

A REVIEW OF THE *BRANCHINECTA* (BRANCHIOPODA: ANOSTRACA) FROM THE BAJA CALIFORNIA PENINSULA: FIRST RECORD OF THE GIANT FAIRY SHRIMP *B. GIGAS* LYNCH, 1937 FROM MEXICO

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ABSTRACT

As a part of an ongoing research initiative on Sonoran Desert large branchiopod biodiversity, we conducted extensive field surveys along the Baja California Peninsula. We present here a taxonomic review of the genus *Branchinecta* on this peninsula. The results confirm the presence of *B. lindahli* Packard, 1883, *B. mackini* Dexter, 1956, and *B. sandiegonensis* Fugate, 1993, and provide the first Mexican records of the world's largest anostracan *B. gigas* Lynch, 1937. The peninsular sites of the four *Branchinecta* represent the southernmost extent of their distribution. The giant fairy shrimp was discovered from two shallow temporary lakes located in the Valle de los Cirios. The large branchiopod species assemblage that occurs in these lakes is unique among the temporary wetlands of Mexico. These lakes, so far, are the only known habitats in Mexico where the tadpole shrimp *Lepidurus lemmoni* Holmes, 1894, and *B. gigas* occur.

KEY WORDS: Anostraca, Baja California (Norte), Baja California Sur, distribution, Laguna Chapala, Laguna El Islote, Sonoran Desert

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INTRODUCTION

Seven species of *Branchinecta* have been reported from Mexico: *B. belki* Maeda-Martínez et al., 1992 and *B. oterosanvicentei* Obregón-Barboza et al., 2002 endemic to the southern Coahuila in the Chihuahuan Desert; *B. mexicana* Maeda-Martínez et al., 1993 endemic to central Mexico; *B. sandiegonensis* Fugate, 1993 endemic to northern Baja California (Norte) Mexico and southern California, USA; *B. lindahli* Packard, 1883 and *B. mackini* Dexter, 1956 with a wide geographical distribution in western North America, but in Mexico restricted to the Baja California peninsula; and *B. packardi* Pearse, 1912 widely distributed in the Chihuahuan and Sonoran Deserts (Obregón-Barboza et al., 2002).

As a part of a research project on large branchiopod biodiversity of the Sonoran Desert, we have made extensive field surveys along the Baja California Peninsula, northwestern Mexico. We present a taxonomic revision of fairy shrimp of the genus *Branchinecta* from the Baja California Peninsula. The results increase our knowledge on the large branchiopod biodiversity of this country, and on the geographical distribution of four North American *Branchinecta*. We further argue that these data provide a scientific base to guide the conservation of desert temporary lakes in the Baja California Peninsula.

MATERIAL AND METHODS

Field surveys were conducted across Baja California and Baja California Sur, the two states comprising the peninsula. Live adult material and dry pond sediment samples were collected. The dry sediments were used to culture material from localities not generally accessible when wet. We also examined *Branchinecta* obtained from the crustacean collections of Centro de Investigaciones Biológicas del Noroeste, S.C., La Paz, Baja California Sur, Mexico (CIB). In the field and outdoor cultures, water temperature and total dissolved solids (TDS) were measured with a portable instrument (EC300, YSI, Yellow Springs, OH, USA). Geographic position of field sites was determined with a GPS unit (12XL, Garmin International, Olathe, KS, USA). Outdoor cultures were conducted using fiber glass tanks (1200 liters) with potable water (TDS = 0.3 g/l) and dry soil from potential habitats of *Branchinecta* (ca. 20 kg) as substrate and source for the eggs of *Branchinecta*.

The species diagnoses are based on descriptions published by Packard (1883), Lynch (1937, 1964), Dexter (1956), and Fugate (1993). We include the morphological terms of antennomere and gonopod used by Rogers et al. (2011). We followed Mura (1991), Fugate (1993), and Hill and Shepard (1997) for egg description. The material examined is organized according to the political state, name of the site, coordinates, collection date, data on water temperature and TDS (where available), senior collector's name, catalog code, number of males and females examined.

SYSTEMATICS

The taxonomic review yielded new distribution sites for *Branchinecta lindahli*, *B. mackini*, and *B. sandiegonensis*, and the first records of the world's largest anostracan, *B. gigas* Lynch, 1937 in Mexico.

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Branchinectidae Daday, 1910
Branchinecta Verrill, 1869
Branchinecta gigas Lynch, 1937
 (Figs. 1C-D, 2A-H)

Type Material.—Holotype and paratypes deposited in the United States National Museum, Smithsonian Institution (USNM-72572), collected by J. E. Lynch in May, 1936 (Lynch, 1937).

Type Locality.—Temporary alkali ponds in the Upper Grand Coulee, 19 miles north of Coulee, Grant County, WA, USA (Lynch, 1937, 1964). The type locality is now under Lake Roosevelt (D. C. Rogers, personal communication).

Diagnosis.—Male: First antenna filiform, longer than eye plus stalk, extending to near the middle of the second antenna proximal antennomere (Fig. 2A); second antenna with two antennomerae devoid of processes, tubercles, or denticulations (Fig. 2B), although granulous areas with papillae are present; proximal antennomere cylindrical, slightly constricted near the middle; distal antennomere blunt, somewhat flattened and slightly curved inward, and twisted in such a way that the broader diameter at the apex is at right angles to the corresponding transverse axis at proximal end of the antennomere (Fig. 2B); compound eyes small; endopod median border of first thoracopod bears chitinized hooked spines (Fig. 2C, D), with a dorsal triangular area of denticles;

everted gonopods bear a spur near the base and two spinose lobes near its distal end (Fig. 2E, F); cercopods (Fig. 2G) diverging with a ventrolateral row of plumose setae extending most of their length, and distal half dorsally and medially with similar, but longer, setae.

Female: First antenna filiform, about one third of the length of second antenna; second antenna tapering gradually to a sharp point; cercopods as in male; ovaries biramous with lateral oviduct positioned at first genital segment; amplexial groove undifferentiated, brood pouch pyriform with no complimentary structures to receive the male second antennae during amplexus, tip ending under first or second abdominal segment (third or fourth apodous segments) (Fig. 2H). Females exceed males in all dimensions except for length of first and second antennae and diameter of eye.

Egg: Spherical with spinulose surface without crests or prominent ornamentations, 570 to 595 μm in diameter.

Distribution in Mexico.—These are the first records of the species in this country; it was collected in Laguna Chapala (Fig. 1A-B), and Laguna El Islote both located in the Valle de los Cirios of the Sonoran Desert in Baja California (Norte). The specimens we examined fit with the morphological diagnosis and general description given by Lynch (1937). It was collected along with *B. mackini*, and *Lepidurus lemmoni* Holmes, 1894.

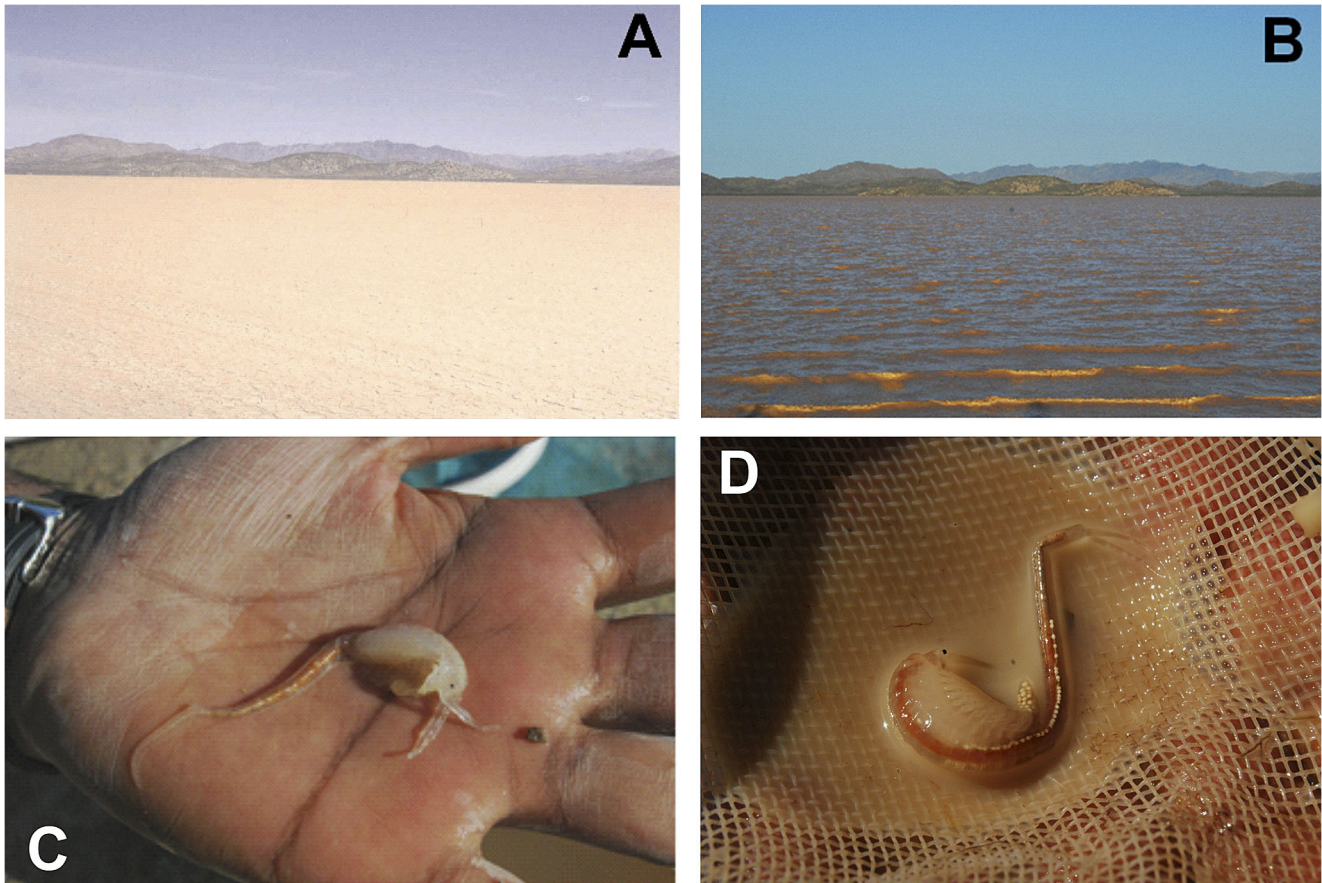


Fig. 1. A-B, Laguna Chapala, Baja California (Norte), Mexico. A, Dry phase, March 2009; B, wet phase, March 2010. C, Male; D, female of *Branchinecta gigas* Lynch, 1937 from Laguna El Islote, Baja California (Norte), Mexico. This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/1937240x>.

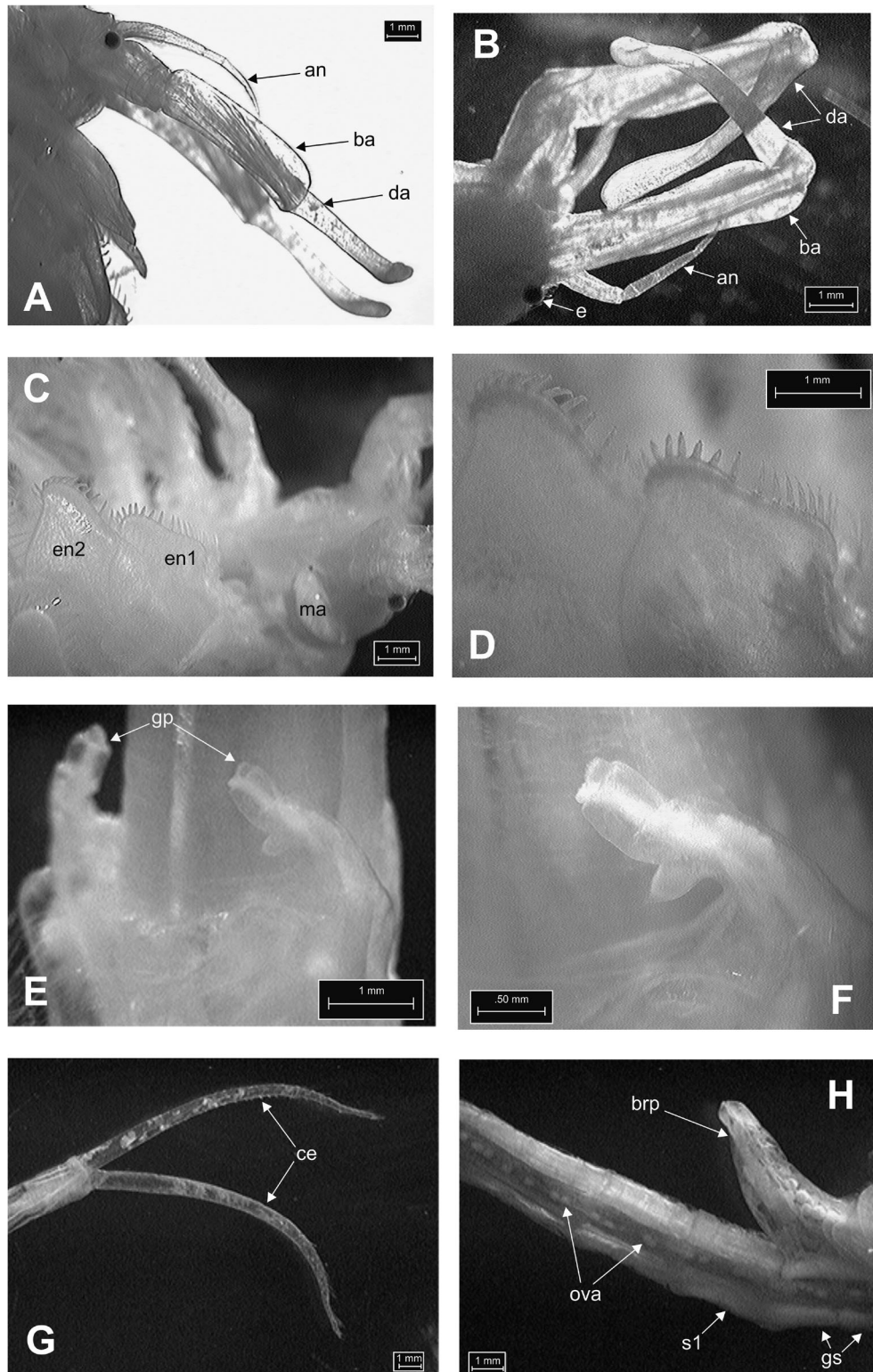


Fig. 2. A-H, Stereomicroscope photographs of *Branchinecta gigas* Lynch, 1937 from Laguna Chapala, Baja California (Norte), Mexico. A-G, Male. H, Female. A, Cephalic region in right lateral view; B, cephalic region in ventral view; C, first left thoracopods in left lateral view; D, magnified view from C; E, external genitalia in ventral view; F, right gonopod in ventral view; G, cercopods in ventral view; H, brood pouch and abdominal region in left lateral view. an, first antenna; ba, second antenna proximal antennomere; brp, brood pouch; ce, cercopods; da, second antenna distal antennomere; e, compound eye; en1, endopod of first thoracopod; en2, endopod of second thoracopod; gp, gonopods; gs, genital segments; ova, ovary; s1, first abdominal segment.

General Distribution.—This species is known from western Canada in Alberta and Saskatchewan, and from the USA in California, Montana, North Dakota, Nevada, Oregon, Utah, and Washington (Lynch, 1937; Dexter, 1953; Belk, 1975; Eng et al., 1990; Jass and Klausmeier, 2000).

Material Examined.—MEXICO: BAJA CALIFORNIA (NORTE): Laguna Chapala, Km 230, Federal highway No. 1, San Quintín-Guerrero Negro, 29°25'23"N, 114°25'38"W, 28.03.2011, 13.2°C, TDS 0.2 g/l, A. Maeda, CIB-769, 03 males, 04 females. Laguna El Islote, 5 km W Laguna Chapala, 29°21'33"N, 114°25'37"W, 28.03.2011, 17.3°C, TDS 0.3 g/l, A. Maeda, CIB-770, 08 males, 13 females. The range values of total body length (from anterior border of head to posterior border of cercopods) of the specimens examined are: from Laguna Chapala, males 60.9–76.6 mm, females 60.5–89.0 mm; from Laguna El Islote, males 56.3–71.9 mm, and females 71.4–93.2 mm.

Branchinecta lindahli Packard, 1883

Branchinecta lindahli Packard, 1883: Belk and Lindberg (1979), Belk (1983), Maeda-Martínez (1991), Maeda-Martínez et al. (1997, 2002a), Obregón-Barboza et al. (2002).

Type Material.—Neotype and paraneotypes deposited in the United States National Museum, Smithsonian Institution (USNM-109475, 109478) (Lynch, 1964; Belk and Brtek, 1995).

Type Locality.—Neotype locality 16 km E Garden City, Finney County, KS, USA (Lynch, 1964; Belk and Brtek, 1995).

Diagnosis.—Male: Second antenna proximal antennomere with pulvillus on anteromedian side near proximal end, and covered by minute spinules and scales; second antenna distal antennomere compressed, curved inward, with two major inflexions, one localized in median proximal part, and other one at distal end of antennomere, curved most strongly, almost at right angle to preceding parts; apex of distal antennomere a spatula-like projection, concave on ventral side, posterior edge with rasplike surface, and dorsal subterminal border not depressed; cercopods not converging, set with plumose setae along median and lateral borders.

Female: First antenna about as long as second antenna; thoracic segments 4 to 9, and sometimes first genital segment with, on both sides, dorsolateral rounded lobes covered by cuticular denticles; cercopods as in male; ovaries biramous with lateral oviduct positioned at the beginning of second genital segment; amplexial groove undifferentiated, brood pouch cylindrical with no complimentary structures to receive the male second antennae during amplexus, tip ending under fourth or fifth abdominal segment (sixth or seventh apodous segments).

Egg: Spherical, with cortical crests forming polygonal areas.

Distribution in México.—Baja California (Norte), and Baja California Sur (Belk and Lindberg, 1979; Belk, 1983; Maeda-Martínez, 1991; Maeda-Martínez et al., 1997, 2002a; Obregón-Barboza et al., 2002). *Branchinecta lindahli* is a common fairy shrimp in the state of Baja California (Norte) (Maeda-Martínez et al., 1997, 2002a), recorded from more

than 44 specific sites. It is also reported from Isla Guadalupe (Belk and Lindberg, 1979). Until now, there is only one record in the state of Baja California Sur, situated near the border with Baja California (Norte) (Belk, 1983).

General Distribution.—Widely distributed in western North America, from Canada in Alberta, and from the USA in Arizona, California, Colorado, Iowa, Kansas, Montana, North Dakota, Nebraska, New Mexico, Nevada, Oklahoma, Oregon, Texas, Utah, Washington, and Wyoming (Lynch, 1964; Belk, 1975; Eng et al., 1990; Belk and Brtek, 1995; Jass and Klausmeier, 2000).

Material Examined.—MEXICO: BAJA CALIFORNIA (NORTE): Ejido El Porvenir, 0.3 km El Tigre, 32°04'58"N, 116°36'20"W, 15.11.2010, H. García, CIB-771, 06 males, 17 females. Km 71.8, Federal highway Tijuana-Ensenada, west side pond, 32°03'27"N, 116°52'30"W, 19.02.1997, H. García, CIB-251, 02 males, 16 females, 05.03.97, H. García, CIB-252, 02 males, 16 females. Km 73, Federal highway Tijuana-Ensenada, 1 km Salina, 32°02'54"N, 116°52'43"W, 20.03.2011, H. García, CIB-772, 37 males, 61 females. Km 10, Federal highway No. 3, Ensenada-San Felipe, Valle La Trinidad, 31°52'05"N, 116°35'02"W, 25.03.1995, H. García, CIB-001, 12 males, 564 females. Km 42, Federal highway No. 3, Ensenada-San Felipe, Valle La Trinidad, 31°53'15"N, 116°15'07"W, 25.03.1995, H. García, CIB-002, 26 males, 155 females. Km 77, Federal highway No. 3, Ensenada-San Felipe, Valle La Trinidad, 31°52'12"N, 116°05'31"W, 25.03.1995, H. García, CIB-007, 76 males, 430 females. Km 105, Federal highway No. 3, Ensenada-San Felipe, Valle La Trinidad, 31°26'13"N, 115°45'10"W, 25.03.1995, H. García, CIB-016, 49 males, 14 females. Km 114, Federal highway No. 3, Ensenada-San Felipe, Valle La Trinidad, 31°29'13"N, 115°47'09"W, 25.03.1995, H. García, CIB-017, 69 males, 243 females. Valle La Trinidad, Federal highway No. 3, 31°20'33"N, 115°43'51"W, 25.03.1995, H. García, CIB-020, 05 males, 01 female. Km 52, junction to Federal highway No. 1, San Vicente-Valle La Trinidad, 31°23'03"N, 115°48'24"W, 25.03.1995, H. García, CIB-021, 06 males, 02 females. Ejido Chapultepec, 31°46'10"N, 116°37'05"W, 24.03.1996, H. García, CIB-245, 59 males, 64 females. Km 85.5, Federal highway No.1, Rancho Buenos Aires, San Vicente, 31°20'44"N, 116°16'07"W, 10.02.1995, H. García, CIB-023, 31 males, 20 females. San Vicente, Federal highway No. 1, 31°18'12"N, 116°14'36"W, 17.03.1995, H. García, CIB-024, 227 males, 52 females. Km 131, Federal highway No. 1, Ensenada-San Quintín, 31°02'07"N, 116°11'31"W, 10.02.1995, H. García, CIB-030, 01 male, 22 females. Junction to La Tasajera, highway San Telmo de Abajo-Observatorio Astronómico UNAM, Sierra San Pedro Mártir, 31°01'00"N, 115°29'26"W, 01.09.1996, A. Maeda, CIB-262, 621 males, 376 females. Km 90, highway San Telmo de Abajo-Observatorio Astronómico UNAM, Sierra San Pedro Mártir, 31°01'05"N, 115°30'08"W, 01.09.1996, A. Maeda, CIB-268, 68 males, 72 females. Vallecitos, Km 93 highway San Telmo de Abajo-Observatorio Astronómico UNAM, Sierra San Pedro Mártir, west side pond No. 1, 31°01'31"N, 115°29'10"W, 01.09.1996, A. Maeda, CIB-263, 21 males, 20 females; west side pond No. 2, 31°01'35"N, 115°29'10"W, CIB-264, 173 males, 225 females; east side pond, 31°01'31"N, 115°29'05"W, CIB-265,

228 males, 345 females. Km 98.5, highway San Telmo de Abajo-Observatorio Astronómico UNAM, Sierra San Pedro Mártir, 31°02'25"N, 115°28'50"W, 01.09.1996, A. Maeda, CIB-267, 404 males, 415 females. Km 99, highway San Telmo de Abajo-Observatorio Astronómico UNAM, Sierra San Pedro Mártir, 31°02'30"N, 115°28'55"W, 01.09.1996, A. Maeda, CIB-266, 262 males, 435 females. Km 148, Federal highway No. 1, Ensenada-Col. Lázaro Cárdenas, Rancho Ibarra, Ejido Jaramillo, 30°52'26"N, 116°07'05"W, 25.03.1995, H. García, CIB-032, 13 males, 130 females. Km 167, Federal highway No. 1, Ejido Emiliano Zapata, Vicente Guerrero, pond 1, 30°47'20"N, 116°00'24"W, 20.03.1995, H. García, CIB-033, 08 males; pond 2, 30°47'04"N, 116°00'13"W, 28.02.1995, H. García, CIB-034, 03 males, 03 females. Colonia Vicente Guerrero, Tienda La Adelita, Federal highway No. 1, 30°44'34"N, 115°59'01"W, 07.03.1995, H. García, CIB-035, 40 males, 42 females. Electric station, Colonia Vicente Guerrero, Federal highway No. 1, 30°44'20"N, 115°59'57"W, 24.03.1995, H. García, CIB-036, 06 males, 03 females. Km 174, Federal highway No. 1, Ejido Zarahemla, 30°42'44"N, 115°59'07"W, 24.03.1995, H. García, CIB-037, 77 males, 158 females. Km 175, Federal highway No. 1, Colonia 13 de Mayo, Vicente Guerrero, 30°42'06"N, 115°59'15"W, 10.03.1995, H. García, CIB-038, 08 males, 14 females. Km 177, Federal highway No. 1, Ampliación Santa Fé, 30°41'14"N, 115°58'28"W, 19.03.1995, H. García, CIB-039, 137 males, 364 females. Km 180, Federal highway No. 1, Ejido Padre Kino, 30°40'37"N, 115°59'03"W, 24.03.1995, H. García, CIB-040, 109 males, 302 females. Ejido Leandro Valle, Avenida 5a y F, 30°37'27"N, 115°59'10"W, 21.03.1995, H. García, CIB-041, 90 males, 186 females. Km 187, Federal highway No. 1, Colonia Las Flores, La Vitamina, San Quintín, 30°36'16"N, 115°58'27"W, 24.03.1995, H. García, CIB-042, 24 males, 115 females. Km 189, Federal highway No. 1, San Quintín, 30°36'55"N, 115°58'12"W, 24.03.1995, H. García, CIB-043, 240 males, 562 females. Km 193, Federal highway No. 1, Secundaria ETA-10, Colonia Lázaro Cárdenas, 30°30'29"N, 115°49'04"W, 24.03.1995, H. García, CIB-044, 231 males, 650 females. Km 1, Federal highway No. 1, San Quintín-El Rosario, electric station, 30°29'20"N, 115°57'04"W, 24.03.1995, H. García, CIB-046, 11 males, 39 females. Km 2.5, Federal highway No. 1, Ejido El Papalote, Colonia Lázaro Cárdenas-El Rosario, 30°29'05"N, 115°57'10"W, 24.03.1995, H. García, CIB-047, 16 males, 33 females. Km 4, Federal highway No. 1, Ejido El Papalote, Colonia Lázaro Cárdenas-El Rosario, 30°29'36"N, 115°49'48"W, 24.03.1995, H. García, CIB-048, 139 males, 690 females. Km 47, Federal highway No. 1, La Meseta, San Quintín-El Rosario, pond 1, 30°33'17"N, 115°44'22"W, 21.01.1995, H. García, CIB-049, 05 males, 27 females; pond 2, 30°33'27"N, 115°44'21"W, 22.01.1995, H. García, CIB-050, 145 males, 144 females. Km 51, Federal highway No. 1, San Quintín-El Rosario, 30°06'10"N, 115°44'44"W, 21.01.1995, H. García, CIB-051, 05 males, 13 females. Km 73, Federal highway No. 1, El Rosario-Cataviña, 30°03'18"N, 115°37'28"W, 21.01.1995, H. García, CIB-052, 02 males, 22 females. Km 92, Federal highway No. 1, El Rosario-Cataviña, 30°03'35"N, 115°23'39"W, 21.01.1995, H. García, CIB-

053, 267 males, 237 females. Km 198, Federal highway No. 1, Cataviña-Guerrero Negro, pond 1, 29°33'21"N, 114°33'03"W, 21.01.1995, H. García, CIB-054, 340 males, 329 females; pond 2, 29°33'21"N, 114°33'03"W, 21.01.1995, H. García, CIB-055, 73 males, 56 females; pond 3, 29°33'20"N, 114°33'04"W, 21.01.1995, H. García, CIB-056, 128 males, 195 females; pond 4, 29°33'20"N, 114°33'04"W, 21.01.1995, H. García, CIB-057, 230 males, 490 females. Km 203, Federal highway No. 1, Cataviña-Guerrero Negro, 29°31'03"N, 114°31'56"W, 22.01.1995, H. García, CIB-058, 507 males, 223 females. Km 211, Federal highway No. 1, Cataviña-Guerrero Negro, 29°27'12"N, 114°27'16"W, 21.01.1995, CIB-059, 332 males, 258 females. Km 232, Federal highway No. 1, Cataviña-Guerrero Negro, 29°24'02"N, 114°22'21"W, 21.01.1995, H. García, CIB-062, 02 males, 08 females. Km 196, Federal highway No. 1, Colonia Lázaro Cárdenas-junction to Bahía Los Angeles, 29°32'12"N, 113°47'22"W, 16.09.1995, CIB-068, 02 males, 08 females. Km 223, Federal highway No.1, Colonia Lázaro Cárdenas-junction to Bahía Los Angeles, 29°25'40"N, 114°24'29"W, 17.09.1995, H. García, CIB-079, 24 males, 16 females. Km 39, highway to Bahía Los Angeles, from Federal highway No. 1, Laguna Agua Amarga, pond 1, 29°02'02"N, 113°47'22"W, 21.01.1995, H. García, CIB-064, 270 males, 281 females. BAJA CALIFORNIA SUR: 28.9 km S El Arco, 27°57'39"N, 13°30'27"W, 15.05.2001, from culture, 20.3°C, TDS 0.28 g/l, CIB-548, 06 males, 15 females.

Branchinecta mackini Dexter, 1956

Branchinecta mackini Dexter, 1956: Brown et al. (1993), Maeda-Martínez et al. (1997, 2002a), Obregón-Barboza et al. (2002).

Type Material.—Holotype, allotype and paratypes deposited in the United States National Museum, Smithsonian Institution (USNM-99216-99218), collected by I. La Rivers in March, 1951 (Dexter, 1956).

Type Locality.—East McNett Place, Fish Lake Valley, Esmeralda County, NV, USA (Dexter, 1956).

Diagnosis.—Male: Second antenna proximal antennomere with basal posteriomedial apophysis and with inconspicuous spines spaced along its medial side; second antenna distal antennomere curved medially, with a major inflexion localized in median proximal part, somewhat flattened, with apex not recurved; cercopods not converging, set with plumose setae along median and lateral margins.

Female: First antenna longer than second antenna; thoracic dorsal side with no lobes; cercopods as in male; ovaries biramous with lateral oviduct positioned at the beginning of second genital segment; amplexial groove undifferentiated, brood pouch cylindrical with no complimentary structures to receive the male second antennae during amplexus, tip ending under second or third abdominal segment (fourth or fifth apodous segments).

Egg: Spherical, with minute cortical crests.

Distribution in Mexico.—Baja California (Norte) from temporary waters situated in the middle part of the state (Brown et al., 1993; Maeda-Martínez et al., 1997, 2002a; Obregón-Barboza et al., 2002). Besides Laguna Chapala and Laguna

Table 1. Comparison of morphological diagnostic characteristics of four *Branchinecta* species from the Baja California Peninsula, Mexico.

Diagnostic feature	<i>B. gigas</i>	<i>B. lindahli</i>	<i>B. mackini</i>	<i>B. sandiegonensis</i>
Male second antenna proximal antennomere	with no processes, tubercles, or denticulations	with pulvillus on proximal anteromedian side	with apophysis on proximal posteriomedial side and spines along medial side	with pulvillus on proximal anteromedian side
Male second antenna distal antennomere	apex blunt and twisted at right angle	apex spatuled, medially recurved, dorsal border not depressed	apex not recurved	apex spatuled, medially recurved, dorsal border depressed
First thoracopod endopod	with chitinized hooked spines on distal medial margin	with plumose setae on distal medial margin	with plumose setae on distal medial margin	with plumose setae on distal medial margin
Female first antenna	shorter than second antenna	shorter than second antenna	longer than second antenna	shorter than second antenna
Female dorsal side	without lobes	with a pair of lobes on thoracic segments 4 to 9, and sometimes first genital segment	without lobes	with two pairs of lobes on thoracic segments 3 to 8
Brood pouch	tip ending under first or second abdominal segment	tip ending under fourth or fifth abdominal segment	tip ending under second or third abdominal segment	tip ending under fourth or fifth abdominal segment
Egg	external surface spinulose without crests	external surface with cortical crests forming polygonal areas	external surface with minute cortical crests	external surface with cortical crests forming hemispherical areas

El Islote, *B. mackini* has been registered in a pond 45 km S of these lakes (Maeda-Martínez et al., 1997).

General Distribution.—Widely distributed in western North America, from Canada in Alberta and Saskatchewan, and from the USA in California, Nebraska, Nevada, New Mexico, Oregon, and Washington (Dexter, 1956; Belk, 1975; Eng et al., 1990; Belk and Brtek, 1995; Jass and Klausmeier, 2000; Lang and Rogers, 2002).

Material Examined.—MEXICO: BAJA CALIFORNIA (NORTE): Laguna Chapala, Km 230, Federal highway No. 1, San Quintín-Guerrero Negro, 29°25'23"N, 114°25'38"W, 21.01.1995, H. García, CIB-060, 532 males, 337 females; 28.03.2011, 13.2°C, TDS 0.2 g/l, A. Maeda, CIB-773, 322 males, 214 females; from culture, 12.03.2001, CIB-774, 25 males, 22 females; 15.02.2002, CIB-775, 58 males, 71 females. Laguna El Islote, 5 km W Laguna Chapala, 29°21'33"N, 114°25'37"W, 28.03.2011, 17.3°C, TDS 0.3 g/l, A. Maeda, CIB-776, 254 males, 602 females. Km 29, highway to Bahía Los Angeles, from Federal highway No. 1, 29°32'47"N, 113°49'06"W, 21.01.1995, H. García, CIB-063, 14 males, 24 females. Km 39, highway to Bahía Los Angeles, from Federal highway No. 1, Laguna Agua Amarga, 29°02'02"N, 113°47'22"W, 21.01.1995, H. García, CIB-139, 245 males, 390 females.

Branchinecta sandiegonensis Fugate, 1993

Branchinecta sandiegonensis Fugate, 1993: Fugate (1993), Brown et al. (1993), Maeda-Martínez et al. (2002a), Obregón-Barboza et al. (2002).

Type Material.—Holotype, allotype, and paratypes deposited in the United States National Museum, Smithsonian Institution (USNM-256556-256558) (Fugate, 1993).

Type Locality.—Network of vernal pools in Del Mar Mesa, San Diego County, CA, USA (Fugate, 1993).

Diagnosis.—Male: Second antenna proximal antennomere with pulvillus on anteriomedial side near proximal end, and covered by minute spinules and scales; second antenna distal antennomere compressed, curved medially, with a major inflexion localized in median proximal parts; distal antennomere apex a spatule like projection, concave on ventral side, posterior edge with rasplike surface, and dorsal subterminal border depressed; cercopods not converging, set with plumose setae along median and lateral margins.

Female: First antenna shorter than second antenna; thoracic segments 3 to 8 with, on both sides, a pair of dorso-lateral conical lobes covered by cuticular denticles; cercopods as in male; ovaries biramous with lateral oviduct positioned at the beginning of second genital segment; amplexial groove undifferentiated, brood-pouch cylindrical with no complimentary structures to receive the male second antennae during amplexus, tip ending under fourth or fifth abdominal segment (sixth or seventh apodous segments).

Egg: Spherical, with cortical crests separated by hemispherical depressions.

Distribution in Mexico.—Baja California (Norte) (Brown et al., 1993; Fugate, 1993; Maeda-Martínez et al., 2002a; Obregón-Barboza et al., 2002).

General Distribution.—Endemic from southern California in Santa Barbara and San Diego counties, USA, and northern Baja California (Norte), Mexico (Brown et al., 1993; Fugate, 1993).

Material Examined.—MEXICO: BAJA CALIFORNIA (NORTE): Km 70, Federal highway No. 1, Tijuana-Ensenada, La Misión, 32°05'37"N, 116°51'45"W, 13.03.2011, H. García, CIB-778, 08 males, 05 females. Ejido El Porvenir, road to El Tigre, 32°04'58"N, 116°36'20"W, 15.11.2010, H. García, CIB-777, 09 males. Km 73, Federal highway

Tijuana-Ensenada, 1 km Salina, 32°02'54"N, 116°52'43"W, 20.03.2011, H. García, CIB-779, 06 males, 04 females.

DISCUSSION

The four species of *Branchinecta* of the Baja California Peninsula can be easily differentiated morphologically (Table 1); *B. gigas* has a much larger body size, and its male second antenna antennomeres devoid of processes, tubercles, or denticulations (Fig. 2A, B) (Lynch, 1937); *B. mackini* is the only one with the male second antenna bearing an apophysis, the female first antenna longer than the second antenna, and the female thoracic dorsal surface lacking lobes (Dexter, 1956; Eriksen and Belk, 1999); *B. lindahli* and *B. sandiegonensis* have a similar pulvillus at the basal part of the male second antenna proximal antennomere, but different distal antennomere morphology; in *B. lindahli* the apex is curved strongly, and its dorsal subterminal border has a depression, whilst in *B. sandiegonensis* the apex is not strongly curved, and its dorsal subterminal border is depressed (Fugate, 1993; Eriksen and Belk, 1999); the *B. lindahli* female has a pair dorsolateral lobes on the thoracic segments 4 to 9, and sometimes first genital segment, whilst the *B. sandiegonensis* female has a two pairs on the thoracic segments 3 to 8 (Fugate, 1993; Eriksen and Belk, 1999; Rogers, 2002; Simovich et al., 2013).

The four species can co-occur in space and time along the range of their geographical distributions (Daborn, 1975, 1977; Eng et al., 1990; Eriksen and Belk, 1999; Rogers, 2014). According to Rogers (2014), *B. gigas* has been reported in three North American anostracan bioregions, Southwest Arid, Great Plains, and Cold Deserts, *B. lindahli* in five, Southwest Arid, Great Plains, Californian, Cold Deserts, and Transmontane, *B. mackini* in three, Southwest Arid, Californian, and Cold Deserts, and *B. sandiegonensis* in one, Southwest Arid. The peninsular sites where the four taxa of *Branchinecta* occur represent their southernmost distributional records. With the new records of *B. gigas* in Mexico, the geographical range of this species is extended in about 570 km south from San Bernardino, California, USA. Thus, the number of species of *Branchinecta* from Mexico is increased to eight (*B. belki*, *B. lindahli*, *B. gigas*, *B. mackini*, *B. mexicana*, *B. packardi*, *B. oterosanicventei*, and *B. sandiegonensis*). We consider that the inventory of the anostracans of Mexico is incomplete because there are large areas such as the northern parts of the states of Sonora, Chihuahua, Coahuila, and Tamaulipas that have not been studied properly.

The large branchiopod species assemblage that occurs during winter and spring in Laguna Chapala and Laguna El Islote is unique among the species groups of Mexican temporary wetlands. These lakes are hitherto the only known habitats in the whole country where the tadpole shrimp *L. lemmoni* (Maeda-Martínez et al., 1997, 2002c), and the giant fairy shrimp *B. gigas* occur. The diversity of large branchiopods in these lakes, considering both the warm and cold water species assemblages, is composed of at least of three anostracans, two notostracans, and one spinicaudatan. During summer, these peninsular systems support a warm water species assemblage composed of the anostracan *Thamnocephalus platyurus* Packard, 1877, a notostracan *Triops* sp.,

and the spinicaudatan *Leptestheria compleximanus* Packard, 1877 (Maeda-Martínez et al., 2002a, b, c). These assemblages can be used as models to study through international initiatives the ecology, evolution, and conservation of crustacean meta-populations and meta-communities from western North America.

Finally, the data presented in this paper on distinct biological resources should call the attention of the general society and Mexican authorities to provide proper protection and also support for more scientific studies on these important wetland systems.

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