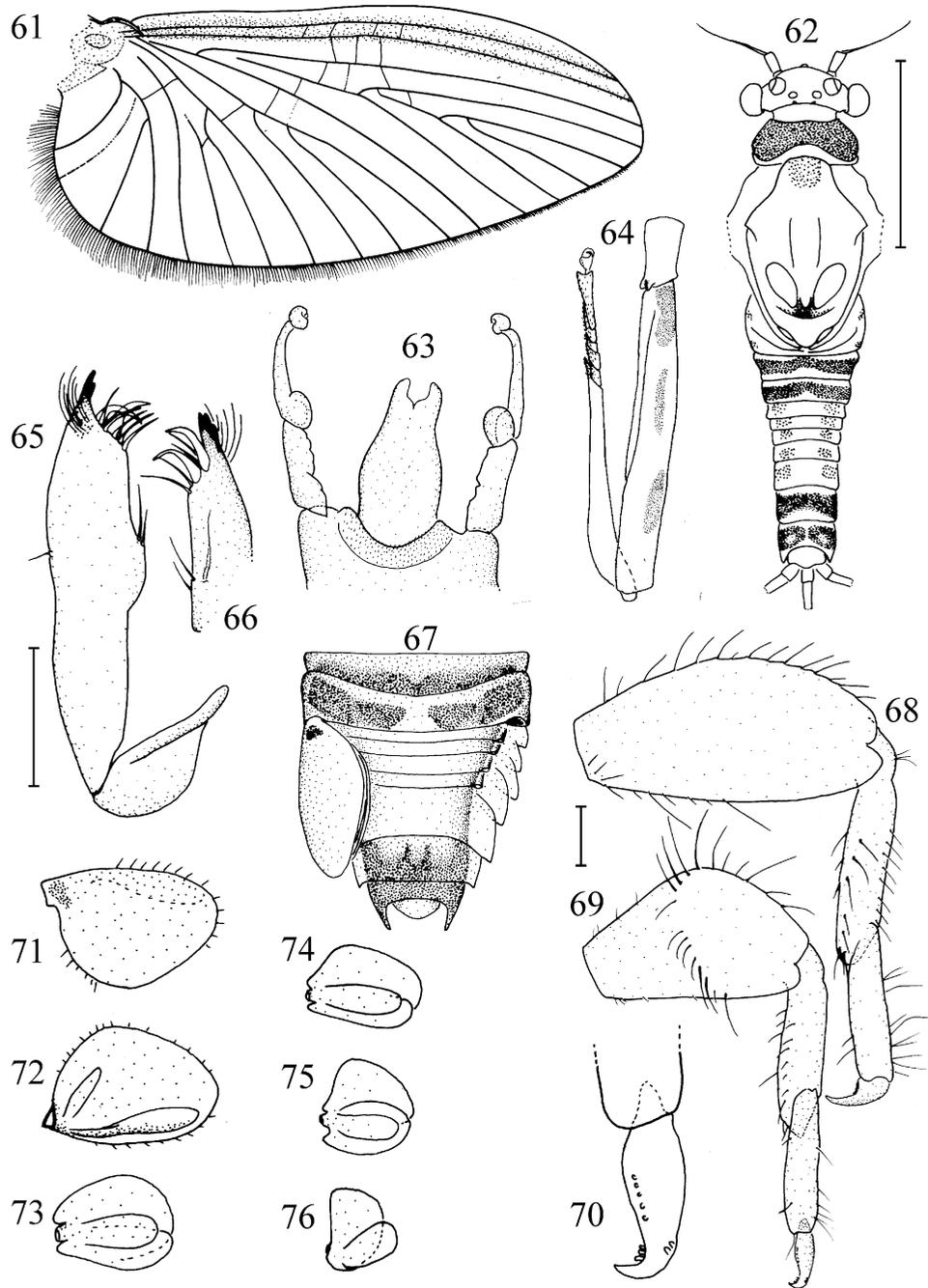
(darker on mesonotal protuberance and middle of mesoscutellum) (Figure 62); meso and metasterna shaded with gray (as on pronotum); mesopleurae and metathorax cream colored anterior to wing insertion. Legs: coxae and trochanters yellowish with gray marks; femora cream, tibiae and tarsi whitish; hind femora shaded with gray basally, medially, and subapically (sometimes forming transverse bands) (Figure 64); fore and middle femora not shaded; forefemora 1/4 the length of foretibiae and tarsi combined, hind femora subequal in length to hind tibiae and tarsi combined (Figure 64). Wings (Figure 61) hyaline, longitudinal veins light yellow, shaded with gray along and around veins Sc and R<sub>1</sub>. Abdomen (Figure 62) whitish with strong blackish marks on terga I–II and VIII–IX; terga III–VII with lighter gray submedian marks (Figure 62), although these marks sometimes absent; tergum X cream; sterna whitish. Genitalia (Figure 63) whitish-yellow, penes narrowing toward apical  $\frac{1}{2}$ – $\frac{1}{3}$ , first and third forceps segments with irregular inner margin; ratio length of forceps segment 1/segment 2: 0.8–0.9. Caudal filaments whitish-translucent.

#### *Female subimago*

Length: body, 2.90 mm; forewing, 3.30 mm. Head and thorax as in male except darker; mesonotum with darker and more extensive shading; membranous filaments of mesoscutellum relatively long, apically shaded with gray. Forewings with vein CuP very weak, hardly visible, remaining longitudinal veins shaded with blackish, cross-veins translucent. Abdominal color pattern as in male but stronger.

#### *Nymphs*

Male length: body, 2.0–2.2 mm, cerci 1.0 mm. Female length: body, 2.5 mm; cerci 1.0 mm. General aspect somewhat broad and flat (not so marked in nymphs ready to molt to subimago), color pattern similar to imago (with three black bands). Head cream shaded with gray around antennae and on a pair of submedian occipital marks; antennae translucent. Mouthparts light cream, maxillary palpi one-segmented with apical setae (Figure 65); inner proximal margin of galea-lacinia with three setae (Figure 66). Thorax: pronotum heavily shaded with black; shading on mesonotum similar but less extensive; wingpads cream-colored without shading. Legs (Figures 68 and 69) cream-colored sometimes shaded with grayish-black to form two femoral bands; foreclaws with 5–6 marginal denticles and double row of 2 + 3 submarginal subapical denticles; denticles not always present on middle and hind claws. Thoracic and abdominal sterna shaded with



Figures 61–76. *Tricorythodes trifasciatus*. Adult: (61) male forewing; (62) male body d.v.; (63) male genitalia v.v.; (64) male hind leg d.v. Nymph: (65) maxilla d.v.; (66) same v.v.; (67) abdomen d.v. (right gills omitted); (68) hind leg; (69) foreleg; (70) foretarsal claw detail; (71) gill II, d.v.; (72) gill II v.v.; (73) gill III v.v.; (74) gill IV v.v.; (75) gill V v.v.; (76) gill VI v.v.

black. Abdomen (Figure 67) whitish-cream with black markings: terga I–II and VIII–IX almost completely black; terga III–VII sometimes with marks along gill borders; terga pale beneath gills. Sterna cream almost completely shaded grayish black. Gills (Figures 71–76): gills II operculate, subtriangular, translucent except for basal black macula, with two well-developed ventral lamellae (Figure 72); other gills translucent. Posterolateral

flanges present on abdominal segments III–VIII, extended as posterolateral spines (although somewhat blunt) on segments III–IX (Figure 67). Caudal filaments translucent.

*Life cycle association*

Adults and nymphs from the same locality are associated by color pattern.

### Material

Holotype male imago: Colombia, Valle del Cauca, Municipio de Riofrío, río Riofrío, 5 km before Salónica, N 04° 07' 39"–W 76° 22' 06", 1150 m, 22.IX.2002, luz 18:00–21:00 h, Z, B, C & CC Cols. Paratypes: 16 male imagines and 1 female subimago, same data as holotype; 1 nymph same data as holotype except 17.XI.2001, Z, E & C Cols.; 4 nymphs, Valle del Cauca, Municipio de Riofrío, río Riofrío, Puente vía Roldanillo, N 04° 08' 45"–W 76° 17' 22", 990 m, 17.XI.2001, Z & E Cols. Holotype, 3 male and 2 nymphal paratypes in MEUV; remaining material in IFML.

### Etymology

From Latin “tri”=three and “fascia”= band, stripe, in allusion to the black markings on the body.

### Diagnosis

*Tricorythodes trifasciatus* sp. n. can be distinguished from the other species of the genus by the following combination of characters. In the imago: (1) body shaded with black forming three transverse bands (pronotum, abdominal terga I–II and VIII–IX) (Figure 62); (2) legs with black markings on femora but not on tibiae or tarsi (Figure 64); (3) penes wide at base and becoming narrower on apical 1/2–1/3 (Figure 63); (4) ratio length of forceps segment 1/segment 2: 0.8–0.9; (5) vein CuP present but very weak (Figure 61), sometimes hardly visible; (6) membrane of wings shaded gray only on veins Sc and R<sub>1</sub>. In the nymph: (1) body with black markings as in adult (Figure 62); (2) legs generally without markings, but may show 2–3 gray femoral bands; (3) operculate gills subtriangular (Figure 71); (4) maxillary palpi one-segmented with apical setae (Figure 65); (5) body broad and flat (Figure 67); (6) transverse row of spines on forefemora located near the middle of the femur (Figure 69); (7) tibiae and tarsi without blackish marks; (8) foreclaw with 5–6 marginal denticles and a double row of 2+3 submarginal subapical denticles (Figure 70); (9) femora broad (Figures 68 and 69). In the key to adults by Molineri (2002), the first statement of couplet 3 should be changed to “femora of all legs (or at least hind legs) with two or three reddish or grayish transverse marks”. With this modification, male adults of *T. trifasciatus* n. sp. will key to *T. zumigae* from which it is easily distinguished by body color pattern. Nymphs of *T. trifasciatus* will also key to *T. zumigae*, but they can be separated by color pattern, gill shape, and maxillary palp. *Tricorythodes zumigae* has a subquadrate operculate gill II, a two-segmented maxillary palpi, and a color

pattern not forming three transverse bands (Molineri, 2002).

### Biology and ecology

The Riofrío River is located in the natural Andean region, on the oriental side of the Occidental cordillera. It belongs to the high basin of the Cauca River, in the SW of Colombia. This zone is covered by dry tropical forest, with air temperatures of 23–28°C and mean annual precipitation of 1420 mm. Riofrío is a fourth-order river, 10.5 m wide and 0.28–0.64 m deep, with a substrate composed of boulders, stones, gravel and sand. Mean water volume is 7.2 m<sup>3</sup>/s, the slope is medium, and mean current speed is 1.45 m/s.

The Riofrío basin above Salónica (type locality) receives a small quantity of wastewater from sparse populations and agricultural activities (mainly coffee plantations and cattle exploitation). Some of the original riparian vegetation is present (Moraceae, Mimosaceae, Bignoniaceae, Anacardiaceae and Fabaceae). The Riofrío lower basin (locality of some paratypes, Puente vía Roldanillo) is affected by the wastewaters of the Riofrío population, just before it flows into the Cauca River. The natural riparian vegetation is completely lost and replaced by sugar cane plantations and grass. The riverbed is modified by stone and gravel extraction. Mean water temperature varies between 19°C (above Salónica) and 23°C at Puente vía a Roldanillo. The watercourse shows a good capacity for re-oxygenation and assimilation of the organic pollution in the lower basin. Oxygen saturation exceeded 90% at both localities, and the organic matter as BOD<sub>5-20°C</sub> varied between 0.5 and 10.8 mg O<sub>2</sub>/l and as COD between 1.6 and 23.6 mg O<sub>2</sub>/l. Values for pH ranged from 7.05 to 7.90. Mean values for the Water Pollution Index (Behar et al., 1997) varied between 71.12% at Salónica (corresponding to good) and 52.13% at Puente vía Roldanillo (acceptable, but waste water impact evident). Pollution indices for mineralization were low for both river reaches (Echeverri, 2004).

Nymphs of *Tricorythodes trifasciatus* were not found in patches of sand, as is commonly reported for other South American species of the genus, but were mainly associated with gravel in riffle areas. Other microhabitats occupied, but at lower frequencies, were stones and leaf packs (Echeverri, 2004).

### Genus *Tricorythopsis*

The presence of this genus was previously reported from Colombia by Domínguez et al. (2002) from two male and numerous female imagines collected near Leticia (Amazonas). Here we describe the males. We were unable to associate them with females, in spite

of the fact that both sexes were collected simultaneously, because of strong differences in size and color pattern.

*Tricorythopsis ticuna* sp. n.

(Figures 77–79)

*Male imago*

Length: body, 1.7–2.1 mm; forewings, 1.6–2.1 mm; terminal filament, 7.0 mm; cerci, 5.0 mm. General coloration grayish-brown. Head tinged yellowish in median part of occiput behind lateral ocelli; shaded black posteriorly. Thorax: pronotum and propleurae translucent shaded black dorsally, prosternum whitish; mesonotum yellowish-brown, sutures paler, with a wide gray dorsal longitudinal band divided into two submedian bands anteriorly; membranous filaments of mesoscutellum short, blunt and translucent shaded with gray; mesopleurae yellowish shaded with black on sutures; mesosternum and metathorax paler. Legs translucent-yellowish, darker on femoral margins and dorsum of femora; foretibiae and tarsi shaded with black. Wings (Figure 77): membrane hyaline, veins hyaline-translucent, except veins and cross-veins of Sc, R, MA<sub>1</sub> shaded black. Abdomen: segments I–VII hyaline, segments VIII–X whitish-yellow; terga completely shaded with gray, darker on terga I and VII–IX; tergum X with brownish median line and brownish posterior margin. Genitalia (Figures 78 and 79) translucent-whitish, except margins of styliger plate yellowish. Caudal filaments translucent shaded light gray at annulations.

Female imago and nymph. Unknown.

*Type material*

Holotype male imago: Colombia, Amazonas, Municipio de Leticia, Parque Nacional Natural Amacayacu, río Amacayacu, S 03°48'28"–W 70°15'21", 93 m, 3.II.1999, luz 18:00–20:00 h, Z, D & M. Cols. Paratype: male imago, Amazonas, Municipio de Puerto Nariño, río Loreto Yacu, S 03°44' 26"–W 70°27 '19", 97 m, 5.II.1999, luz 18:00–19:30 h, Z, D & M Cols. Holotype in MEUV, paratype in IFML.

*Etymology*

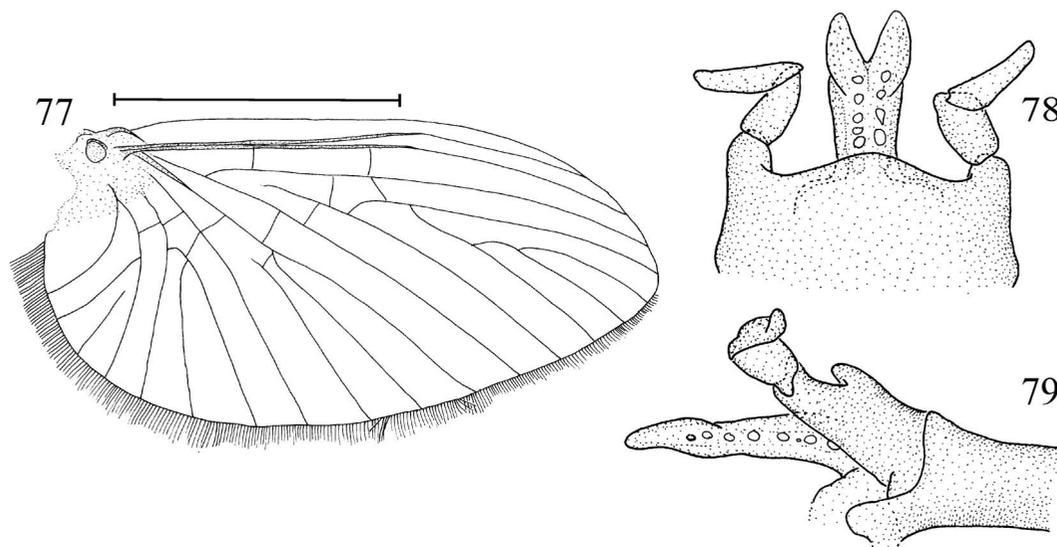
Ticuna is the name of one of the most numerous ethnic group of the region.

*Diagnosis*

Male imagines of this species can be distinguished from other species in the genus by the following combination of characters: (1) body with relatively dark coloration, abdomen completely shaded with gray; (2) bases of forceps relatively short (Figures 78 and 79); (3) penes divided in apical 1/3 (Figure 78); and (4) penes broader towards apex with lateral margins somewhat sclerotized and with small bubble-like structures (Figures 78 and 79).

**Discussion**

There is a conspicuous intraspecific variation in the distribution of epidermal pigments in *Tricorythopsis* (Molineri, 1999, 2001). As we have only two male imagines, this variation could not be fully



Figures. 77–79. *Tricorythopsis ticuna*. Adult: (77) male forewing; (78) male genitalia v.v.; (79) same l.v.

evaluated. In the paratype, the mesonotum is broadly tinged with gray (instead of the median band of the holotype); also, the gray shading is more extensive on the abdomen and head. The structure of the penes indicates a relationship closer to *T. gibbus* (Allen) and *T. undulatus* (Allen) than to other species of the genus. This phylogenetic proximity will only be confirmed with the knowledge of the eggs (with polar caps aside the main axis of the egg in *T. gibbus* and *T. undulatus*) and nymphs (showing coxal spines and abdominal tubercles in both species). In the key to species by Molineri (2001), *Tricorythopsis ticuna* n. sp. will key to couplet 2 (*T. gibbus* and *T. undulatus*) from which it is easily distinguished by the absence of grayish or blackish bands on middle and hind femora, and form of penes.

#### Biology and ecology

Male imagines were captured at light and no swarm activity was observed. Locality records belong to the natural Amazon region in the lowlands of the Colombian Amazon basin in the small “trapezium” between Peru and Brazil. The water of the river is slightly colored by soluble organic compounds such as tannins and lignins originating from the flooded forest.

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