



## ***Camelobaetidius guaycara*, a new species of Baetidae (Ephemeroptera) from Costa Rica, Central America**

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### **Abstract**

The nymphs of a new species of *Camelobaetidius* (Ephemeroptera: Baetidae) possibly related to the South American species of this genus were found on the Atlantic and Pacific slopes of Costa Rica. Among other characteristics it is distinguished by having the anterodorsal arc of labrum with 1 + 6 setae, the first two frayed, ventrally 4 small setae near the lateral margin, and a minute seta near the anterior margin, on both sides of the cleft; the left mandible incisors with 6 denticles similar in size and the tip of the slender process extended at about the same level as the incisors; the paraglossa and glossa equal in length and a little shorter than segment II of labial palp, and a short triangular distomedial projection on segment II of labial palp; small nipple-like thoracic gills at base of forecoxa; claws with 27–32 denticles; posterior margin of abdominal terga with rounded spines; paraproct with 1–3 sclerotized spines, and cerci approximately 12% longer than the median filament. Both sexes present several different colorations. Some data on microhabitat preferences of nymphs are also given.

**Key words:** mayfly, taxonomy, biodiversity, Latin America

### **Introduction**

The genus *Camelobaetidius* (Ephemeroptera: Baetidae) was erected by Demoulin (1966) to include a species of small minnow mayflies (Baetidae) from Suriname whose nymphs have distinctive spatulate claws. Traver & Edmunds (1968) proposed the genus *Dactylobaetis* for nymphs from Argentina, Brazil, Honduras, Mexico, United States, and Peru having a similar claw morphology that were different in some details they considered sufficient to warrant separate genera. McCafferty & Waltz (1990) studied the types of both genera and concluded that they were of the same genus, placing *Dactylobaetis* as a junior synonym of *Camelobaetidius*.

*Camelobaetidius* ranges from Argentina and Uruguay in the south (Traver & Edmunds, 1968) to Canada, in the north (Lehmkuhl, 1976). Lugo-Ortiz & McCafferty (1995) provided the last major review of the North and Central American species; subsequent contributions to the taxonomy of the genus for Central America have been made by Wiersema (1998), and Jacobus & McCafferty (2005), resulting in the description of seven species for this region, four of which are known from Costa Rica (Lugo-Ortiz & McCafferty, 1995; Wiersema & Baumgardner, 2000; McCafferty, 2011).

During an ongoing study of the mayfly fauna of Costa Rica, nymphs of a distinct new species of this genus were found in both slopes of the country and they are described herein.

### **Material and methods**

Nymphs of this species were collected from four streams from the Pacific and two from the Atlantic slope (Fig. 1); the nymphs were collected by scraping rocks with an aquarium net in different microhabitats of the streams. Line drawings were made in ink from original pictures taken with an AmScope 1803 digital camera adapted to a

Premiere® (MRP-161) microscope and stereomicroscope Premiere® SMZ-05. The type series are preserved in 95% ethanol in microvials and are housed in the Aquatic Insects Collection of the Laboratorio de Entomología of the Escuela de Ciencias Biológicas of the Universidad Nacional (LEUNA), Museo Nacional de Costa Rica (MNCR), Museo de Zoología of the Universidad de Costa Rica (MZUCR), Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil (MNRJ), Museum of Aquatic Entomology at Florida A&M University (FAMU), and Purdue University Entomological Research Collection (PERC).

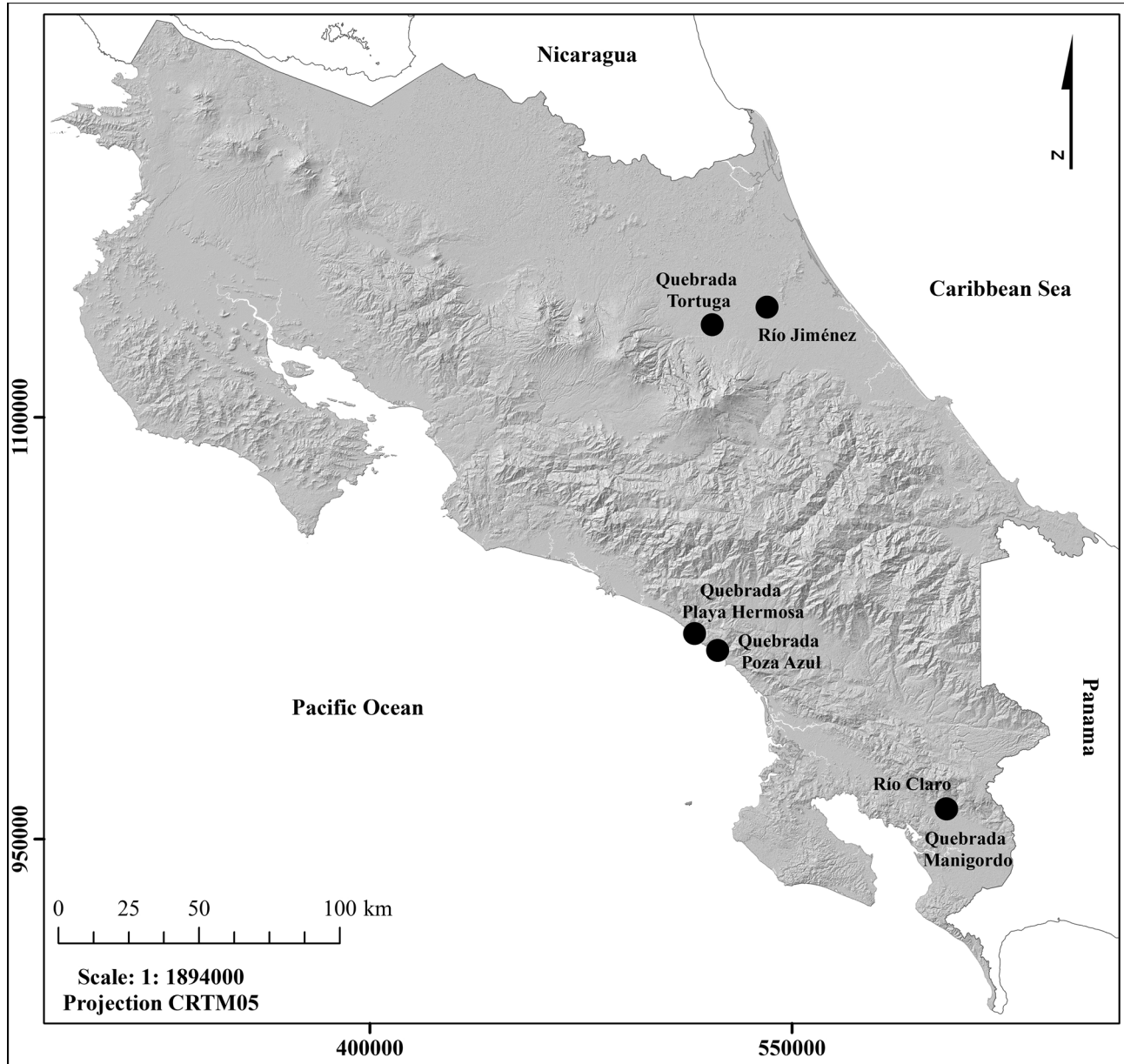


FIGURE 1. Geographic distribution of *Camelobaetidius guaycara* sp. nov. in Costa Rica.

## Results

### *Camelobaetidius guaycara* Sibaja-Araya & Esquivel, sp. nov.

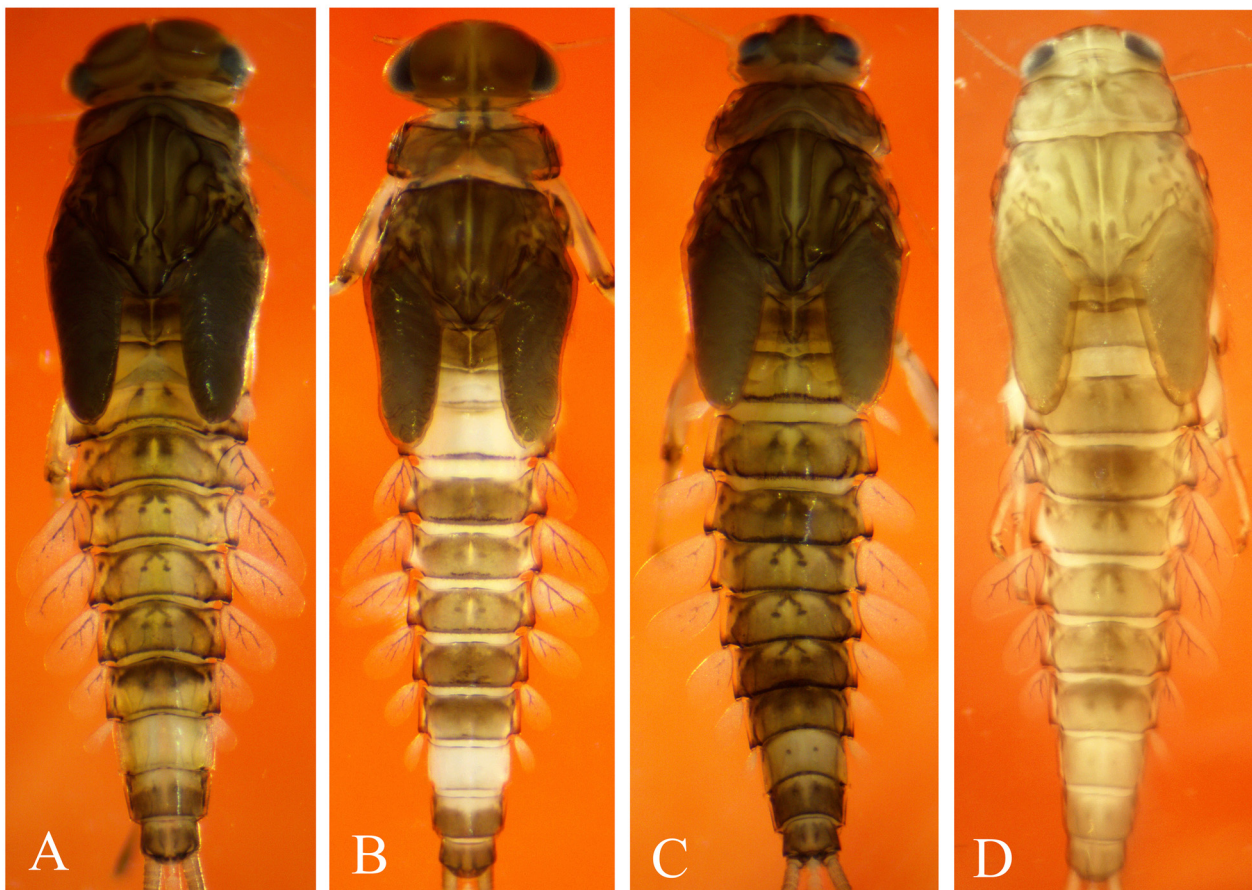
Figures 1–8.

**Diagnosis. Mature nymphs.** 1) labrum with anterior margin with about 13 small, double, frayed setae; arc of anterodorsal setae of labrum with 1 + 6 setae, the two inner ones frayed; intermediate setae present; several small simple setae near posterior margin; ventral surface with a dense arc of short, fine setae near the anterior margin and

with 4 short setae near lateral margin; a minute seta near the anterior margin on both sides of the cleft (Fig. 4a); 2); left mandible with 5 short incisors, tip of the slender process extended at about the same level as the incisors (Fig. 4b); 3) segment II of labial palp with a short triangular distomedial projection (Figs. 5c, d, e); 4); one small thoracic gill at the base of foreleg; 5) tarsal claws with 27–32 denticles (Fig. 6b); 6) posterior margin of abdominal tergum IV with rounded spines of different sizes (Fig. 6c); 7) paraproct with 1–3 spines (Fig. 6e).

Size: Mature nymphs. Body length: 4.5–5.5 mm, females larger than males; antenna: 2.0–3.0 mm; cerci 3.5–4.0 mm; terminal filament 3.0–3.5 mm.

Body coloration: head with olive spots on frons; pro and metanotum homogeneous dark olive; mesonotum with elongate dark olive marks; femora with elongate olive marks on anterior face; abdominal terga coloration sexually dimorphic, additionally both sexes from both slopes have distinct patterns of abdominal coloration (Fig 2), that of males being as follows: **a)** tergum VIII completely white while other terga have a dark/light olive pattern (14 individuals), **b)** terga I, II, VIII completely white, other terga with dark/light olive pattern (21 individuals), **c)** tergum VIII light gray with two small spots and other terga with dark/light olive pattern (21 individuals), and **d)** all terga with dark/light olive pattern (12 individuals); females present two coloration patterns: one similar to male pattern **c)** (15 individuals), and the other like male pattern **d)** (31 individuals); femora with elongate olive marks on anterior face, femur-tibia articulation dark brown; tibiae and tarsi white; cerci dark grey and terminal filament white (Fig. 3).



**FIGURE 2.** Variation in body coloration of *Camelobaetidium guaycara* sp. nov from the Atlantic and Pacific slopes of Costa Rica (males **a**: Pacific slope, **b**: Atlantic slope; females **c**: Pacific slope, **d**: Atlantic slope).

**Body morphology. Head:** Antennae scape and pedicel with minute, simple setae on lateral margins; both dorsal and ventral surfaces bare.

Labrum (Fig. 4a) broader than long; anterior margin with about 13 double, frayed setae, arc of anterodorsal setae with 1 + 6 setae, second inner seta longer than the first, both frayed, remainder of setae simple, all setae of arc long, extending beyond margin of labrum; intermediate seta absent; lateral margin with 4 simple setae and 9–11

frayed, anterolateral setae. Ventral surface with a dense arc of short, fine setae near anterior margin, 4 small setae near the lateral margin and a minute seta near the anterior margin on both sides of cleft.



**FIGURE 3.** Coloration pattern of cerci and central filament of *Camelobaetidius guaycara* sp. nov. from the Atlantic and Pacific slopes of Costa Rica.

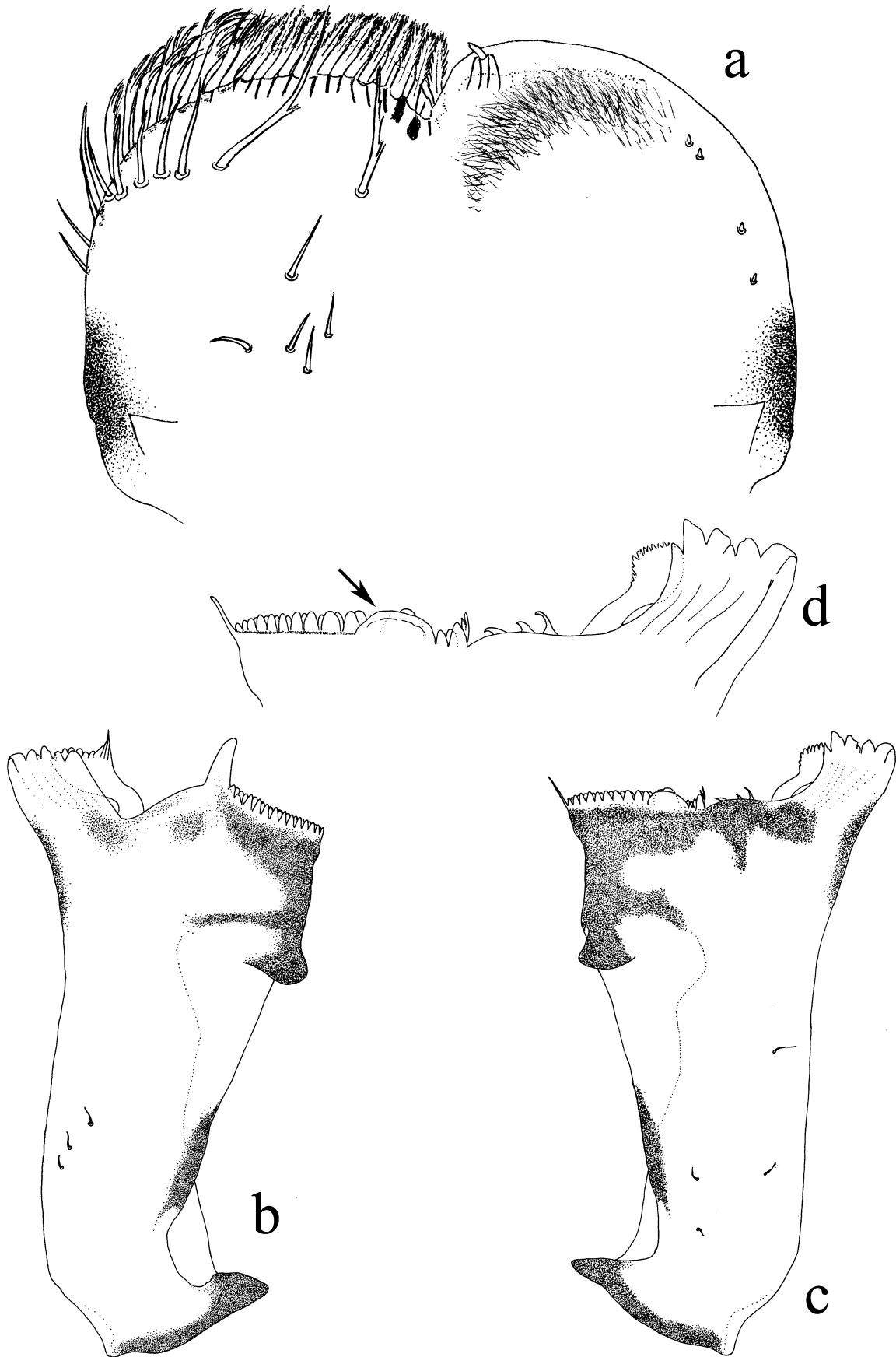
Left mandible (Fig. 4b): incisors with 6 denticles similar in size; prostheca well developed; no setae between prostheca and mola; area bearing the slender process (thumb) raised, the tip of the slender process extending to about same level as incisors; molar region longer than length between prostheca and slender process; and three simple setae on the mandible's basal region.

Right mandible (Fig. 4c): incisors with 6 denticles similar in size; prostheca not well developed; three small simple setae between prostheca and mola; molar region with a well developed disk-like process ("molar disk") (fig. 4d); molar region shorter than length between prostheca and molar disk and four simple setae on mandible's basal region.

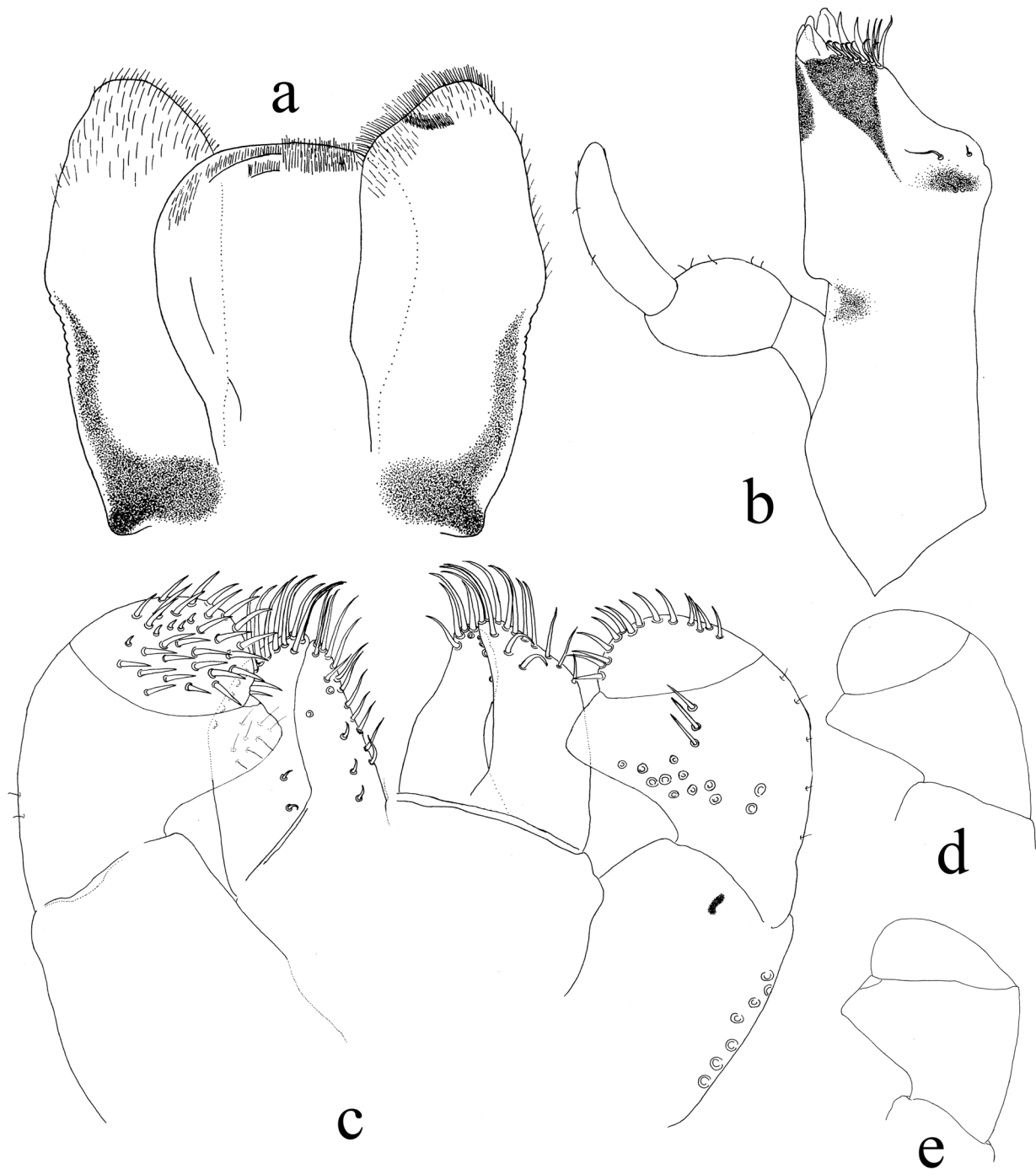
Hypopharynx (Fig. 5a): lingua shorter than superlinguae, apically hairy on dorsal and ventral surfaces; superlinguae apically hairy on dorsal and ventral surfaces and with serrate area at the middle of lateral margin.

Maxillae (Fig. 5b): robust; galea with four apical canines and two apical rows of setae, some setae of one of these rows large and thick while others are thin, and setae of other row shorter and curved; three setae on subdistal internal margin; maxillary palp not surpassing apical canines, segment I short; segment II thick, biceps-like; segment III elongate, longer than segment II.

Labium (Fig. 5c): paraglossa and glossa equal in length, both dorsally and ventrally with numerous elongate and curved setae on apex; palp segment I thick, as long as segments II + III, dorsal surface with several micropores along external margin; segment II with a short triangular distomedial projection, variable as shown in Fig. 5d and 5e; distomedial projection distinctly larger on the right palp of some individuals, dorsal surface with several micropores and a row of 3–4 simple setae, 5–8 simple marginal setae on ventral surface; segment III rounded, broader than longer, with numerous robust spines on ventral surface, dorsal surface with a row of robust setae on apex.

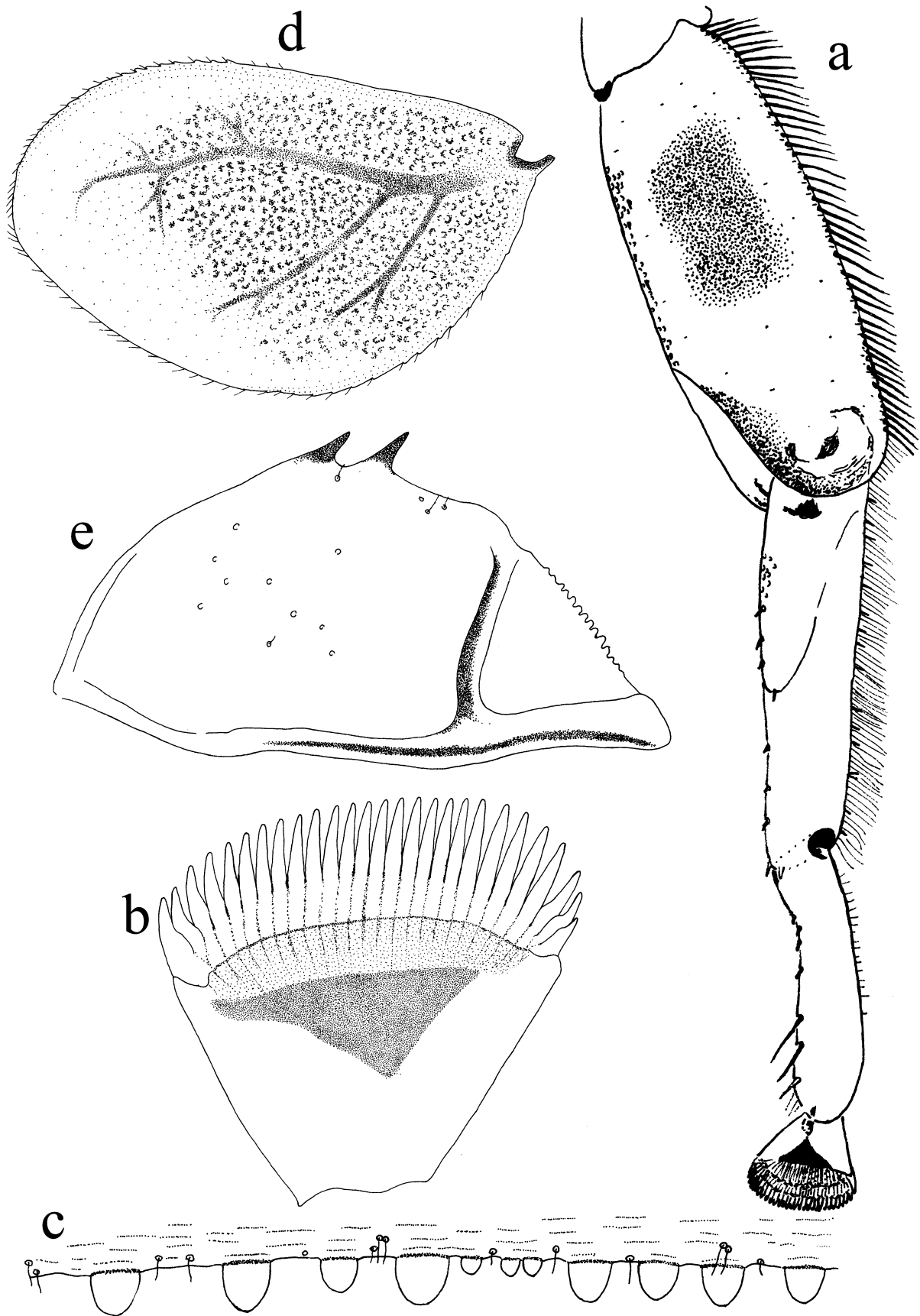


**FIGURE 4.** *Camelobaetidius guaycara* sp. nov., nymph. a) labrum (left d. v., right v. v.), b) left mandible, c) right mandible, d) molar disk of right mandible detail.



**FIGURE 5.** *Camelobaetidius guaycara* sp. nov., nymph. a) hypopharynx (left v. v., right d. v.), b) maxilla, c) labium (left v. v., right d. v.), d), e) labial palp II variations.

**Thorax:** Dorsally with dark olive pattern, pro and metanotum entirely dark olive, mesonotum with elongate dark olive marks; ventrally yellowish. Hind wing pads present. Small nipple-like thoracic gills present at base of forecoxa; femora with elongate olive marks on anterior face, dorsal edge with one row of 40–45 long spine-like setae, ventral edge with numerous micropores and several short spine-like setae, anterior face with several fine and short setae, articulation femur-tibia dark brown; tibia light brown, patella-tibial suture present, two rows of setae on dorsal edge, one of them with fine long setae and the other with fine, short setae, ventral edge with several micropores near articulation with femur-tibia and 5–6 spine-like setae along its margin, anterior face with several fine and short setae; tarsi light brown, several short fine setae on dorsal edge, ventral edge with 6 setae along margin, 2 of them long and 1 short on apex (Fig. 6a); claws with 27–32 denticles (Fig. 6b).



**FIGURE 6.** *Camelobaetidius guaycara* sp. nov., nymph. a) midleg, b) claws, c) posterior margin of terga IV, d) gill, e) paraproct.

**Abdomen:** posterior margin of abdominal terga with rounded spines of different sizes and simple fine setae not surpassing length of larger spines (Fig. 6c); gills white, oval; reduced on segments I and VII and with no pigmented tracheation; well-developed tracheation on others gills, margins with fine, small setae (Fig. 6d); paraproct with 1–3 sclerotized spines, several micropores and simple, fine setae on dorsal surface, (Fig. 6e); cerci dark gray and terminal filament white, cerci approximately 12% longer than the central filament (Fig. 3).

**Adults.** Unknown.

**Material examined:** **Holotype**, mature ♀ nymph on 95% alcohol (mouthparts, legs, gills, terga and paraprocts in microvial), Costa Rica, Puntarenas province, Río Claro de Golfito, Río Claro, 8°41'13.05"N/ 83°02'48.78"W, 70 meters above sea level, IV/15/2017, F. Sibaja-Araya coll., deposited at the **MNCR**. **Paratypes**, two mature nymphs (parts in microvial), same data as the holotype, housed at **LEUNA**; two mature nymphs (parts in microvial), same data as the holotype, housed at **MZUCR**; two mature nymphs, same data as the holotype, housed at **PERC**; eight mature nymphs, Costa Rica, Limón province, Guácimo, Duacarí, Río Jiménez, 10°18'04.95"N/ 83°37'24.67"W, 45 meters above sea level, VI/15/2017, F. Sibaja-Araya, M. Guevara-Mora, D. Romero-Serrano, respectively deposited at **MNCR** (two mature nymphs), **LEUNA** (two mature nymphs), **MNRJ** (two mature nymphs), and **FAMU** (two mature nymphs).

**Etymology:** The name of this species honors the indigenous king Guaycara who several centuries ago ruled the Boruca people in southern Costa Rica where this new species was first collected.



**FIGURE 7.** Microhabitat preferences of immature (black arrow) and mature nymphs with visible underlying subimago structures (white arrow) of *Camelobaetidius guaycara* sp. nov., Río Jiménez, Atlantic slope.

## Discussion

This species was found on both the Pacific and Atlantic slopes of Costa Rica. On the Pacific slope *C. guaycara* sp. nov. was found in low densities in three first order streams (Quebrada Poza Azul: 1 individual, Quebrada Playa Hermosa: 6 individuals, and Quebrada Manigordo: 3 individuals), and in high density in a third order stream (Río Claro: 40 individuals); on the Atlantic slope the same pattern was observed, low density in a first order stream (Quebrada Tortuga: 1 individual) and high density in a fourth order stream (Río Jiménez: 63 individuals) (Fig.1), thus suggesting a preference for large rivers for this species.



A microhabitat preference among the nymphs of different developmental degrees was observed; immature nymphs were commonly found in rapids on large rocky substrates in the Pacific slope or alluvial sediments in the Atlantic slope rivers, whereas mature nymphs with visible underlying subimago structures (e.g., wing veins in the wing pads, developing subimago legs), were commonly found on the lateral sides or in cavities of rocks in riffles (Fig. 7).

Unlike *C. kondratieffi* and *C. musseri*, the other two species of *Camelobaetidius* with more than 27 denticles on the claws previously reported for Central and North America, *C. guaycara* **sp. nov.** possesses a short triangular distomedial projection on segment II of labial palp (Figs. 5c, 5d, 5e); this character is shared only with South American species like *C. anubis* Traver & Edmunds, 1968, *C. edmundsi* Dominique, Mathuriau & Thomas, 2001, *C. lassance* Salles & Serrão, 2005, *C. penai* Traver & Edmunds, 1968, *C. sallesi* Boldrini & Pes, 2014, and *C. serapis* Traver & Edmunds, 1968; *C. musseri* Traver & Edmunds, 1968 and *C. kondratieffi* (Lugo-Ortiz & McCafferty, 1995) have a truncate distomedial projection (Traver & Edmunds 1968, Lugo-Ortiz & McCafferty, 1995). A triangular distomedial projection on segment II of labial palp plus the left mandible slender process extended at about the same level as the incisors, and the rounded spines along the posterior margin of abdominal terga, are characters shared only with the South American species *C. edmundsi* from Colombia and Venezuela (Dominique *et al.*, 2001; Cruz *et al.*, 2012); differences between the two species are detailed in Table 1.

Regarding the structure we call “molar disk” present on the right mandible of *C. guaycara*, Brown (1964) was apparently the first to mention it (as “blade of heavily sclerotised cuticle”, p. 164) and illustrate it in Baetidae (e.g., Figs. 7c, 7d). However, it has not been pointed out or illustrated by the previous workers on *Camelobaetidius*. This is remarkable since it is a large structure, appreciable at 40X microscope magnification. Moreover, examination of other *Camelobaetidius* species (e.g., *C. kondratieffi*, *C. maidu*, *C. shepardii* and *C. variabilis*, unpub. data) shows that the molar disk clearly differs among the different species of this genus, and although it apparently does not have a strict taxonomical significance, its prominence should not be underestimated. Therefore, we suggest that the molar disk should be mentioned and illustrated in future taxonomic works on this genus.

The presence of thoracic gills in *C. guaycara* is also shared with *C. kondratieffi* since a careful examination of the paratypes of this species also reveals their presence (unpub. data), contrary to what Lugo-Ortiz & McCafferty (1995) reported in the original description. All individuals of *C. guaycara* we examined had them, but in some individuals these gills were inconspicuous, therefore this taxonomic character is variable within populations. The inconspicuousness of these structures may be explained by the fact that at least in *C. guaycara* thoracic gills are present only in mature nymphs whose bodies have not yet visible underlying subimago structures. This suggests that thoracic gills are absorbed during the subimago developing process, and consequently only some mature nymphs might have them while others do not as has been previously mentioned for other species as well such as *C. leentvaari* (Boldrini *et al.* 2013). Therefore, this character should be carefully examined when studying *Camelobaetidius* nymphs for taxonomic purposes.

**TABLE 1.** Morphological differences between *Camelobaetidius guaycara* **sp. nov.** and *C. edmundsi* (Dominique *et al.* 2001).

	<i>Camelobaetidius guaycara</i> <b>sp. nov.</b>	<i>Camelobaetidius edmundsi</i>
Altitude (masl)	0–70	970–1550
Size (mm)	4.5–5.5	3.9–7.3
Pedicele	<b>Not</b> chagrined	Chagrined
Labrum	<b>7 long</b> setae in arc of anterodorsal setae, 2 inner setae <b>frayed</b>	<b>3 short</b> setae in arc of anterodorsal setae, 2 inner setae <b>simple</b>
Labial palp	Segment II with a <b>short</b> triangular distomedial projection apically rounded	Segment II with a <b>long</b> triangular distomedial projection apically rounded
Tarsal spines	<b>3, all simple</b>	<b>3, 2 spatulated and 1 simple</b>
Claw denticles	27–32	34–39
Thoracic gills	Present	Absent
IV tergum spines	Rounded, <b>different</b> sizes	Rounded, <b>similar</b> sizes
Paraproct	<b>1–3</b> spines	<b>1</b> spine

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