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New species and records of *Ulmeritoides* (Ephemeroptera: Leptophlebiidae) from Costa Rica

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Abstract

Ulmeritoides acosa **new species** (type locality: La Palma, Costa Rica) and *Ulmeritoides chavarriae* **new species** (type locality: Santa Elena, Parque Nacional Santa Rosa, Costa Rica) (Ephemeroptera: Leptophlebiidae) are described from imagos and nymphs. Both species occur along the west coast of Costa Rica, and both are adapted to living in temporary streams. Additional localities are given for *Ulmeritoides guanacaste* Domínguez and *Ulmeritoides tifferae* Domínguez, and a key is given for adults and nymphs of the four Costa Rican species of *Ulmeritoides*.

Key words: *Ulmeritoides*, Ephemeroptera, Leptophlebiidae, Osa, Nicoya, Santa Elena, new species, temporary streams

Resumen

Se describe de imagos y ninfas *Ulmeritoides acosa* **especie nueva** (localidad tipo: La Palma, Costa Rica) y *Ulmeritoides chavarriae* **especie nueva** (localidad tipo: Santa Elena, Parque Nacional Santa Rosa, Costa Rica) (Ephemeroptera: Leptophlebiidae). Ambas especies se encuentran a lo largo de la costa oeste de Costa Rica, y ambas están adaptadas para vivir en quebradas temporales. Se presentan localidades adicionales para *Ulmeritoides guanacaste* Domínguez y *Ulmeritoides tifferae* Domínguez, y se presentan claves para adultos y ninfas de las cuatro especies de *Ulmeritoides* en Costa Rica.

Introduction

The genus *Ulmeritoides* Traver currently contains ten species with a very disjunct range from Argentina to Costa Rica. Six species are known from northern Argentina to southern Brazil, a single species is known from Surinam, another was recently described from

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Colombia (Dominguez and Zuñiga 2003) and the remaining two species are found in northwestern Costa Rica. Traver (1959) originally established *Ulmeritoides* as a subgenus of *Ulmeritus*; Domínguez (1991) raised *Ulmeritoides* to generic status. Domínguez (1995) reviewed the genus, describing five new species and presenting a cladistic analysis. Two of these new species, *U. tifferae* Domínguez and *U. guanacaste* Domínguez, were collected from two localities in the northeast part of the Área de Conservación Guanacaste of northwestern Costa Rica and up to now both have been known only from the type series. During a survey of aquatic insects of the Pacific peninsulas (Santa Elena, Nicoya and Osa) of western Costa Rica, we regularly collected *Ulmeritoides* in leaf packs in pool areas in both permanent and temporary streams. In this paper we describe two additional species of *Ulmeritoides* from western Costa Rica, both of which have the ability to live in temporary streams.

Materials and Methods

Nymphs were collected by manually washing from leaf packs collected in the bottom of pools. Rearings were done in the field using plastic cups with screened windows, as described in Edmunds *et al.*(1976). Adults were collected at blacklight. Geographic coordinates and elevations of collecting sites were determined in the field using a Garmin etrex Summit™ GPS unit, or by locating the site on Costa Rican topographic maps . Positions determined from the maps are given in Lambert coordinates; other positions are given in lat/long. Specimens are deposited in the following institutions: FAMU, Florida A&M University, Tallahassee, Florida, USA; IFML, Instituto–Fundación Miguel Lillo, Tucumán, Argentina; INBio, Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica, MZUCR, Museo de Zoología, Universidad de Costa Rica, San José, Costa Rica.

Ulmeritoides acosa Ávila and Flowers, new species

(Figs. 1, 2, 5, 6, 9, 10, 12, 14, 16, 18, 19, 22)

Holotype: Male imago (in alcohol). Length: body 7.3 mm; forewing, 7.1 mm. Head: light orange brown washed with black, orange–yellow spots at base of antennae and below median ocellus; antenna translucent yellowish brown, scape and pedicel washed with brown on undersides. Upper portion of eyes orange–brown, lower portion blackish. Ocelli whitish, their stalks orange washed with black. Thorax: pronotum yellowish brown, washed with black laterally and with a black streak on midline; mesonotum yellowish brown, margins and carinae darker; metanotum brown, dark brown laterally. Pleura yellowish brown washed with darker brown, a diagonal area above mesocoxae washed with black. Thoracic sterna orange–brown, washed with black. Forewing (Fig. 1): membrane

hyaline, costal and subcostal area shaded with light brown, a dark brown patch on wing base; longitudinal veins and cross veins translucent brown, cross veins between costa and Rs narrowly shaded with dark brown; 7 cross veins basal to bulla. Hind wing (Fig. 2): membrane hyaline, a brown spot at base; C, Sc, and R_1 brownish, remaining veins hyaline; cross veins in costal area brown, remaining cross veins hyaline. Foreleg: coxa and trochanter brown, femur orange, washed with dark brown dorsally and on apex tibia dark brown, tarsus whitish, washed with dark brown on basal 2/3. Hind legs orange yellow with dark brown dorsal spot on apex of femora, hind femur also with two basal brownish streaks. Abdomen (Fig. 10): terga orange–brown, terga I and II heavily washed with dark brown, terga III–VIII with dark brown lateral areas and a posterior band, band narrowed medially; terga IX and X with brown apical spots at midline; terga II–IX with a pair of yellowish white anterior submedian spots each side of midline. Abdominal sterna yellowish orange washed with brown, a pair of paler spots anterioraly on each segment. Genitalia (Fig. 5): styliger plate orange–brown, forceps and penes smoky brown. Penis lobes (Fig. 6) elongate, compressed and curved dorsally, with a median triangular ventral projection. Caudal filaments orange brown, whitish apically.

Allotype: Female Subimago (in alcohol). Length: body 8.6 mm; forewing 7.3 mm. Coloration as in male imago except: head yellowish white, marked with dark brown between ocelli; antenna with scape and pedicel yellowish white, flagellum yellowish brown. Wing membrane translucent, longitudinal veins pale, crossveins brown, pale posteriorly. Legs as in male imago except forefemur with a dark patch on posterior surface. Abdomen yellowish tan with dark brown markings and pale spots as in male imago; sterna yellowish white, washed with brown on sterna I, VII–IX and with median and transverse brownish bands on sterna II–V. Subgenital plate yellowish white with dark brown lateral margins. Caudal filaments orange yellow.

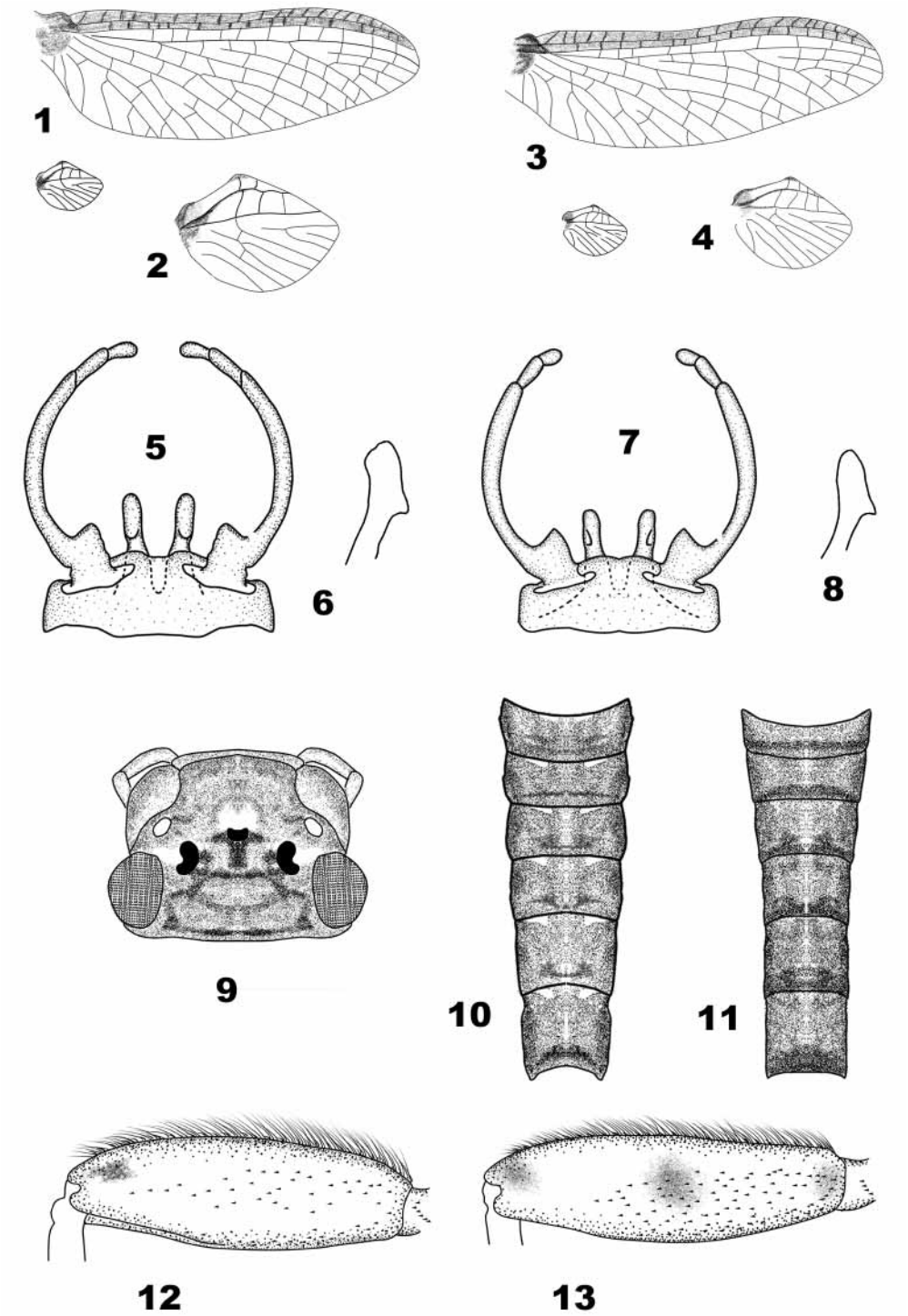
Mature nymph (in alcohol): Body length 6.4–9.3 mm. Head: yellowish brown to chestnut brown, a pale spot anterior to median ocellus, and pale areas between eyes and lateral ocelli (Fig. 9). Antenna yellowish brown. Mouthparts: labrum (Fig. 14) with maximum length slightly less than 1/2 width, anteromedian emargination well developed, denticles obsolete or very weakly developed; maxilla (Fig. 16) with anteromedian tooth very small, galea–lacinia with inner subapical row of 13–15 pectinate setae, slightly convergent to lower border of apical setae; segment 2 of labial palpi (Fig. 18) subequal to segment 1; segment 3 slightly less than 1/4 length of segment 2, segment 3 (Fig. 19) with 9 denticle-like setae on inner margin and tip; clypeus, labrum, basal 2/3 and base of molars of mandibles, basal 1/2 of maxillae and segment 1 of palp and labium yellowish brown, submentum yellowish brown with 2 pale basal spots. Thorax: terga yellowish to chestnut brown, washed with black on lateral margins, pleura and sterna yellowish tan. Legs: yellowish to reddish brown, coxae washed with black; femora dark at apex, hind femur with a dark basal streak, forefemur with a dark median spot on inner surface; tibiae and tarsi yellow to orange brown, tarsi paler at base and apex; in very mature nymphs foretibiae and basal half

of foretarsi dark reddish brown. Abdomen: terga yellowish to deep chestnut brown, with dark brown lateral and apical markings as in male imago (Fig. 10); sterna yellowish or orange–brown washed with darker brown. Gills gray, tracheae and fimbriae gray-violet. Caudal filaments yellowish brown, alternating segments slightly darker.

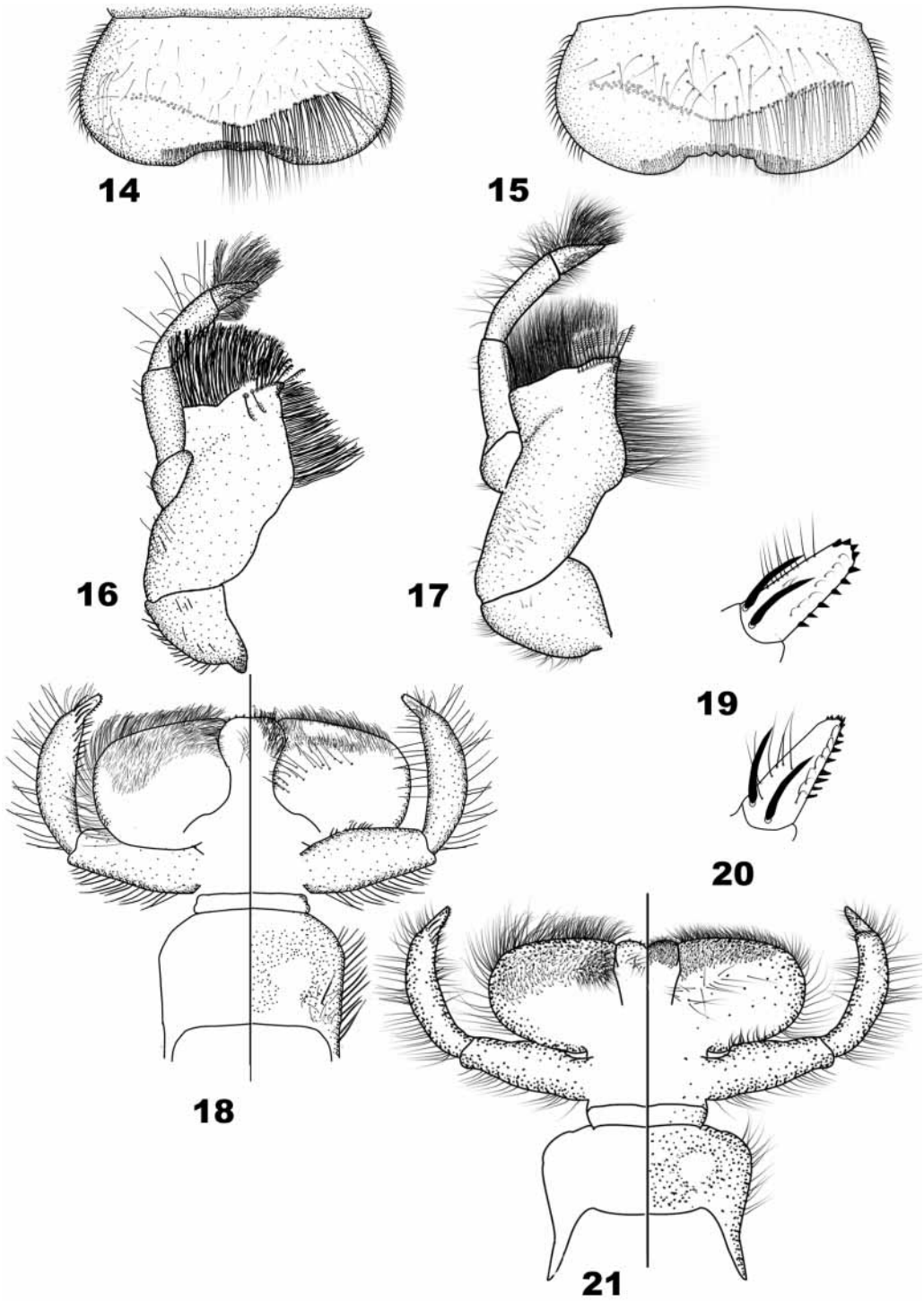
Etymology. *acosa*, noun in apposition. This species is dedicated to the personnel of the Area de Conservación Osa (ACOSA) in recognition of the support given to both authors during this study. The Area de Conservación Osa is also where the senior author first collected and reared this species.

Specimens Examined. (10 ♂♂, 4 ♀♀, 177 nymphs)(INBio): Male imago HOLOTYPE (with nymphal exuvium) labeled COSTA RICA, Puntarenas, Peninsula de Osa, La Palma, quebrada que cruza la calle a 600m del cementario después del puente carretera a Guadelupe, 25m, L_S_287000-521500, 17–I–2005, S. Ávila, R. W. Flowers. Female subimago ALLOTYPE. same data as holotype. PARATYPES: Guanacaste Province: 5 ♂, 2♀ (2 ♂, 1♀ reared with nymphal exuviae; 1 ♂ FAMU, 1 ♂ IFML) Santa Elena Peninsula, Río Mairena 2km arriba de Cuajiniquil, 21m, 10°56'N, 85°41'W, 27–I–2005, S. Ávila, R. Tiffer, R.W. Flowers; 21 nymphs, same locality, 25–I–2005, S. Ávila, M. M. Chavarría, R.W. Flowers; 34 nymphs, Río Potrero Grande, L_N_315779-351937, 21–III–2004, M. M. Chavarría D.; Nicoya Peninsula, 17 nymphs, Parque Nacional Diriá, Río Enmedio, 190m, 10°10'N, 85°06'W, 14–II–2005, S. Ávila, W. Porras, R. W. Flowers; Nandayure: 10 nymphs, Río Santa Rita, 50m, 10°01'N, 85°16'W, 17–I–2005, W. Porras; 26 nymphs (6 IFML, 6 MZUCR, 14 INBio), Maquenco, Quebrada Maquenco, 392m, 9°58'N, 85°59'W, 16–II–2005, S. Ávila, W. Porras, R. W. Flowers; 11 nymphs, Tacanis, Quebrada Pavas, 200-300m, L_N_224500-392600, 8–V–2004, W. Porras; 19 nymphs, Finca Pochote, 100–200m, L_N_219500–347000, 7–V–2004, W. Porras; Puntarenas Province, same locality, date, and collectors as holotype: 2 ♂ imagos, 1 ♂ subimago (reared with nymphal exuviae), 27 nymphs (5 FAMU, 3 MZUCR, 13 INBio); same locality as holotype: 1 ♂ subimago, 1 ♀ subimago, 22 nymphs (3 IFML, 19 INBio), 29–VII–2004, S. Ávila; 1 nymph, 24–III–2004, S. Ávila; 10 nymphs, 9–X–2004, S. Ávila; 18 nymphs, 25–XII–2005, S. Ávila; Golfito, Río Claro, Queb. Lagarto, 40m, L_S_293100-564700, 24–II–2004, S. Ávila. Association of adults and nymphs is by rearing.

Ecology. This species is always found in masses of decaying leaves at the bottom of pools in slow–flowing streams in medium to low altitudes (less than 500m). The population at the type locality on the Osa Peninsula inhabits a deep pool on a small stream flowing through an agricultural landscape with small farms and pastures in what once was Pacific lowland rainforest. Here and elsewhere nymphs are best collected by washing them out of packs of leaves collected from the bottom of pools. At La Palma, nymphs with black wingpads have been collected from July to January. Adults of the type series were collected at blacklights and by hand along the stream banks, the first adults appearing at blacklight just after 8:00 PM. Subimagos emerged between 7:30 and 8:30 the morning after they were collected.



FIGURES 1–13. *Ulmeritoides*. Figs. 1,2,5,6,9,10, 12. *U. acosa*; 1, wings; 2, hind wing, enlarged; 5, male genitalia; 6, pene, profile; 9, head of nymph; 10, tergites II-VII of male abdomen; 12, middle femur. Figs. 3,4,7,8,11. *U. chavarriae*; 3, wings; 4, hind wing, enlarged; 7, male genitalia; 8, pene, profile; 11, tergites II-VII of male abdomen. Fig. 13. *U. tifferae*; 13, middle femur



FIGURES 14–21. *Ulmeritoides*, nymphal mouthparts. Figs. 14, 16, 18, 19. *U. acosa*; 14, labrum (setae on left side not shown); 14, maxilla; 18, labium: right, ventral view; left, dorsal view; 19, apical segment of labial palp, dorsal. Figs. 15, 17, 20, 21. *U. chavarriae*; 15, labrum (setae on left side not shown); 17, maxilla; 20, apical segment of labial palp, dorsal; 21, labium: right, ventral view; left, dorsal view.

Farther north on the Nicoya and Santa Elena peninsulas, *U. acosa* is common to very abundant in pools of permanent and temporary streams in areas of dry forest and former dry forest. The temporary streams of Santa Elena lack water for up to five months of the year, and even during most of the rainy season there is very low current through the pools. We collected and reared nymphs in Santa Elena during the early dry season when the pools were isolated and the water level was dropping rapidly. Fairly small to full grown nymphs were present but there seems to be little chance that any but the largest attained the adult stage before the habitat completely dried. In the Río Pochote on the Nicoya Peninsula, *Ulmeritoides* nymphs do not appear until well into the dry season when leaf packs build up at the bottom of the pools. No nymphs are present during the rainy season when the river is subject to frequent spates (Wendy Porras, pers. comm.). However, in Río Enmedio (Parque Nacional Diriá), a permanent stream, small to full-grown nymphs were present, suggesting a extended emergence period similar to the population at La Palma.

Diagnosis. *Ulmeritoides acosa* can be separated from all other species of *Ulmeritoides* by the following combination of characters. In the imago: (1) fore wings with costal and subcostal areas shaded with brown; (2) penis lobes flattened, curved dorsally, and with ventral projection straight; (3) abdominal color pattern as in Fig. 10. In the nymph: (1) maxillary tusk very small (Fig. 16); (2) middle and hind femora with few spines on exterior surface; (3) maxilla with subapical row of setae diverging laterally from apical setae (Fig. 16); (4) abdomen with dark apical bands usually well defined.

We were initially inclined to view *U. acosa* populations in the temporary streams of the Nicoya and Santa Elena peninsulas as a different species from the population on Osa, based on their different habitats and what appear to be different life cycles. However, we found no consistent morphological differences either in the adult or nymph among the three different areas we studied. Although further studies of the biology and genetics of these populations may support dividing them into different species, we take the conservative approach here and consider them as one variable species.

Ulmeritoides chavarriae Ávila and Flowers, new species
(Figs. 3, 4, 7, 8, 11, 15, 17, 20–22)

Holotype: Male imago (in alcohol, with nymphal exuvium). Length: body 7.2 mm; forewing, 7.2 mm. Head: dark brown, orange–yellow spots at base of antennae, below median ocellus, and between lateral ocelli; antenna translucent brown. Upper portion of eyes orange–brown, lower portion blackish. Ocelli whitish, their stalks dark brown. Thorax: pronotum yellowish brown, washed with black laterally and a black streak on midline; mesonotum shining brown, margins and carinae darker; metanotum orange brown at base, piceous brown laterally. Pleura yellowish tan washed with darker brown. Thoracic sterna chestnut brown, washed with black. Forewing (Fig. 3): membrane hyaline, costal and subcostal area shaded with light brown, a dark brown patch on wing base. Longitudinal veins

and cross veins translucent brown, cross veins between costa and Rs narrowly shaded with dark brown; 7 cross veins basal to bulla. Hind wing (Fig. 4): membrane hyaline, a brown spot at base; C, Sc and R_1 brownish, remaining veins hyaline; cross veins in costal area brown, remaining cross veins hyaline. Foreleg: coxa and trochanter tan washed with dark brown, femur orange brown, washed with dark brown dorsally and on apex, a dark brown spot at middle; tibia dark brown, tarsus brown, apical segment paler. Middle and hind legs orange yellow with dark brown dorsal spot on apex of femora, hind femur washed with brown at base. Abdomen: terga I–VII brown, terga VIII–X orange brown, terga with dark brown markings as in Fig. 11, markings reduced on terga IX and X. Sterna I–VII translucent brown weakly washed with black; sterna VIII and IX orange brown. Genitalia (Fig. 7): styliger plate orange–brown, forceps and penes smoky brown. Penis lobes (Fig. 8) elongate, compressed and curved dorsally, with a triangular ventral projection pointed toward midline at its tip. Caudal filaments chestnut brown.

Allotype: Female imago (in alcohol with nymphal exuvium). Length: body 6.9 mm; forewing 7.9 mm. Coloration as in male imago except: head yellowish white, washed with dark brown between ocelli; antenna yellowish brown. Thorax and pleura orange–tan, washed with black above mesocoxa. Wing membrane translucent, longitudinal veins pale, crossveins brown, pale posteriorly. Legs as in male imago except for usual sexual differences in foreleg. Abdomen yellowish tan with dark brown markings as in male imago; sterna yellowish white, washed with brown. Subgenital plate translucent brown with dark brown lateral margins. Caudal filaments chestnut brown.

Mature nymph (in alcohol): Body length 6.6–11.4 mm. Head: yellowish tan to yellowish brown, pale spots anterior to median ocellus and between eyes and lateral ocelli. Antenna yellowish brown. Mouthparts: labrum (Fig. 15) with maximum length 1/2 width, anteromedian emargination well developed, with 5 weakly developed or obsolete denticles; maxilla (Fig. 17) with anteromedian tooth very small, galea–lacinia with inner subapical row of 14–17 pectinate setae, subapical setae closely parallel to apical setae; segment 2 of labial palpi (Fig. 21) subequal to segment 1; segment 3 slightly greater than 1/4 length of segment 2; segment 3 (Fig. 20) with 13 denticle-like setae on inner margin and tip; clypeus, labrum, basal 2/3 and base of molars of mandibles, basal 1/2 of maxillae and segment 1 of palp and labium yellowish brown, submentum yellowish brown with 2 pale basal spots. Thorax: terga yellowish tan to brown, washed with black on lateral margins, pleura and sterna yellowish tan. Legs: yellowish tan to brown, coxae washed with black; femora dark at apex, hind femur with a dark basal spot, forefemur with a dark median spot on inner surface. Tibiae and tarsi tan to brown, tarsi paler at base and apex; in very mature nymphs the foretibiae and basal half of fore tarsi dark brown. Abdomen: terga yellowish brown to dark brown, with dark brown lateral and apical markings as in male imago, apical markings often weak or absent; sterna yellowish brown washed with darker brown. Gills grey, tracheae and fimbriae gray-violet. Caudal filaments yellowish brown, alternating segments slightly darker.

Etymology. This species is dedicated to María Marta Chavarría Diaz, Programa de Investigatión of the Area de Conservación Guanacaste, who collected many specimens in the type series, and who has contributed significantly to the success of this project.

Specimens Examined. (17♂♂, 5♀♀, 81 nymphs)(INBio): Male imago HOLOTYPE (with nymphal exuvium) labeled COSTA RICA, Guanacaste Province, Area de Conservación Guanacaste, Parque Nacional Santa Rosa, Sector Santa Elena, Río Cuajiniquil at road to Playa Potrero Grande L_N_ 360103–317790, 2–XII–2004, S. Ávila, M.M. Chavarría, R.W. Flowers. Female subimago ALLOTYPE. same data as holotype. PARATYPES: 15 ♂♂, 3 ♀♀ imagos (1 ♂, 1 ♀ FAMU; 1♂ IFML; 15 ♂♂, 2 ♀♀ INBio) same data as holotype, 30 nymphs (5 FAMU; 5 MZUCR; 20 INBio), same locality as holotype, X–2004, M.M. Chavarría D.; 14 nymphs, same locality as holotype, L_N_360103–3317790, 2–XII–2004, M.M. Chavarría; 1 ♂, 1 ♀ imago, 15 nymphs (5 IFML; 10 INBio), same locality, 1–XII–2004, M.M. Chavarría, S. Ávila, R. W. Flowers; 7 nymphs, same locality, L_N_360147–315723, 17–X–2004, M. M. Chavarría; 15 nymphs, same locality, 24–I–2005, S. Ávila, R.W. Flowers. Association of adults and nymphs is by rearing.

Ecology. This species lives in pools in a seasonally dry river in an area which generally lacks rain for five months of the year. Nymphs have been collected from October to January; during July, two months into the rainy season, no nymphs were found. In December nymphs were very abundant in deep pools and emergence was observed; by late January these pools were greatly reduced in volume and nymphs were much less abundant. Subimagos were collected at lights from 9–10PM and emergence of imagos took place the following morning from 10–11AM. Based on observations to date, we conclude that this species has a short life cycle to avoid both the long dry season and flash floods that occur during the early part of the rainy season.

Diagnosis. *Ulmeritoides chavarriae* can be separated from all other species of *Ulmeritoides* by the following combination of characters. In the imago: (1) fore wings with costal and subcostal areas shaded with brown; (2) penis lobes flattened, upturned, and with ventral projection turned inward; (3) abdominal color pattern as in Fig. 11. In the nymph: (1) maxillary tusk very small; (2) middle and hind femora with few spines on exterior surface; (3) maxilla with subapical row of setae closely parallel to apical setae (Fig. 17); (4) abdomen with dark apical bands usually lacking.

Ulmeritoides chavarriae is most similar to *U. acosa*, but differs consistently in the adult in the color pattern, which in *U. acosa* has an overall orange cast and a pattern of light spots and dark bands while in *U. chavarriae* the color is dark yellowish brown and the pattern is at most vague darker bands, and in the ventral projections of the penes, which turn inward in *U. chavarriae* but not in *U. acosa*. Nymphal differences are not as consistent; the position of the subapical row of setae on the maxillae is somewhat variable but in *U. chavarriae* the outer and inner ends of the row are equally distant from the field of apical setae, while in *U. acosa* the outer end is almost always farther from the apical

setae than the inner end; the transverse dark bands on the abdomen are always well defined in *U. acosa* but usually small or lacking in *U. chavarriae*. Confirmed specimens of *U. chavarriae* are known only from the type locality, but small nymphs (all non-paratypes) collected in nearby streams in Sector Santa Elena may also belong to this species: 1 nymph, Quebrada Calera, L_N_356216-316528, 5–IX–2004, M M Chavarría Díaz; 13 nymphs, tributary of Río Potrero Grande, 3–XII–2004, S. Ávila, M.M. Chavarría, R.W. Flowers.

Ulmeritoides guanacaste **Domínguez**

Ulmeritoides guanacaste Domínguez 1995:30.

This species is closely related to *U. acosa* and *U. chavarriae*, all three species sharing the same basic shape of the penis lobes, hind femora lacking spines on dorsal half of the anterior surface, and maxillae with a very reduced tusk on the inner apical margin. *Ulmeritoides guanacaste* can be distinguished from the preceding two species by its abdominal color pattern which is predominantly dark brown with a pair of large pale spots on each segment, and by the lack of a dark band on the leading edge of the forewing. Until now known only from the type locality, *U. guanacaste* appears to be widely distributed in lowland streams on the Atlantic side of Costa Rica. The following are additional locality records: COSTA RICA, Alajuela Province, Tilarán, Lago Cote, 647m E.I.A. C.N.F.L.: 3 nymphs (UCR), 17–II–2002, R. Acosta, M. Springer; 2 nymphs (UCR), 26–X–2002, R. Acosta, M. Springer; Guanacaste Province Area de Conservación Guanacaste, Sector El Hacha: 6 nymphs (INBio), arriba del Modulo, 26–I–2004, M.M. Chavarría, R.W. Flowers, R. Blanco S.; 13 nymphs (INBio), abajo de Modulo, 26–I–2004, M.M. Chavarría, R.W. Flowers, R. Blanco S.; 1 nymph (INBio), Quebrada Guachepelin, puente en carretera a Santa Cecilia, 26–I–2004, M.M. Chavarría, R.W. Flowers, R. Blanco S.; 2 nymphs (UCR), Heredia Province, Res. Rara Avis, “El Plastico”, Queb. El Tigre, 560m. I–1999, Col. Monika Springer, curso de OET; Limón Province, Talamanca: 1 nymph (UCR), Quebrada Mata de Limón, finca Lomas, Proyecto ANAI, 21–V–2000, Col. B. McLarney, S. Griffiths, G. Kahsala; 4 nymphs (UCR), Crique Botadero (Gandoca), Proyecto ANAI, 19–III–2001, Col. B. McLarney.

Ulmeritoides tifferae **Domínguez**
(Fig. 13)

Ulmeritoides tifferae Domínguez 1995:27

Ulmeritoides tifferae differs from the other Costa Rican *Ulmeritoides* in having a moder-

ately well developed tusk on the inner apical margin of the maxilla and the outer surface of the hind femur evenly and densely covered with short spines. Like *U. guanacaste*, *U. tifferae* was described from a single locality; the following are additional localities for this species. COSTA RICA, Guanacaste Province: 4 nymphs (INBio), Río Animas, carretera a Santa Cecilia, 27–I–2005, S. Ávila, R.W. Flowers; 3 nymphs, Reserva Lomas Barbudal, Queb. Cabuyo, 28–VIII–1994, Y. Astorga, R.W. Flowers.

Discussion

Ulmeritoides acosa, chavarriae, and *guanacaste* form a species complex that can be distinguished by the following combination of characters: in the adult the penes are flattened and turned upward; in the nymph 1) the maxillary tusk is very small, 2) the exterior surfaces of the middle and hind femora lacks spines except on the apical margin. *Ulmeritoides guanacaste* is an Atlantic Drainage species (Fig. 22), while the other two have been found only in the Pacific Drainage. Additional nymphs belonging to this complex but too small or in too poor a condition to identify are known from the Lomas Barbudal Biological Reserve, other streams in the lower Tempisque Drainage, all in Guanacaste Province; and Ciudad Colon in San José Province.

All *Ulmeritoides* known from Costa Rica inhabit leaf packs in pools or other areas of slow water within lowland (<500m) stream ecosystems. They appear to favor masses of leaves in advanced stages of decay in deep areas with little or no current; this preference may indicate an ability to tolerate fairly anoxic conditions. However, *U. acosa* and *U. guanacaste* have also successfully adapted to living in temporary streams which lack water for up to five months of the year. They share these pools with other Ephemeroptera: *Choroterpes*, *Farrodes*, *Caenis*, *Americabaetis*, *Baetodes*, and *Callibaetis*. Beyond some very fragmentary information on emergence of imagos and subimagos, biological data on these drought–resistant *Ulmeritoides* and other genera are lacking. It is not known, for example, if the intense Santa Elena dry season is passed in a drought–resistant egg stage, or in the nymphal stage in the few upstream springs and pools that have water year around. *U. acosa* appears to have different seasonal cycles in permanent and temporary streams. In permanent streams such as the stream at La Palma in Osa, nymphs of all sizes from very small to mature were collected at various times during the year, suggesting an extended emergence period or multiple short emergence periods. Similar size distributions of nymphs occur in permanent streams on the Nicoya Peninsula. In temporary streams only larger sized nymphs are present during the early dry season and the emergence period is much shorter.

It is possible that the adaptations of *Ulmeritoides* and other genera for living in temporary streams are a recent evolutionary response to deforestation. Both the Santa Elena and Nicoya peninsulas have been extensively altered since the arrival of Europeans, and removal of forest cover can intensify the effects of long dry seasons in tropical arid and

semi-arid climates (Viramontes and Descroix 2003, Bewket and Sterk 2005). In stream environments of decreasing permanence in northwestern Costa Rica, an ancestor of the *U. guanacaste* complex could have responded with a shortened life cycle. The shortened cycles in increasingly intermittent streams would favor increased isolation of *Ulmeritoides* populations, which could have led to the segregation of *U. chavarriae* and perhaps other localized species yet to be recognized.

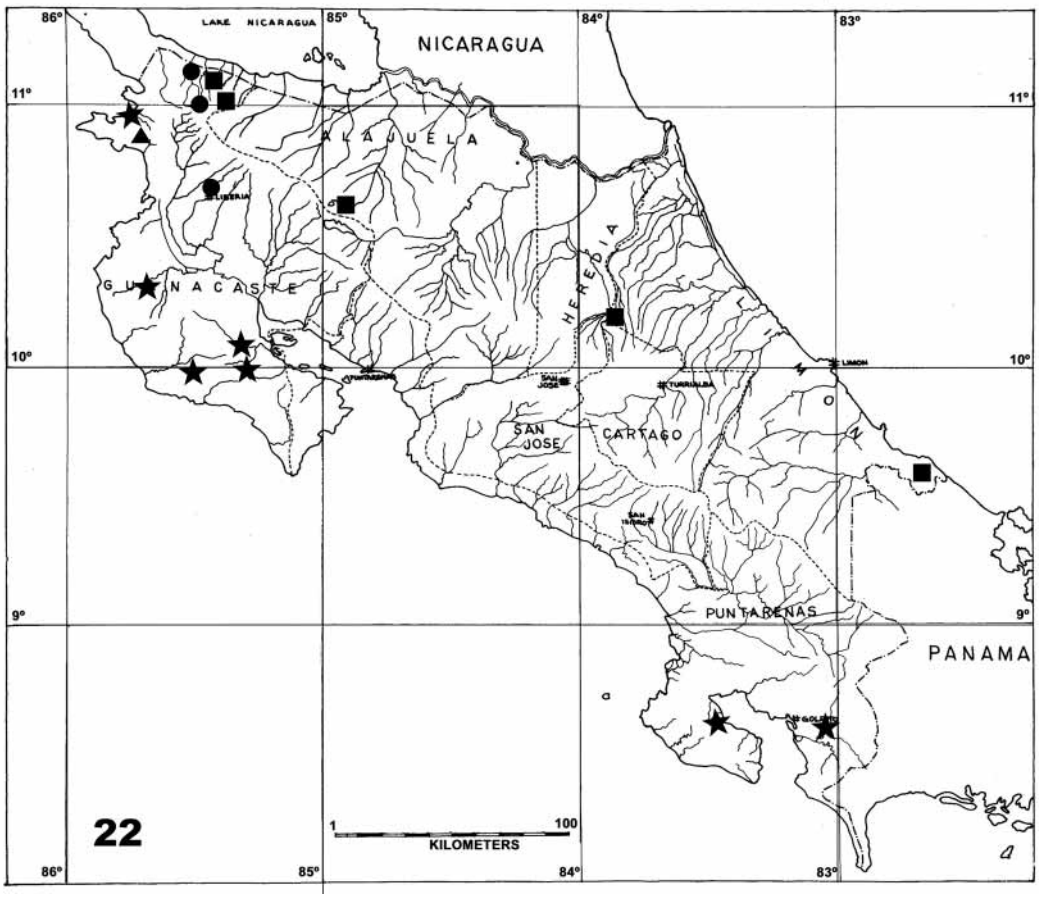


FIGURE 22. Distribution of *Ulmeritoides* in Costa Rica. *U. acosa*, star; *U. chavarriae*, triangle, *U. guanacaste*, square; *U. tifferae*, circle.

Key to described Costa Rican species of the genus *Ulmeritoides*
(modified from Domínguez 1995)

Male imagos

1. Forewings with membrane between costa and radius tinged with brown, anterior cross veins shaded with brown (Figs. 1,3) 2

- Forewings with costal and subcostal areas hyaline..... *U. guanacaste* Domínguez
2. Penis lobes with a shallow small prominence on outer margin near apex..... ..... *U. tifferae* Domínguez
- Penis lobes with a ventral projection (Figs. 6, 8).....3
3. Abdomen translucent yellowish brown, lacking pattern of pale spots or dark bands .... *U. chavarriae* new species
- Abdominal terga orange-brown with pale basal spots and dark brown apical transverse spots .....*U. acosa* new species.

Mature nymphs

1. Exterior surface of femora II and III with numerous short acute spines; femora II with a median black spot (Fig. 13).....*U. tifferae* Domínguez
- Exterior surface of femora II and III devoid of spines except for a row along the dorsal edge; femora II without a median spot (Fig. 12).....2
2. Abdominal terga with large pale median and/or submedian spots..... ..... *U. guanacaste* Domínguez.
- Pale spots on abdominal terga, if present, small 3
3. Abdominal terga with dark brown posterior bands; found in pools of permanent or temporary streams..... *U. acosa* new species.
- Abdominal terga with posterior bands weak or missing; found in temporary streams... ..... *U. chavarriae* new species.

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