

Illustrated record of the freshwater copepod *Leptodiaptomus dodsoni* (Calanoida, Diaptomidae) from central Mexico with comments on the distribution of the genus

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Abstract: The freshwater planktonic calanoid copepod *Leptodiaptomus dodsoni* Elías-Gutiérrez, Suárez-Morales & Romano, 1999, a rare species known only from western Mexico, is here recorded from the State of Aguascalientes, central Mexico. This species has a uniquely large, sinuous spine on segment 13 of the right male antennule, reaching the distal margin of segment 15. There are subtle differences between these two known populations; the morphological range of the species is complemented with data from the new specimens. This is the first record of *L. dodsoni* after its original description; it is probably restricted to a latitudinal fringe in central Mexico. Of the 22 nominal species of *Leptodiaptomus* currently recognized, up to 7 are known from the Neotropical region and some appear to be true endemics. Apparently, this primarily Nearctic genus radiated in North America and some species reached the Neotropical region where they diversified. A key for the identification of the species of the genus known from the Neotropical region is also provided.

Keywords: *freshwater zooplankton, Neotropical limnobiology, crustacean taxonomy, copepods.*

SILVA-BRIANO, M. & SUÁREZ-MORALES, E. **Registro ilustrado del copépodo dulceacuícola *Leptodiaptomus dodsoni* (Calanoida, Diaptomidae) del centro de México con comentarios acerca de la distribución del género.** *Biota Neotrop.* 10(2): <http://www.biotaneotropica.org.br/v10n2/es/abstract?short-communication+bn02510022010>.

Resumen: El copépodo calanoide planctónico de aguas continentales *Leptodiaptomus dodsoni* Elías-Gutiérrez, Suárez-Morales & Romano, 1999, una rara especie conocida sólo en la zona occidental de México, se registra aquí para el estado de Aguascalientes, en el centro de México. Esta especie tiene una espina sinuosa distintivamente larga en el segmento 13 de la anténula derecha del macho, la espina alcanza el margen distal del segmento 15. Existen diferencias sutiles entre estas dos poblaciones; se complementa el espectro morfológico de la especie con datos de los nuevos especímenes. Este es el primer registro de *L. dodsoni* después de su descripción original; probablemente está restringida a una franja latitudinal del centro de México. De las 22 especies nominales de *Leptodiaptomus* reconocidas, 7 se conocen en la zona Neotropical y algunas parecen ser verdaderos endémicos. Aparentemente, este género primariamente Neártico radió en América del Norte y estas especies alcanzaron la región Neotropical donde se diversificaron. Se presenta una clave para la identificación de las especies del género conocidas en la región Neotropical.

Palabras-clave: *zooplancton de aguas continentales, limnobiología Neotropical, taxonomía de crustáceos, copéodos.*

Introduction

The genus *Leptodiaptomus*, as described by Light, 1938 comprises small or medium-sized diaptomid copepods characterized mainly by a left male and both female antennules with only one seta on segment 11, a very reduced female fifth leg terminal exopodite, and a right male antennule with strong spines on segments 10, 11 and 13 (Wilson 1954, Dussart & Defaye 1995). Up to seven species of this genus have been hitherto recorded in Mexico: *Leptodiaptomus novamexicanus* (Herrick, 1895), *L. mexicanus* (Marsh, 1929), *L. siciloides* (Lilljeborg, 1889), *L. connexus* (Light, 1938), *L. cuauhtemoci* (Osorio-Tafall, 1941), *L. dodsoni* Elías-Gutiérrez, Romano & Suárez-Morales 1999, and *L. garciai* (Osorio-Tafall, 1941) (Marsh, 1929, Grimaldo-Ortega et al. 1998, Suárez-Morales & Reid 1998, Elías-Gutiérrez et al. 1999, Montiel-Martínez et al. 2008). Some of these species have a close morphological resemblance with their congeners; this has caused some taxonomic confusion within the genus. Recently, two previously synonymized species were revalidated (see Suárez-Morales et al. 2000, Montiel-Martínez et al. 2008). Based on the current data (Elías-Gutiérrez et al. 2008), it is presumed that most species of *Leptodiaptomus* known from Mexico show a restricted distribution. Hence, detailed morphological accounts of the species and reliable records are needed to reveal the true distributional patterns of these species.

The freshwater copepod fauna of the state of Aguascalientes, central Mexico, has been investigated (Dodson & Silva-Briano 1996, Silva-Briano & Suárez-Morales 1998). In early October 2000, zooplankton samples were collected by the first author (MS-B) in the northern zone of Aguascalientes. Several male and female diaptomid copepods were obtained. The taxonomic examination of this material resulted in the identification of *L. dodsoni*; these specimens were compared with the type material and with other specimens previously collected from Aguascalientes (Silva-Briano & Suárez-Morales 1998). Complementary morphological data are added to the original description. The diversity and distribution of the genus in Mexico are revised and discussed herein. A key for the identification of the species of *Leptodiaptomus* known from the Neotropical region is also provided.

Material and Methods

Adult males and females of *Leptodiaptomus dodsoni* were collected during a survey carried out by the Universidad de Aguascalientes to determine the composition, diversity, and distribution of the freshwater zooplankton of this state of north-central Mexico. This effort included more than 500 localities in Aguascalientes (see Dodson & Silva-Briano 1996). Zooplankton was collected by using a standard plankton net with a mesh size of 0.06 mm. The samples were fixed with 4% formalin solution. Copepods were sorted and transferred to 70% ethanol for preservation and storage. The taxonomic analysis of the copepods involved dissection, preparation of microscope slides using glycerol as a mounting medium, and illustrations prepared with the aid of a camera lucida. Some specimens were processed for SEM analysis.

Results

FAMILY DIAPTOMIDAE BAIRD, 1850

Subfamily Diaptominae Kiefer, 1932

Leptodiaptomus dodsoni Elías-Gutiérrez, Suárez-Morales & Romano, 1999 (Figures 1-5).

Leptodiaptomus cf. *signicauda*: Silva-Briano & Suárez-Morales 1999, p. 41.

Material examined: Four adult ♂♂, collected October 4, 2001 from pond in Potrerillos, San José de Gracia, Aguascalientes, central Mexico (22° 14' N and 102° 30' W), plankton sample from littoral zone, collector M. Silva-Briano, specimen dissected on two slides, mounted in glycerol and sealed with Entellan®, deposited in collection of Zooplankton of El Colegio de la Frontera Sur (ECOSUR), Chetumal, Mexico (cat. ECO-CHZ-05629). Three adult ♂♂, collected August 4, 1990 from same locality, date and collector, plankton sample, littoral zone, specimens undissected, ethanol-preserved (ECO-CHZ-05628). Two adult ♀♀, one adult ♂ of *Leptodiaptomus* cf. *signicauda* collected August 4, 1990,

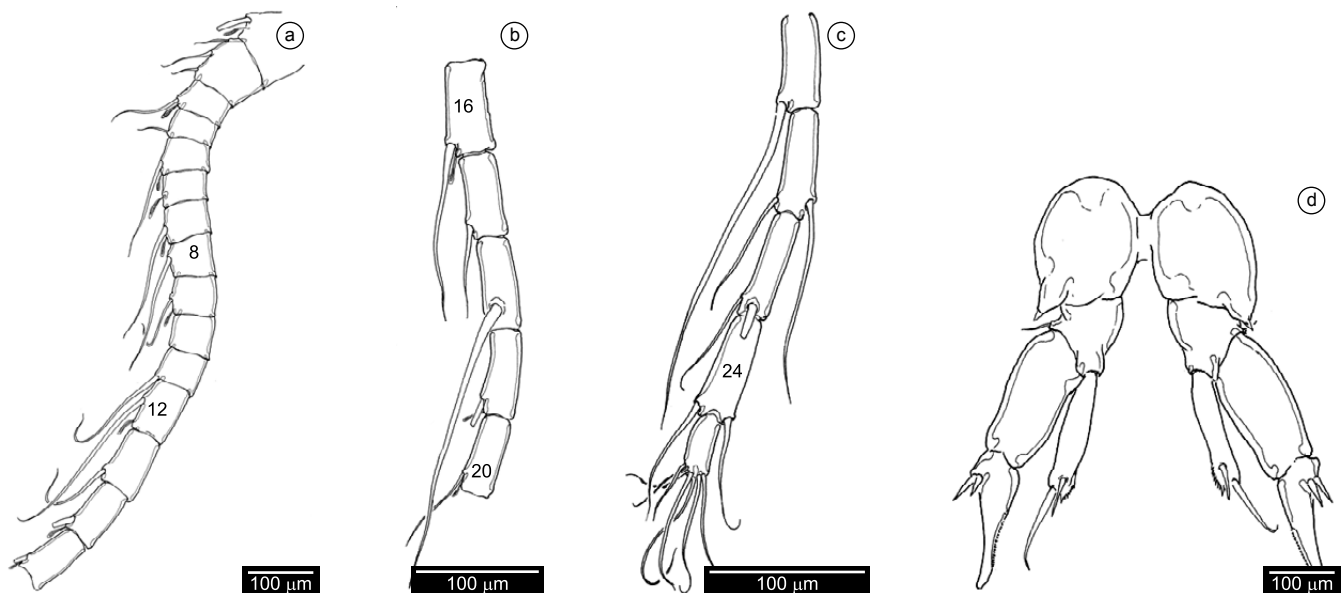


Figure 1. *Leptodiaptomus dodsoni*. Adult female from Aguascalientes, Mexico. a) antennule segments 1-15; b) antennule segments 16-20; c) antennule segments 21-25; d) fifth leg.

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same locality and collector, specimens dissected, slides mounted in glycerol, collection of M. Silva-Briano at University of Aguascalientes. Four adult ♀♀, collected October 4, 2001, same locality and collector, specimens undissected, ethanol-preserved, vial (cat. ECO-CHZ-05627). One adult ♀, collected October 4, 2001, same locality and collector, specimen dissected, two slides mounted in glycerol (cat. ECO-CHZ-05626). Two adult ♂♂, two adult ♀♀ paratype specimens from La Barca, Jalisco, Mexico (ECO-CHZ-00409).

Additional material: Several adult ♀♀, several adult ♂♂, same collection data, undissected, preserved in 70% ethanol and original zooplankton samples are deposited in the Laboratory of Ecology, University of Aguascalientes, Mexico.

Comparisons: Female. Body length and proportions as described by Elías-Gutiérrez et al. (1999) from type specimens, including robust cephalothorax (Figure 4a), rounded thumblike process on right distal margin of genital double somite (Figures 4b, c),

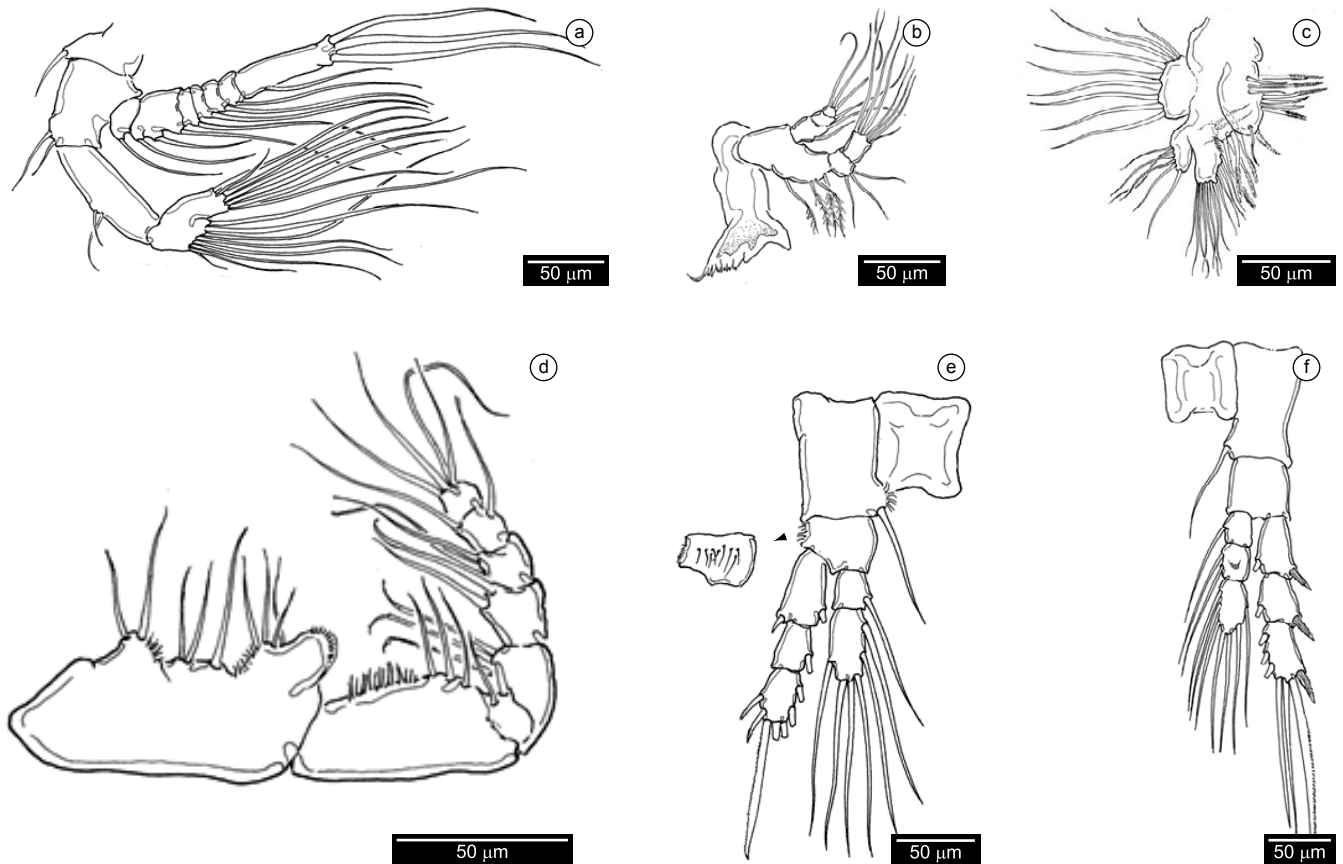


Figure 2. *Leptodiptomus dodsoni*. Adult female from Aguascalientes, central Mexico. a) antenna; b) mandible with palp; c) maxillule; d) maxilliped. Adult male holotype, e) first swimming leg, showing variant ornamentation of basis in female (arrowed); f) second swimming leg.

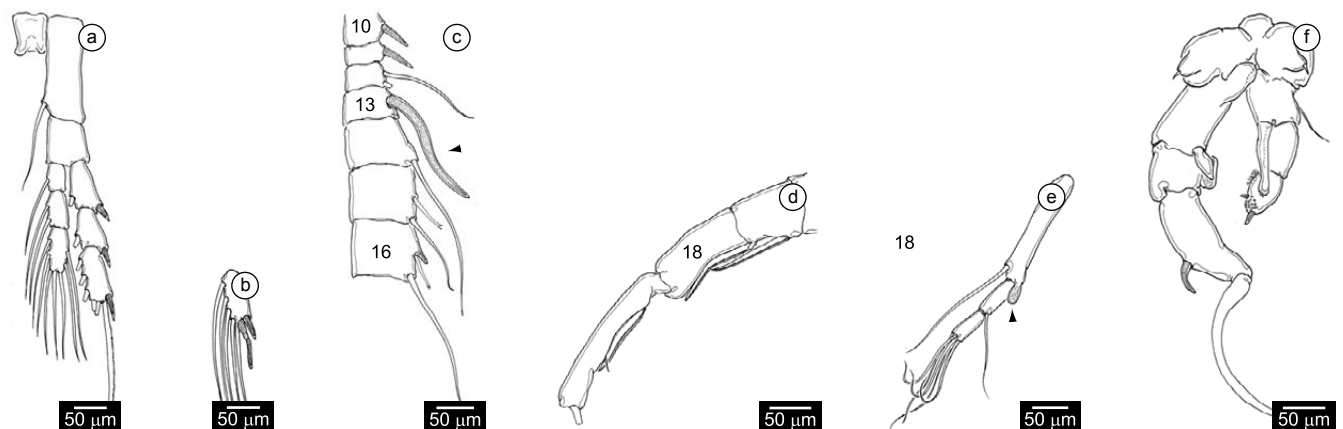


Figure 3. *Leptodiptomus dodsoni*. Adult male from Aguascalientes, Mexico. a) third swimming leg; b) terminal segment of exopod of third legs showing underdeveloped apical spiniform seta (another specimen); c) right geniculate antennule segments 10-16; d) same, segments 17-19; e) same, segments 20-22; f) fifth legs.

asymmetrical structure of wings on fifth pedigerous somite (Figure 4d), and relatively large anal somite (Figure 4b).

Antennules (Figures 1a-c) as in Elías-Gutiérrez et al. (1999), 25-segmented, relatively long, reaching posterior margin of caudal rami. Armature with one aesthetasc less on segment 3, one seta less on segments 9, 10, and two more distal setae on segment 25.

Antenna (Figure 2a) as in Elías-Gutiérrez et al. (1999) except for relatively shorter coxal and basipodal setae and a longer seta on the inner margin of the distal exopodal segment. Mandible (Figure 2b) as in original description except for relatively longer dorsal seta on the mandible edge, ventral outermost tooth without spine-like projection at tip. Maxillule (Figure 2c) and maxilla as in original description. Maxilliped syncoxal lobes armed with 2, 3, 4 setae, two additional setae than in original description (Figure 2d).

First leg (Figure 2e) as in original description except for presence of rows of hair-like elements on inner margin of coxa and outer margin of basipod and long hair-like elements on caudal surface of basipod. Second, third and fourth legs (Figures 2f, 3a) as in original description.

Leg 5 (Figures 1d, 4e, 5a) as in Elías-Gutiérrez et al. (1999) except for slightly shorter endopod, barely reaching distal margin of first exopodal segment and relatively shorter basipodal setae.

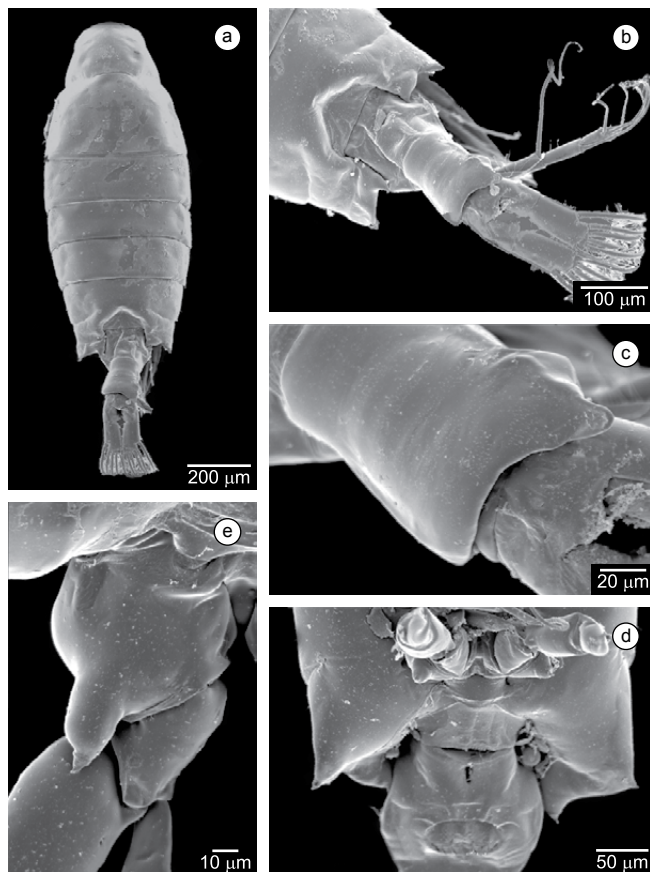


Figure 4. *Leptodiptomus dodsoni*. Adult female from Aguascalientes, Mexico, SEM photographs. a) habitus, dorsal view; b) urosome and caudal rami, dorsal view; c) detail of process on distal margin of genital somite; d) fifth pedigerous somite and proximal half of genital somite, ventral view; e) coxal process of fifth leg.

Male. Body proportions and length as in original description including slender body (Figure 5b), acute rostral points, and distal processes and asymmetry on fifth pedigerous somite (Figure 5e). Mouthparts and swimming legs as described for female except for lighter ornamentation on the basipod of first leg; one male specimen showed an underdeveloped distal spiniform seta on the third exopodal segment of the third swimming legs (Figure 3b). Right geniculate antennule as described by Elías-Gutiérrez et al. (1999), including segmentation with 22 articles, geniculation between segments 18 and 19 (Figures 3c-e), segments 10 and 11 with spiniform process, 12 with two setae and 13 with strong, long sinuous spine, its base almost as wide as 1/2 of bearing segment, spine almost reaching proximal margin of segment 16 (Figures 3c, 5c). Segment 14 with long seta, segment 15 with one distal seta and distally bifurcate aesthetasc on middle of segment. Segment 16 with one reduced, blunt spine, an aesthetasc and one seta (Figure 3c). Segment 20 with conspicuous thumb-like process on distal inner margin, reaching midway of succeeding segment. Left and right legs 5 as in original description except for larger inner process on inner margin of left coxa (Figures 3f, 5f).

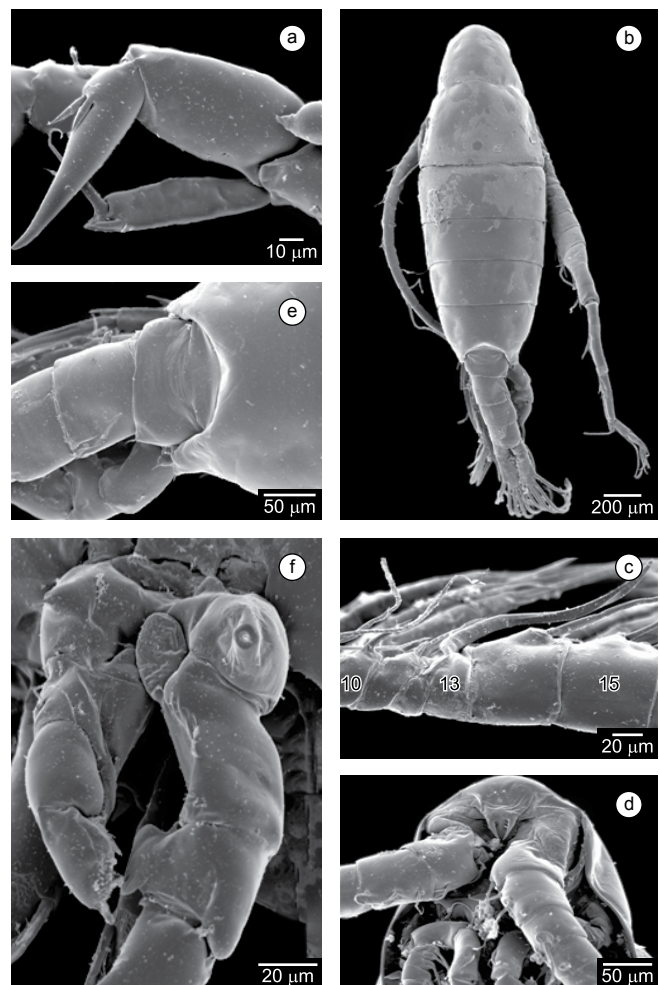


Figure 5. *Leptodiptomus dodsoni*. Adult female from Aguascalientes, Mexico, SEM photographs. a) endo- and exopod of fifth legs, lateral view. Adult male from same locality, b) habitus, dorsal view; c) right antennule segments 10-15; d) cephalic area including rostrum, ventral; e) fifth pedigerous and first urosomites, dorsal view; f) fifth legs showing left leg and basis and exopod 1 of right leg.

Discussion

Based on the reexamination of the specimens identified by Silva-Briano & Suárez-Morales (1998) as *L. cf. signicauda*, it is confirmed here that they are assignable to *L. dodsoni*. Overall, the subtle morphological differences resulting from our comparative analysis of both known populations of *L. dodsoni* represent a moderate range of intraspecific variation; diaptomids show morphological differences associated to the habitat and region in which they dwell (Montiel-Martínez et al. 2008).

This is the second record of *L. dodsoni* after its original description from specimens collected in Jalisco, western Mexico; Elías-Gutiérrez et al. (1999) regarded this species as an endemic form, restricted to this locality. The record of this species in Aguascalientes, central Mexico, represents a modest expansion of its known geographic range. Two facts, however, support the notion that it has a geographically restricted distribution: 1) it was recorded in a single locality out of more than 500 sampled, and 2) this is an easily distinguishable species that might have been easily spotted from other copepod surveys carried out in central Mexico. Hence, it is likely that its distributional range is still limited to the latitudinal fringe of western-central Mexico. Other species of the genus show the same presumably restricted distribution in central Mexico, including *L. cuauhtemoci* (Osorio-Tafall 1941, Suárez-Morales et al. 2000), *L. mexicanus* (Grimaldo-Ortega et al. 1997), and *L. garciai*, a strict endemic known from a single locality (Montiel-Martínez et al. 2008).

Leptodiptomus is known to contain about 22 species (Dussart & Defaye 2002). The genus is distributed in North America, it is absent from South America. At least two species, *L. tyrrelli* (Poppe, 1888) and *L. angustilobus* (Sars, 1898) have been recorded outside the continent. Several other non-Neotropical species, such as *L. coloradensis* (Marsh, 1911), *L. insularis* (Kincaid, 1956), and *L. trybomi* (Lilljeborg, 1889) have restricted known distributional ranges. Other species are distributed only in cold-temperate latitudes, but a few, such as *L. siciloides*, and *L. novamexicanus* are assumed to have a wide latitudinal distributional range that includes USA and Canada and reach the Neotropical region. Among the Neotropical species, the same is assumed for: *L. garciai*, known from a single locality, and also for *L. cuauhtemoci*, *L. mexicanus*, and *L. dodsoni*, apparently restricted to a few localities in central Mexico, not reaching southern Mexico or southern USA.

In an overall analysis of the American diaptomid distributional patterns, Suárez-Morales et al. (2005) suggested that *Leptodiptomus* is part of a group of genera largely restricted to the Nearctic region with some tendency to radiate southwards into the Neotropical region. Species of *Leptodiptomus* have been recorded in fully tropical areas of southeast Mexico (Suárez-Morales & Reid 1998, Elías-Gutiérrez et al. 2008). Members of other genera appear to be restricted to North America (i.e. *Nordodiptomus*, *Eudiaptomus*, and *Onychodiptomus*) (Suárez-Morales et al. 2003).

Ancestral members of *Leptodiptomus* could have spread from the Nearctic region (at least 12 species recorded in Canada and northern USA) into the Neotropical region where it radiated (5 species in the Neotropical region). These species could have remained isolated from the other North American *Leptodiptomus* as remains of radiation events that were affected by glaciations (Granados-Ramírez & Suárez-Morales 2003). Postglacial repopulation in glacial refugia areas might have resulted in isolation and speciation (see Boileau 1991).

Key for the identification of the species of *Leptodiptomus* known from the Neotropical region.

- 1a. With right antennule modified, geniculate (males) 2
- 1b. With right and left antennules with identical structure
..... (females) 8

- 2a. Antennule with segment 13 bearing long, strong sinuous spine reaching beyond distal margin of segment *L. dodsoni*
- 2b. Antennule with segment 13 bearing straight, shorter spine, not reaching the distal margin of segment 14 3
- 3a. Spine on segment 11 clearly shorter than that on segment 13
..... 4
- 3b. Spine on segment 11 subequal to or longer than that on segment 13 5
- 4a. Process on antepenultimate segment of right antennule reaching halfway of the penultimate segment *L. novamexicanus*
- 4a'. Process on antepenultimate segment of right antennule relatively short, not reaching halfway of penultimate segment
..... *L. garciai*
- 5a. Right antennule with large spine on segment 8, clearly longer than that on segment 12 6
- 5b. Right antennule without spine or reduced spine on segment 8, when present as long as or shorter than that on segment 12 7
- 6a. Spine on antennular segment 8 at least twice as long as that on segment 12, but shorter than that on segment 11. Large spines on antennular segments 8, 10, 11, and 13. Antepenultimate antennular segment with relatively short process, reaching only halfway of succeeding segment. Anal somite without lateral processes ..
..... *L. connexus*
- 6b. Spines on antennular segment 8 reduced, shorter than bearing segment. Large spines on antennular segments 10, 11, 13, and 15. Antepenultimate antennular segment with long, distally curved process reaching well beyond distal margin of succeeding segment. Anal somite with digitiform projection on right posterior margin *L. mexicanus*
- 7a. Left coxa of fifth leg with large outer spine. Hyaline process on inner margin of first exopodal segment of right fifth leg squarish. Distal claw of right fifth leg exopod terminally acute, without inner lamella *L. siciloides*
- 7b. Left coxa of fifth leg without outer spine. Hyaline process on inner margin of first exopodal segment of right fifth leg anvil-shaped. Distal claw of right fifth leg exopod terminally rounded, with an inner lamella *L. cuauhtemoci*
- 8a. Genital somite with postero-distal process on right margin 9
- 8b. Genital somite without postero-distal process on right margin ..
..... 11
- 9a. Genital somite asymmetrical, with lateral thumb-like projection on right posterior margin reaching halfway of anal somite. Genital somite with acute process halfway on right margin, left margin rounded. Distal seta of fifth leg endopod asymmetrical, outer seta 1.8 times as long as inner seta *L. dodsoni*
- 9b. Genital somite with two acute lateral projections: the left projection more produced than the left one, both with terminal spiniform element 10
- 10a. Process on the right posterior margin of genital somite well developed, reaching well beyond halfway of anal somite
..... *L. novamexicanus*

- 10b. Process on the right posterior margin of genital somite weakly developed, represented by short rounded process not reaching halfway of anal somite.....*L. garciai*
- 11a. Endopod of fifth leg elongate, 1.4 times longer than inner margin of first exopodal segment, reaching beyond half of second exopod, with apical setae symmetrical, 0.8-1 times as long as bearing segment..... *L. mexicanus*
- 11b. Endopod of fifth leg relatively short, 0.8-1.0 as long as inner margin of first exopodal segment, not reaching halfway of second exopod, apical setae relatively short, 0.3-0.5 times as long as bearing segment..... 12
- 12a. Genital somite pilose on posterior dorsal margin; lateral projections strongly asymmetrical: right one strongly produced, left one represented by rounded expansion. Genital somite relatively short, 1.1 times as long as wide..... *L. connexus*
- 12b. Genital somite with smooth posterior dorsal margin; lateral projections moderately asymmetrical. Genital somite elongate, 1.3-1.6 times as long as wide..... 13
- 13a. Genital operculum proximally rounded, lateral projections of genital somite asymmetrical, left one larger, wing-like, with terminal blunt process, right projection weak, with terminal spiniform element. Spines of third endopod of the fifth leg relatively short, equally long*L. cuauhtemoci*
- 13b. Genital operculum proximally straight, lateral projections of genital somite weakly asymmetrical, left one small, rounded, with terminal spine-like element, right projection stronger, acute, with terminal spiniform element. Spines of third endopod of the fifth leg relatively long, uneven, one at least twice as long as the other.....*L. siciloides*

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