

## Contribution to the Taxonomy of the Leptohiphidae (Insecta: Ephemeroptera) of Central America

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Three new species of Leptohiphidae (Insecta: Ephemeroptera) are described from larval specimens collected from streams in Costa Rica: *Haplohyphes aquilonius*, n. sp., *Leptohiphys curiosus*, n. sp., and *Tricorythodes undatus*, n. sp. *Leptohiphys lumas* Allen and Brusca is reinstated as a valid species, and *L. zelus* Allen is synonymized with it. *Leptohiphys castaneus* Allen and *L. murdochi* Allen are newly reported from Costa Rica. *Leptohiphys hispidus* Allen and Brusca is newly reported from Belize and Costa Rica. *Leptohiphys packeri* Allen is newly reported from Belize.

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### Introduction

The mayfly family Leptohiphidae constitutes an important component of stream ecosystems in Central America. This group was originally considered a subfamily of Tricorythidae by Edmunds and Traver (1954) and later was raised to familial status by Landa (1973). Eighteen nominal species have been reported from the region in the genera *Haplohyphes* Allen (one species), *Leptohiphys* Eaton (16 species), and *Tricorythodes* Ulmer (one species), and it is evident that with the continuing effort to document the Central American entomofauna more species will be found. However, four major problems involving the taxonomy of this family in the region require considerable attention, as described below.

With the exception of *Leptohiphys packeri* Allen, the nominal species reported from Central America are known either from only larvae or only adults. The taxonomic status of such species will remain tenuous until associations of both stages are established.

The unreliability of characters used in the past to differentiate species in the larval and adult stages has made it difficult to accurately identify leptohiphids. Allen and his co-workers (Allen, 1967, 1973, 1977, 1978; Allen and Brusca, 1973; Kilgore and Allen, 1973; Allen and Murvosh, 1987) emphasized the use of general body coloration and tarsal claw denticulation of larvae to distinguish species in *Leptohiphys*, but we have found these characters to be highly variable, even within populations. Because only a few male adults are known from the

region, it remains to be seen which characters will differentiate species in this sex and stage. Traver (1935, 1958a, 1958b, 1959) and Kluge and Naranjo (1990) used general body coloration and the shape of the male genitalia to distinguish species of *Leptohyphes* and *Tricorythodes*; however, as is the case with the larvae, body coloration can be variable, and we have found the shape of the male genitalia too generalized and uniform among species presently known as adults.

The primary type materials pertaining to some species of *Leptohyphes* are apparently lost (see discussion under *L. lumas* Allen & Brusca, below). This obviously impedes assessments of their taxonomic status.

Despite recent efforts by Kluge (1992), the generic concepts of *Leptohyphes* and *Tricorythodes* are unclear, and there appears to be a strong possibility that *Tricorythodes* could be synonymous with *Leptohyphes* if strict cladistic methodology is followed (T. Wang, pers. comm.). This may well be the case, particularly in the light of Kluge and Naranjo's (1990) comments that some Cuban leptohyphid larvae possess characters that would place them in *Leptohyphes*, whereas their adults have characters that would place them in *Tricorythodes*.

We have carefully reviewed new collections of Leptohyphidae from Central America, and have discovered numerous varieties, especially of larvae, not recorded in the literature. From these, we are confident at this time that only a few actually represent new species, and that some others are varieties of particular species. Thus, in this paper we describe three new species of Leptohyphidae based on larval material collected from Costa Rica and comment on their significance. In addition, we provide short accounts of only those species involving new records from Central America (i. e., *L. castaneus* Allen, *L. hispidius* Allen & Brusca, *L. murdochi* Allen, and *L. packeri*) or new taxonomic status (i. e., *L. lumas*). The materials which formed the basis of this study are housed in the Purdue Entomological Research Collection (PERC), West Lafayette, Indiana, and the Florida A & M University (FAMU), Tallahassee.

### ***Haplohyphes aquilonius* Lugo-Ortiz and McCafferty, new species**

#### **Material Examined**

Holotype: Female larva, COSTA RICA, Puntarenas Prov., 10 km N of San Vito, at quarry waterfall, at light, III/16/1969, W. P. McCafferty, deposited at PERC. Paratypes: Five female larvae, same data and deposition as holotype; one male larva, COSTA RICA, Puntarenas Prov., Río Bellavista, nr 1.5 km NW of Las Alturas, 8.951° N/82.846° W, 1400 m, VI/15-17/1986, Holzenthal, Heyn, and Armitage, deposited at FAMU.

#### **Larva**

(Fig. 1). Body length: 4.8 - 7.0 mm; caudal filaments: 3.0 - 3.5 mm. Head: Anterior margin pale yellow, grading to brown posteriorly. Compound eyes widely separated. Antennae very long, 4.5 - 5.0 × longer than head capsule; scapes bare; pedicels with many short, simple setae ventrally; whorls of very small, simple setae at articulations. Clypeus densely covered with short, simple setae. Labrum (Fig. 2) rectangular, with anteromedian emargination and numerous long, simple setae scattered dorsally. Right mandible (Fig. 3) with two sets of incisors; distal set with three denticles; basal set with two denticles; prostheca reduced to minute simple seta; small triangular process at base of molar; molar consisting of six to

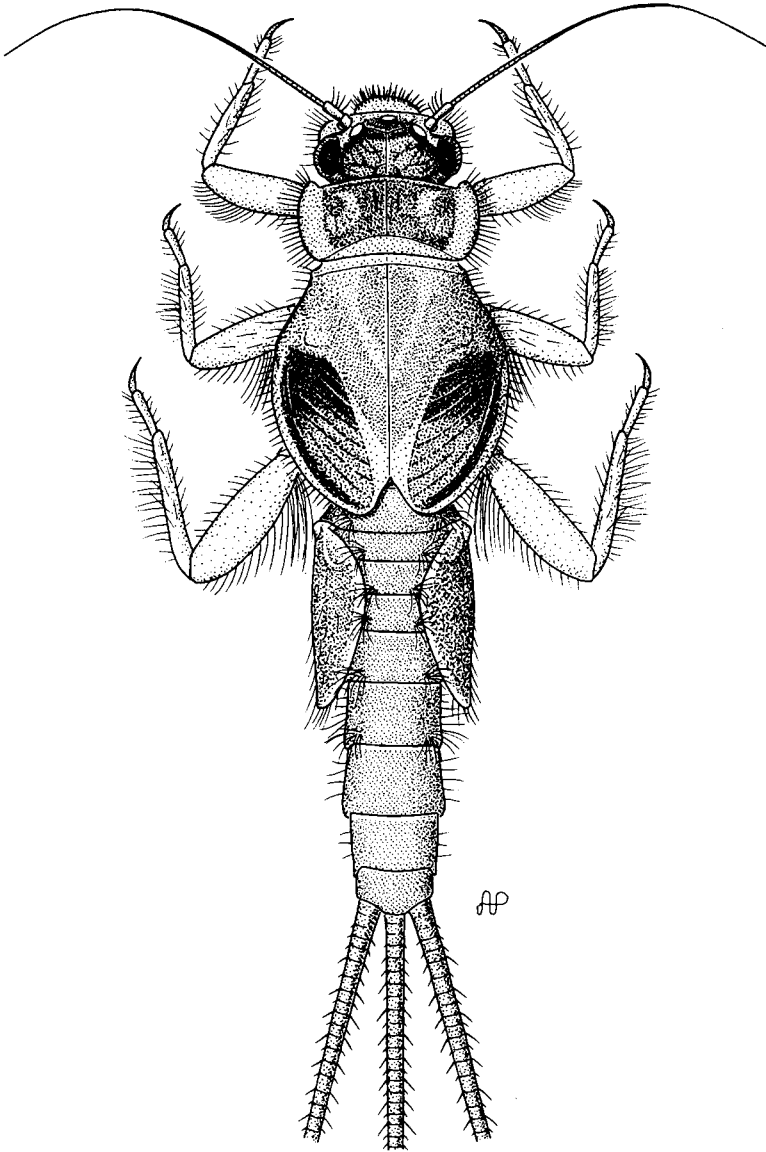
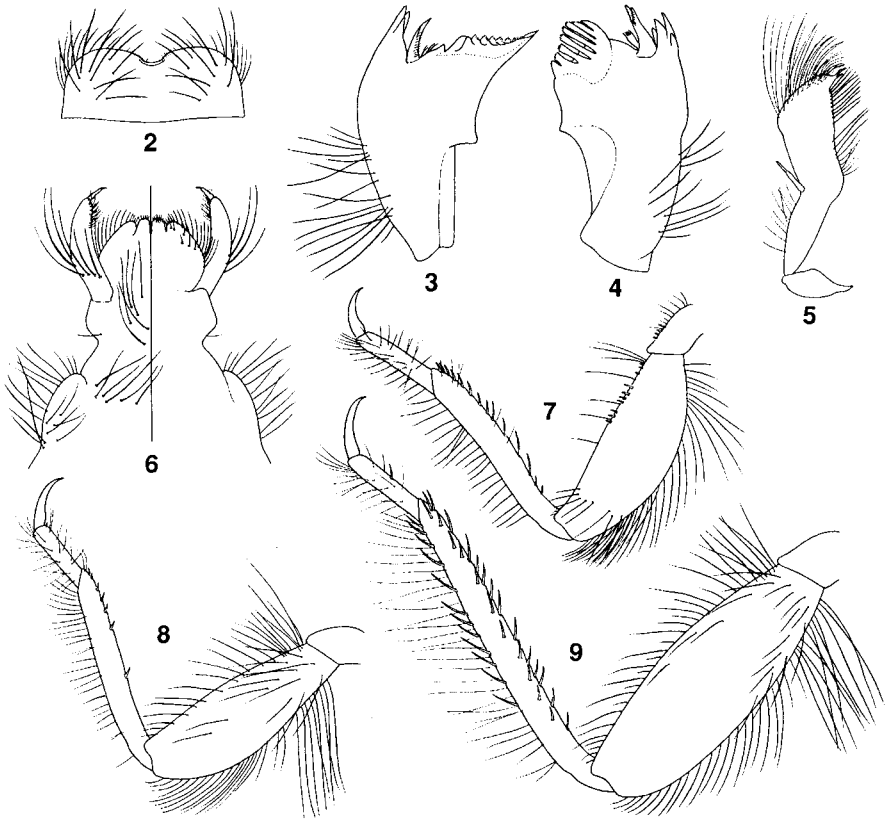


Fig. 1. *Haplohyphes aquilonius*, n. sp., larva, dorsal view.

nine densely packed tufts of simple setae (each tuft denticlelike); lateral margin with scattered long, fine, simple setae. Left mandible (Fig. 4) with two sets of incisors; distal set with four denticles; basal set consisting of two fused denticles; prosthema distally broad, with four or five small denticles; molar subparallel to lateral margin, with seven to eight denticles; short, stout simple setae present at

base of molar; long, fine, simple setae laterally. Maxillae (Fig. 5) with numerous long, fine simple setae distally and medially on galealaciniae; maxillary palps 2-segmented. Labium (Fig. 6) small and fleshy; labial palps 3-segmented; palp segment 1 long and robust, almost cylindrical, with row of long setae about 1/3 from base, and patch of small, simple setae distally on median margin; segment 2 small and cylindrical; segment 3 smaller, clawlike; glossae and paraglossae fused except distally; glossae with many small, simple setae surrounding large, simple seta distally; paraglossae with numerous long, simple setae laterally; submentum narrow, with numerous long, simple setae laterally and sublaterally and row of long, simple setae near anterior ventral margin. Thorax: Color brown to pale yellow. Notae fringed with fine, simple setae. Sternae brown to pale yellow. Hindwingpads present in both sexes. Legs (Figs. 7 - 9) medium brown to pale yellow-brown; forefemora with numerous fine, simple setae along dorsal margin and short, stout, simple setae basally on ventral margin; foretibiae with numerous long, fine, simple setae dorsally, ventral margin with robust, simple setae



Figs. 2-9. *Haplohyphes aquilonius*, n. sp., larva: 1, labrum (dorsal); 2, right mandible; 3, left mandible; 4, right maxilla; 5, labium (left-ventral; right-dorsal); 6, left foreleg, 7, left midleg; 8, left hindleg.

decreasing in length distally; fore- and midtarsi with only very fine, simple setae scattered over surface; fore- and midtarsal claws elongate and sharp, with inconspicuous denticles; midfemora similar to forefemora, except without short, stout, simple, setae basoventrally and with long, simple setae basodorsally; midtibiae similar to foretibiae, except only short, simple setae present ventrally; hindfemora similar to midfemora, except long, simple setae more abundant; hindtibiae with long, robust, simple setae dorsally and ventrally and fine, simple setae scattered over surface but more abundant dorsally; hindtarsi with robust, simple setae near medial region of ventral margin; hindtarsal claws with no denticles. Abdomen: Color medium to dark brown, intersegmental areas yellow-brown. Shape relatively narrow-elongate. Terga with numerous scattered fine, simple setae, becoming more abundant posterolaterally on each tergite, particularly on terga 2-7. Operculate gills subtriangular and elongate; color pale, suffused with purplish dots, with scattered fine, simple setae dorsally and marginally. Caudal filaments yellow-brown to medium brown, with whorls of short, simple setae at articulations.

#### **Adult**

Unknown.

#### **Etymology**

The specific epithet is a Latin word meaning northern. It is in reference to the species being in the northernmost part of the range of the genus.

#### **Discussion**

Domínguez (1984) described the first known larvae of *Haplohyphes* from two species, *H. baritu* Domínguez and *H. furtivus* Domínguez, from Argentina. This is the first larval description of a member of the genus from Central America. *Haplohyphes aquilonius* differs from the Argentinian species in its darker abdominal coloration and the presence of long, simple setae at the base of the femora. *Haplohyphes aquilonius*, however, could be the undescribed larva of *H. mithras*, the only other species of *Haplohyphes* presently known from Central America (Traver, 1958a).

### ***Leptohyphes castaneus* Allen**

#### **Material examined**

COSTA RICA, Puntarenas Prov., 10 km N of San Vito, at quarry waterfall, III/16/1969, W. P. McCafferty, larvae, deposited at PERC.

#### **Discussion**

Allen (1967) described *L. castaneus* from larval material collected from Guatemala. Recently, Lugo-Ortiz and McCafferty (1994) reported this species from southern Mexico. The adult stage of this species remains unknown.

### *Leptohyphes curiosus* Lugo-Ortiz and McCafferty, new species

#### Material Examined

Holotype: Female larva, COSTA RICA, Guanacaste Prov., Río Tenorio at Finca La Pacífica, E of Panamerican Hwy, II/2/1969, W. P. McCafferty, deposited at PERC.

#### Larva

(Fig. 10). Body length: 2.8 mm; caudal filaments: 0.8 mm. Head: Coloration pale brown, fringed with numerous long, fine, simple setae. Antennae pale yellow, near  $1.5 \times$  length of head capsule. Mouthparts typical of *Leptohyphes* [as in Allen (1978): Figs. 3 - 7]. Maxillae with palps absent. Thorax: Nota medium brown, pale yellow laterally, fringed with fine, simple setae. Sterna pale yellow. Legs medium brown to pale yellow, short and robust, fringed with long, fine, simple setae; forefemora with distinct transverse ridge near base of dorsal face; tarsal claws distinctly curved, with five to six denticles and subapical simple seta. Abdomen: Color medium brown. Sterna pale yellow. Segments 7 - 8 with distinct posterolateral projections. Operculate gills pale yellow, ovate, somewhat pointed distally. Caudal filaments pale yellow, with whorls of short, simple setae at articulations.

#### Adult

Unknown.

#### Etymology

The specific epithet is a Latin word meaning strange. It refers to the singular combination of characters that distinguish the species from other members of the genus.

#### Discussion

*Leptohyphes curiosus* is unique among the members of the genus because of its small size, dorsoventrally flattened body, distinct posterolateral projections on segments 7 - 8, shape of the operculate gills, and leg setation (Fig. 10). The species appears to be intermediate between the traditional characterization of the larvae of *Leptohyphes* and that of *Tricorythodes*. Leg setation would place the species under *Tricorythodes*, but the distinct ridge on the forefemora is not found in any larvae currently assigned to that genus, and the morphology of the operculate gills is closer to that found in the larvae of *Leptohyphes*. Given these morphological peculiarities, it is possible that this species is representative of a distinct Neotropical lineage within *Leptohyphes*.

### *Leptohyphes hispidus* Allen & Brusca

#### Material examined

BELIZE, Cayo Prov., Roaring Creek, riffle, VI/20/1974, V. Resh, larvae, deposited at PERC. COSTA RICA, Cartago Prov., Río Chitarfa, Rt 10, 10 km NW Río Reventazón, 9.920° N/83.604° W, 740 m, II/4/1986, Holzenthal, Morse and Fasth, larvae, deposited at FAMU; Reserva Tapanti, Río Badilla, 9.688° N/83.757° W, 1640 m, III-21-1987, Holzenthal and Hamilton, larvae, deposited at FAMU; Puntarenas Prov., Río Sinigri, ca 2 km (air) S of Finca Helechales, 9.057° N/83.082° W, 720 m, II/21/1986, Holzenthal, Morse, and Fasth, larvae, deposited at FAMU; Río Guineal, ca 1 km (air) E of

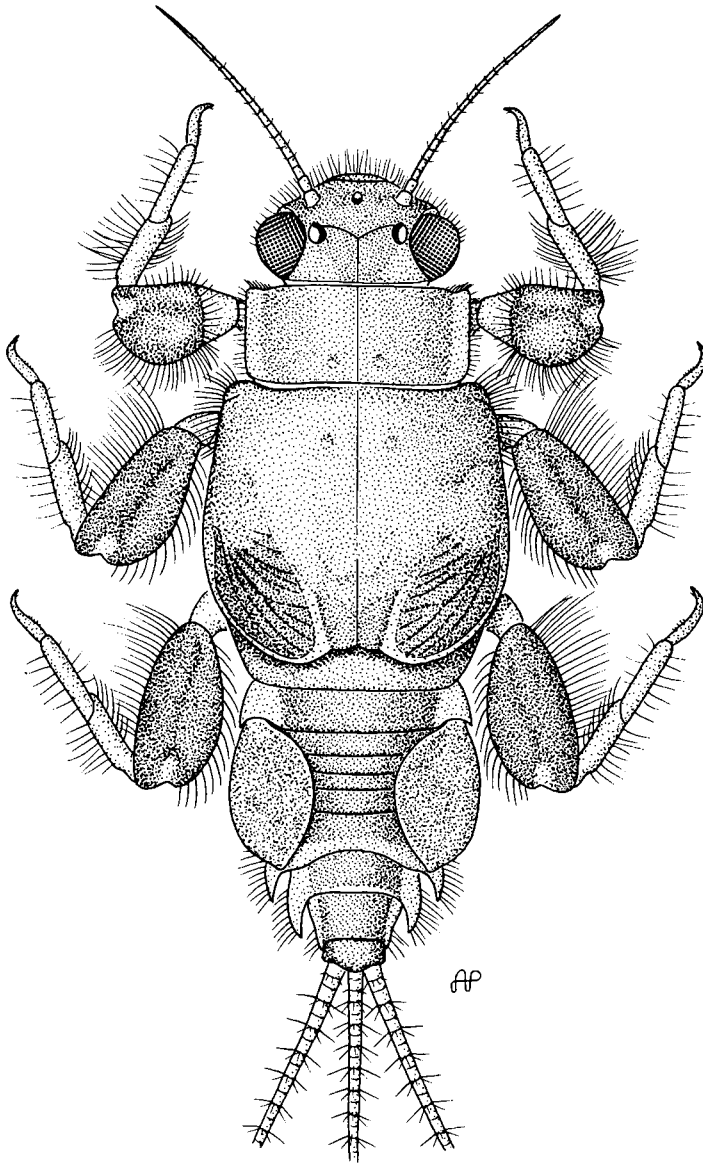


Fig. 10. *Leptohyphes curiosus*, n. sp., larva, dorsal view.

Finca Helechales, 9.076° N/83.092° W, 840 m, II/22/1986, Holzenthall, Morse, and Fasth, larvae, deposited at FAMU; Reserva Bosque Nuboso Monteverde, Quebrada Cueba, 10.31° N/84.79° W 1550 m, II/28/1986, Holzenthall and Fasth, larvae, deposited at FAMU; 10 km N of San Vito, at quarry waterfall, III/16/1969, W. P. McCafferty, larvae, deposited at PERC.

**Discussion**

Allen and Brusca (1973) reported this species from Veracruz, Mexico. Allen (1978) subsequently synonymized *L. lumas* Allen and Brusca with *L. hispidus*, and provided additional records from El Salvador and Guatemala. We do not agree with this synonymy (see below). The adult stage of *L. hispidus* remains unknown.

***Leptohyphes lumas* Allen and Brusca***Leptohyphes zelus*

Allen, 1978: 557. New synonym.

**Discussion**

Allen and Brusca (1973) described *L. lumas* from larvae collected from Veracruz, Mexico. Later, Allen (1978) synonymized *L. lumas* with *L. hispidus* stating that he could not find any major morphological differences between the two species. Based on Allen and Brusca's (1973) original descriptions and figures, however, *L. hispidus* and *L. lumas* are distinct, particularly with reference to body spiculation and head and abdominal coloration [compare, for example, Figures 23 and 25 in Allen & Brusca (1973)]. We thus reinstate *L. lumas* as a valid species. Allen's (1978) records of *L. hispidus* from El Salvador and Guatemala are likely referable to *L. lumas*.

Allen (1978) described *L. zelus* from larvae collected from Guatemala and Honduras. His description of that species is very similar to that of *L. lumas*, and it is impossible to separate the two based on published characterization. Moreover, Allen (1978) used the exact same figure to depict *L. zelus* that Allen and Brusca (1973) used to depict the head of *L. lumas*. Based on our unsuccessful efforts to locate the type material pertaining to these names at the places where they reportedly were deposited, we must assume that they are lost. Nonetheless, we must consider *L. zelus* a junior synonym of *L. lumas* based on available data.

***Leptohyphes murdochi* Allen****Material examined**

COSTA RICA, Puntarenas Prov., Río Sinigri, nr 2 km (air) S of Finca Helechales, 9.057° N/83.082° W, 720 m, III/21/1986, Holzenthal, Morse, and Fasth, larva, deposited at FAMU.

**Discussion**

Allen (1967) described this species, as *L. murdocki*, from larval material collected from Panama. Edmunds et al. (1976) subsequently emended its specific epithet to *murdochi*. Brusca (1971) and Allen (1978) indicated that *L. alleni* Brusca and *L. murdochi* may be closely related since both species possess distinct white spots covering their bodies, a characteristic not found in other members of the genus. The adult stage of this species remains unknown.



*Leptohyphes packeri* Allen**Material examined**

Belize, Roaring Creek, riffle, VI/20/1974, V. Resh, larva, deposited at PERC.

**Discussion**

*Leptohyphes packeri* is a widespread species, being reported from Arizona and Texas (USA) south to Honduras (Allen, 1967, 1978; Henry, 1986; Allen & Murvosh, 1987). Its presence in Belize is not surprising. Allen (1967) originally described the species from larvae, and Henry (1986) subsequently associated the adult stage by rearing.

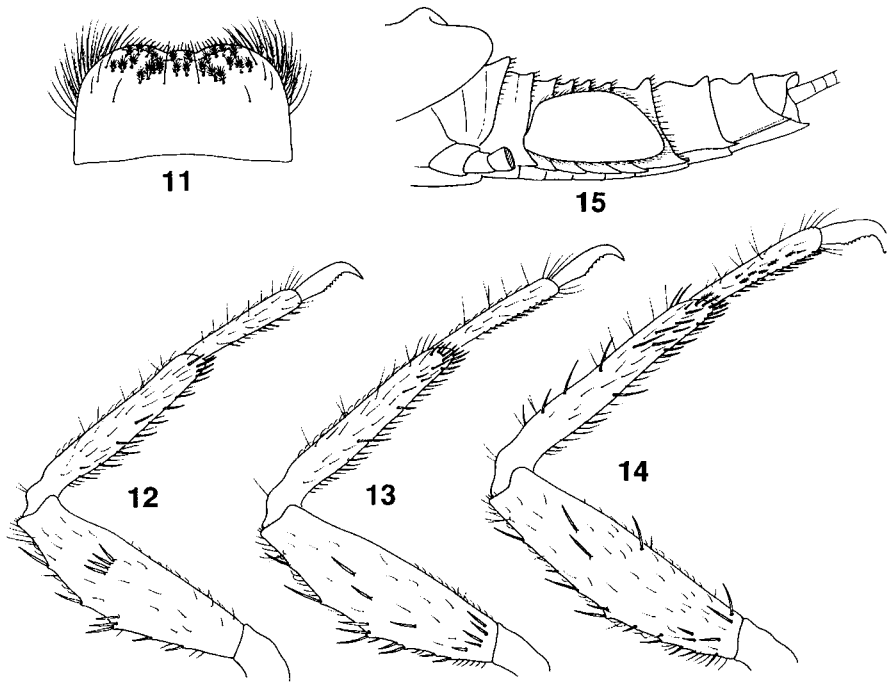
*Tricorythodes undatus* Lugo-Ortiz and McCafferty, new species**Material Examined**

Holotype: Larva, COSTA RICA, Puntarenas Prov., Peninsula de Osa, Río Rincón at end of Playa Blanco Rd, III-3-1969, W. P. McCafferty, deposited at PERC. Paratypes: Two larvae, same data and deposition as holotype.

**Larva**

Body length: 3.3 - 4.4 mm; caudal filaments: 2.7 - 4.2 mm. Head: Coloration pale yellow. Antennae almost  $2.5 \times$  length of head capsule; scapes and pedicels pale yellow; flagella pale, except for brown basal segment, with three to four subapical simple setae on each segment. Compound eyes widely separated. Ocelli mounted on small tubercles. Labrum (Fig. 11) twice as broad as long; long, fine, simple setae laterally, some setae branched; anterior margin with setae shorter than those on lateral margin, some branched; scattered long, fine, simple setae dorsally and many branched setae anteriorly (branched setae more abundant near anteromedial emargination); ventral surface with two rows of simple setae increasing in length anteriorly. Thorax: Color pale yellow.

Pronotum anterolaterally acute, with two small posterolateral ridges; mesonotum with two anterolateral tubercles and one posteromedian tubercle. Sterna pale yellow to pale brown. Legs (Figs. 12 - 14) pale yellow. Forefemora elongate, with long, simple setae and minute, simple setae dorsally; four long, simple setae near midregion of dorsal face; minute, simple setae ventrally; foretibiae and foretarsi with many long, simple setae ventrally and scattered long, fine setae dorsally; foretibiae with many long, simple setae distally, some setae branched; foretarsi with numerous long, fine simple setae ventrally and scattered long, fine, simple setae dorsally; tarsal claws distinctly hooked apically, with five to seven denticles. Midlegs similar to forelegs, except row of four simple setae absent near midregion of dorsal surface of femora and tarsal claws with denticles less pronounced. Hindfemora similar to midfemora; hindtibiae similar to fore- and midtibiae, except branched setae more abundant distally, and with two or three rows of small, simple setae ventrally and scattered long, fine, simple setae dorsally. Abdomen (Fig. 15): Color pale yellow and very lightly suffused with black dots laterally, or suffused with black and with distinct pale median stripe. Tergum 1 distinctly raised along posterior margin; 2 - 6 slightly raised along posterior margin; terga 3 - 6 laterally produced; tergum 7 distinctly raised along posterior



Figs. 11-15. *Tricorythodes undatus*, n. sp., larva: 11, labrum (dorsal); 12, left i foreleg; 13, left midleg; 14, left hindleg, 15, abdomen (lateral).

margin and with long posterolateral projections; terga 8-9 with anterior transversal hump and distinctly raised dorsally, posterolateral projections present; tergum 10 slightly raised anteriorly, posteriorly flattened. Sterna pale brown, with median black spots on sterna 2-9 and black spots at bases of lateral projections on sterna 2-7. Operculate gills pale yellow or suffused with black, subrectangular, somewhat rounded proximally, slightly tapering distally, and fringed with fine, simple setae. Caudal filaments pale brown to medium brown, with whorls of long, fine, simple setae at articulations.

#### Adult

Unknown.

#### Etymology

The specific epithet is a Latin word meaning wavy. It is an allusion to the wavy nature of the abdomen as seen laterally.

#### Discussion

*Tricorythodes undatus* is unique among the Central American members of the genus in that it possesses distinct tubercles on the head and thorax, and has a

distinct abdominal morphology (Fig. 15). Only two other members of *Tricorythodes*, *T. bullus* Allen and *T. cristatus* Allen, both reported from Brazil (Allen, 1967), have these distinctive features. *Tricorythodes undatus* differs from those two species in the shape of the tubercles and the presence of posterolateral projections on terga 8-9. It is possible that the three species represent a distinct lineage of *Tricorythodes* that may have originated in South America during the Eocene (54 - 38 mya) and then invaded Mesoamerica after the emergence of the Panamanian land bridge during the Pliocene (5 - 2 mya).

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