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Records of mud shrimps (Crustacea: Decapoda: Axiidea and Gebiidae) from Pacific Mexico

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A total of 75 specimens belonging to four species of thalassinoids were collected in the intertidal and estuarine zones of two localities along the Pacific coast of Mexico. Callianassa tabogensis *is recorded for the first time in Mexico, and is transferred to the genus* Neotrypaea. *Material of* Callichirus *is assigned to* Callichirus seilacheri *with some doubts due to taxonomic problems related to this genus in the eastern Pacific.* Neocallichirus *cf.* grandimana*, an amphi-American species described for the western Atlantic and previously reported in Ecuador and along the Pacific coast of Panama and Colombia, is reported for the first time in Mexico.* Upogebia dawsoni *is recorded for the second time from the coast of Jalisco. An updated list of Axiidea and Gebiidea known from the Mexican Pacific is provided, including 35 species.*

Keywords: mud shrimps, Axiidea, Gebiidae, new records, Mexican Pacific

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INTRODUCTION

Mud shrimps (also known as ghost or mud lobsters) is a heterogeneous group of decapod crustaceans whose systematics and classification have long been a puzzling issue for carcinologists. Most species burrow in muddy or muddy–sandy substrates, although they are also found among coral rubble and in burrows in harder substrates (e.g. among pebbles on muddy or sandy substrate and in coral reefs). They play an important role in the structure of many soft-bottom benthic communities (Posey, 1986; Wynberg & Branch, 1994). Some species are typically found on muddy flats near river estuaries or mangrove forests, where they make their burrows and often form extremely high densities, but they have been found in water deeper than 2000 m (Brusca & Brusca, 2002; Robles *et al.*, 2009). Known until recently as the 'Thalassinidea', these lobster-like decapods have been moved from one infraorder to another. Following opinions of several authors who addressed both morphological and molecular issues related to the Thalassinidea (e.g. Gurney, 1942; de Saint Laurent 1979a, b; Sakai, 2004, 2005; Tsan *et al.*, 2008) (see De Grave *et al.*, 2009 for further information), Robles *et al.* (2009) conducted an extensive review of the group based on the analysis of ~1800 nuclear and 550 mitochondrial characters. They confirmed the paraphyletic nature of the group and suggested recognition of two well defined clades (as previously defined by de Saint Laurent, 1979b): the Axiidea de Saint Laurent, 1979b, and the Gebiidea de Saint Laurent, 1979b. In their classification of the decapod crustaceans genera, De Grave *et al.* (2009) enlisted nine families of Axiidea (estimated number of extant species: 423) and four families of Gebiidea (192 species). Ahyong *et al.* (2011), however, provided a different classification, recognizing two superfamilies (i.e. Axioidea and Callianassoidea) within the Axiidea and providing a family category for several subfamilies enlisted by De Grave *et al.* (2009), thus accounting for as many as 19 families of Axiidea. It should be noted, however, that some conclusions obtained by Robles *et al.* (2009; e.g. merging of Thomassiniidae into Callianideidae) were not followed either by De Grave *et al.* (2009) or Ahyong *et al.* (2011). Evidently, further analysis of phylogenetic relationships among the Axiidea and Gebiidea is needed before a universally accepted classification can be established.

As a group, the Thalassinidea have been extensively reviewed or studied by a large series of authors (e.g. Poore, 1994; Tudge *et al.*, 2000; Tudge & Cunningham, 2002; Tsang *et al.*, 2008; Robles *et al.*, 2009). Most significant contributions on American species were written by Williams (1986), Manning & Felder (1991), Felder (2001, 2003), Felder & Robles (2009) and Kensley & Heard (1990). Another series of contributions by Sakai (Sakai & de Saint Laurent, 1989; Sakai, 1999, 2005, 2006, 2011) provided a large body of information and some valuable illustrations for many species distributed worldwide. There were, however, some clear differences between the classification adopted by the 'American school' and the opinions of Sakai, particularly in what concerns the family Callianassidae s.l. (see Felder & Robles, 2009).

Checklists for mud shrimps of the Pacific coast of America have been provided by Lemaitre & Ramos (1992; 12 species for Pacific Colombia and 47 for the eastern Pacific), Hendrickx

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(1993; 25 species for Mexican Pacific, 1995a; 47 species for the eastern tropical Pacific, 2005b; 19 species for the Gulf of California) and Campos *et al.* (2009). Records, based on freshly collected material, museum collections and literature records, however, were occasionally incomplete or somewhat misleading, due to the complexity of the taxonomy of the group. Consequently, an updated list of mud shrimps of the Mexican Pacific is wanting.

As pointed out by Dworschak (2000, 2005), the number of recognized species of mud shrimps increased by ~7.7% between 1998 and 2004, but at that time as many as 20% of these species were known from a single specimen and many had not been recorded again in the 50 years following their description. Due to their cryptic and burrowing habits, and because large areas of the tropical coast along the American Pacific have been largely underexplored, a substantial increase in marine diversity and species distribution range is to be expected once the soft bottom habitats of this region are properly sampled. This contribution reports on samples of mud shrimps collected along the Pacific coast of Mexico, including the detailed description of the material obtained for three species: *Neotrypaea tabogensis* (Sakai, 2005), *Callichirus* cf. *seilacheri* (Bott, 1955) and *Neocallichirus* cf. *grandimana* (Gibbes, 1850).

MATERIALS AND METHODS

A reviewed and updated list of species of mud shrimps from Pacific Mexico is provided based on previous contributions by Hendrickx (1993, 1995a, 2005b) and literature published later than 1995 for the eastern Pacific. The generic sequence proposed by De Grave *et al.* (2009) is followed and adapted to the family sequence proposed by Ahyong *et al.* (2011). In the list of species, major or updated sources of information are provided.

The material examined during this work was collected using a simple 'yabby pump' in several localities of western Mexico. A total of three localities were visited: Isla de la Piedra, on the southern limit of Mazatlán, Sinaloa; Bahía Chamela, Jalisco; and Estero de Pérula, Bahía Chamela, Jalisco. All the specimens have been deposited in the Regional Collection of Marine Invertebrates (EMU), Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México (UNAM), in Mazatlán, Mexico and in the Reference Collection of the Laboratorio de Ecosistemas Marinos y Acuicultura (LEMA-CR), Centro Universitario de Ciencias Biológicas y Agropecuarias (CUCBA-UDG), in Zapopan, Jalisco, Mexico.

Terminology generally follows that of Sakai (1999, 2005). The measurements (in mm) used are total length (TL), from the tip of carapace to the end of telson, and carapace length (CL), from the orbit to the posterior margin of carapace. To avoid confusion all geographical names are in their original spelling.

RESULTS

According to previous records, eight families of Axiidea and two families of Gebiidea (*sensu* Ahyong *et al.*, 2011) have representatives along the coast of Pacific Mexico (Appendix). Previous to this study, a total of 33 species had been recorded in the area, and two species are now added to the list: *Neotrypaea tabogensis*, so far known only from Panama, and *Neocallichirus* cf. *gandimana,* reported from Colombia and Ecuador. Additional records are provided for a species very close to *Callichirus seilacheri* and for *Upogebia dawsoni* Williams, 1986.

SYSTEMATICS

Infraorder AXIIDEA de Saint Laurent, 1979
Superfamily AXIOIDEA Huxley, 1879
Family CALLIANASSIDAE Dana, 1852
Neotrypaea tabogensis (Sakai, 2005) comb. nov.
(Figures 1–4)

Callianassa tabogensis Sakai, 2005; 59, figures 11–12.
Callianassa biffari.– Holthuis, 1991; 242 (partim).
Trypaea tabogensis.– Sakai, 2011; 409.

MATERIAL EXAMINED

Holotype: ♂ TL 21.0 mm, northern coast of Taboga, Bahía de Panamá (ZMUC CRU-3772, Zoological Museum, Copenhagen). 3 ovigerous ♀, TL 21.5–23.2 mm, CL 5.0–5.7 mm, Estero de Pérula, Bahía Chamela, Jalisco, Mexico, 19°36′16″N 105°08′09″W, intertidal, muddy bottom, LEMA-CR-52, 28/11/2011. 2 ovigerous ♀, TL 23.2–26.6 mm, CL 5.7–5.9 mm, same locality, EMU-9590. 3 ♀, TL 12.8–16.1 mm, CL 4.3–3.5 mm, and 2 juveniles, TL 8.7–10.6 mm, CL 2.6–2.8 mm, Estero de Pérula, Bahía Chamela, Jalisco, Mexico, 19°35′09″N 105°08′08″W, intertidal, sandy mud, EMU-9591, 29/11/2011. 7 adult ♂, TL 20.4–29.0 mm, 11 ovigerous ♀ TL, 18.5–29.5 mm, Estero de Pérula, Bahía Chamela, Jalisco, Mexico, 19°35′06″N 105°08′07″W, intertidal, sandy, EMU-9873, 06/03/2013. 1 adult ♂, TL 29 mm, CL 6.3 mm, Estero de Pérula, Bahía Chamela, Jalisco, Mexico, 19°35′06″N 105°08′07″W, intertidal, sandy, EMU-9874, 07/03/2013. 2 adult ♂, TL 23.2–30.2 mm, CL 4.6–6.4 mm, 1 ovigerous ♀, TL 32 mm, CL 6.2 mm, Estero de Pérula, Bahía Chamela, Jalisco, Mexico, 19°35′06″N 105°08′07″W, intertidal, sandy, 06/03/2013, EMU-9875. 2 adult ♂ TL, 32 mm, CL 7.4 mm, 3 ovigerous ♀, TL 27–33 mm, CL 6–7 mm, Estero de Pérula, Bahía Chamela, Jalisco, Mexico, 19°35′06″N 105°08′07″W, intertidal, sandy, 07/03/2013, LEMA-CR-55.

DESCRIPTION

Carapace with dorsal oval (Figure 1A–C); rostrum short, blunt, triangular or ending in minute spine, overreached by the eyestalks almost their full length. Eyestalks triangular, convergent distally, reaching about to distal end of antennular basal segment, dorsal surface convex; cornea rounded, located subdistally, pigmented black in alcohol specimens. Antennal angles low, rounded, unarmed, shorter than rostrum.

Antennular peduncle (Figure 1A–C) distinctly longer than antennal one, terminal segment 2 times length of penultimate segment. Antennal terminal segment as long as penultimate; antennal flagellum 4 times as long as antennular flagella.

Third maxilliped (Figure 1D, E) with ischium–merus operculiform, without exopod; basis with 1 spine on inner face; ischium as long as broad, with crista dentata on inner face (11–13 denticles); merus subtriangular, 1.3 times wider

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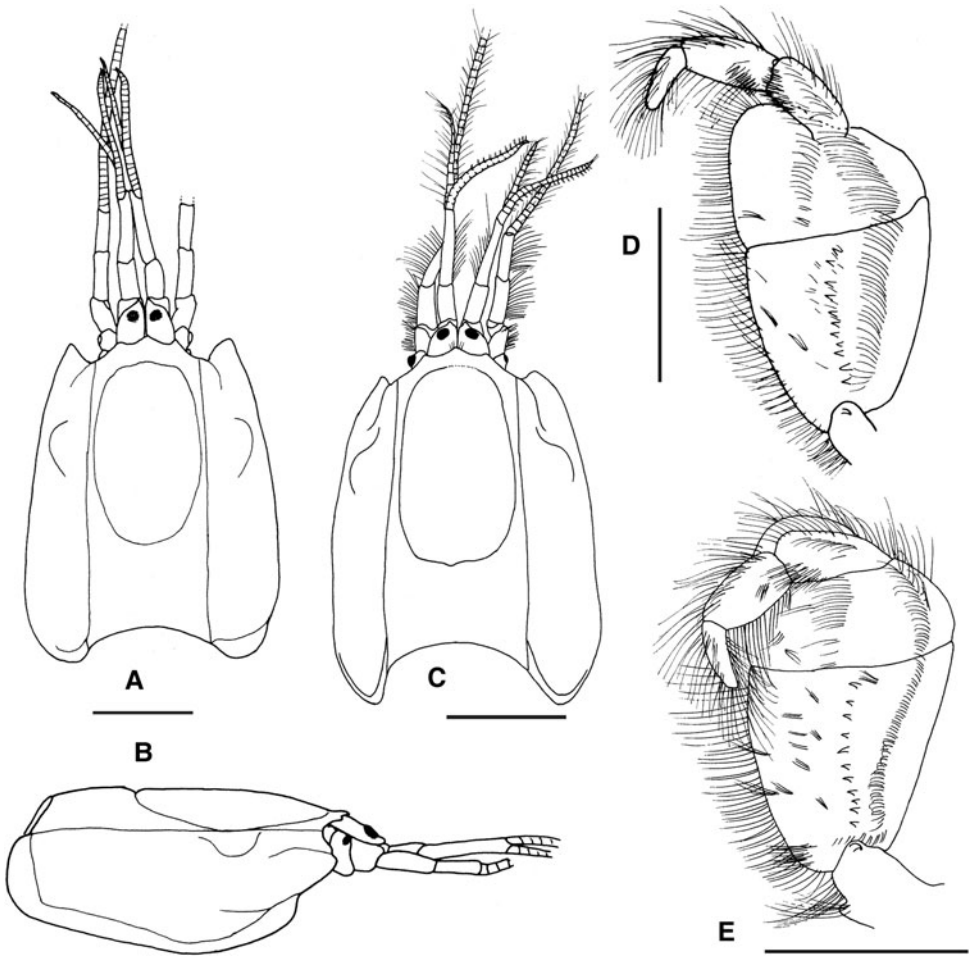

Fig. 1. *Neotrypaea tabogensis* (Sakai, 2005). (A, B, D) male (carapace length (CL) 6.3 mm) (EMU- 9874); (C, E) female (CL 5.7 mm) (EMU-9590): (A, C) carapace and cephalic appendages, dorsal view; (B) carapace and cephalic appendages, lateral view; (D, E) third maxilliped, inner view. Scale bars: 2.0 mm.

than long. Carpus, propodus and dactylus pediform; merus subtriangular, twice as long as broad; propodus subrectangular, almost twice as long as broad; dactylus digitiform, 0.8 times as long as propodus.

Male first pereopods unequal, dissimilar. Major cheliped (Figure 2A, B) massive; ischium slender; dorsal margin slightly concave and unarmed, ventral margin with a row of 9–12 denticles, outer face with five small granules proximally. Merus sligthly longer than ischium, twice as long as high, dorsal margin slightly arcuate and denticulate in proximal half; ventral margin with sharply pointed proximal lobe, exterior surface convex in upper half, concave around basal part of proximal lobe; proximal lobe denticulate on ventral margin. Carpus broadened, 1.25–1.50 times as long as high, largely rounded on posteroventral margin, ventral margin with very small granules or denticles. Chela heavy, about as long as carpus; palm 0.60–0.70 times as long as carpus, about as high as long; dorsal margin smooth, ventral margin with small granules or denticles, distal gap convex with one or several denticles above broad concavity at the base of fixed finger, fixed finger 0.70 times to about as long as palm, prehensile margin smooth; dactylus distinctly incurved downward distally, prehensile margin with a thick subtruncate tooth on proximal half. Minor cheliped (Figure 2C) as in female.

Female first pereopods unequal, similar in armature (Figure 3A–C). Major cheliped with ischium as long as merus, broader distally, unarmed. Merus twice as long as broad, ventral margin with 1 strong median tooth and usually 1 minute tooth posterior to it, several small granules anterior to larger tooth. Carpus longer than wide, 1.3 times length of palm, proximal margin convex ventrally. Palm longer than wide, smooth, ventral and dorsal margins with tufts of setae, setae longer ventrally. Dactylus slightly shorter than palm, incurved distally, tip acutely pointed; prehensile margin with a few minute denticles; fixed finger 0.6 times as long as palm, prehensile margin denticulated on proximal half, tip acutely pointed. Minor cheliped with ischium slightly longer than merus, unarmed. Merus more than twice as long as wide, ventral margin with 1 strong median tooth. Carpus 2.5 times longer than wide, twice as long as palm. Dactylus slender, incurved distally, almost as long as palm; prehensile margin unarmed, tip acutely pointed. Fixed finger with prehensile margin denticulated or serrated on proximal half, tip acutely pointed.

Second pereopod (Figure 4A) chelate; ischium subquadrate, about as long as broad; merus 3.5 times as long as high and 5 times as long as ischium; carpus 0.7 times as long as merus; chela about as long as carpus, dactylus twice as long as palm. Third pereopod (Figure 4B) ischium twice as long as broad; merus more than 2.5 times as long as ischium and 2.8 times as long as high; carpus subtriangular, 0.8 times as long as merus; propodus bean-shaped, slightly

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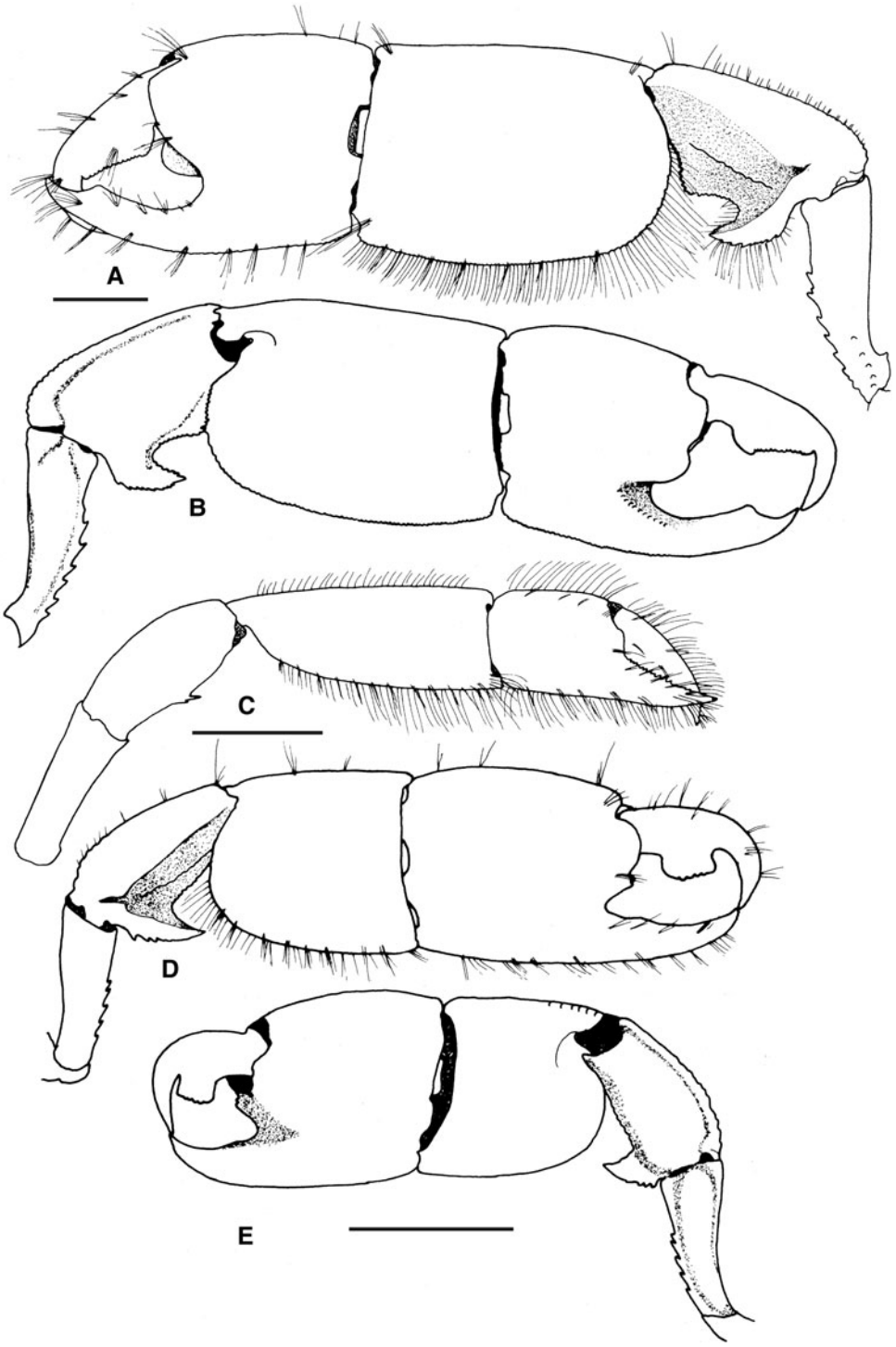

Fig. 2. *Neotrypaea tabogensis* (Sakai, 2005). (A–C) male (carapace length (CL) 6.3 mm) (EMU- 9874); (D, E) holotype male (CL 4.1 mm) (ZMUC CRU-3772): (A, D) major cheliped, outer view; (C) minor cheliped, outer view; (B, E) major cheliped, inner view. Scale bars: 2.0 mm.

higher than long, postero-ventral margin roundly protruded, lateral surface setose; dactylus as long as palm, pointed at tip. Fourth pereopod (Figure 4C) simple; ischium 2 times as long as high, merus 1.8 times as long as ischium; carpus 0.8 times as long as merus; propodus rectangular, 0.8 times as long as carpus, lateral surface setose, ventrodistal corner not protruded; dactylus half the length of propodus, setose on external surface. Fifth pereopod (Figure 4D) subchelate; merus 3 times as long as ischium, carpus 0.7 times as long as merus, propodus slightly shorter than carpus, forming a short fixed finger ventrodistally; dactylus hooked towards external side of fixed finger, tip incurved.

Pleomeres smooth, glabrous dorsally; pleura 3–5 each with a tuft of setae laterally; pleomere 6 smooth, as long as wide, slightly convergent posteriorly to posterior fourth on lateral margins.

Male pleopod 1 uniramous (Figure 4E), 2-segmented. Pleopod 2 absent. Pleopods 3–5 biramous, foliaceous, each

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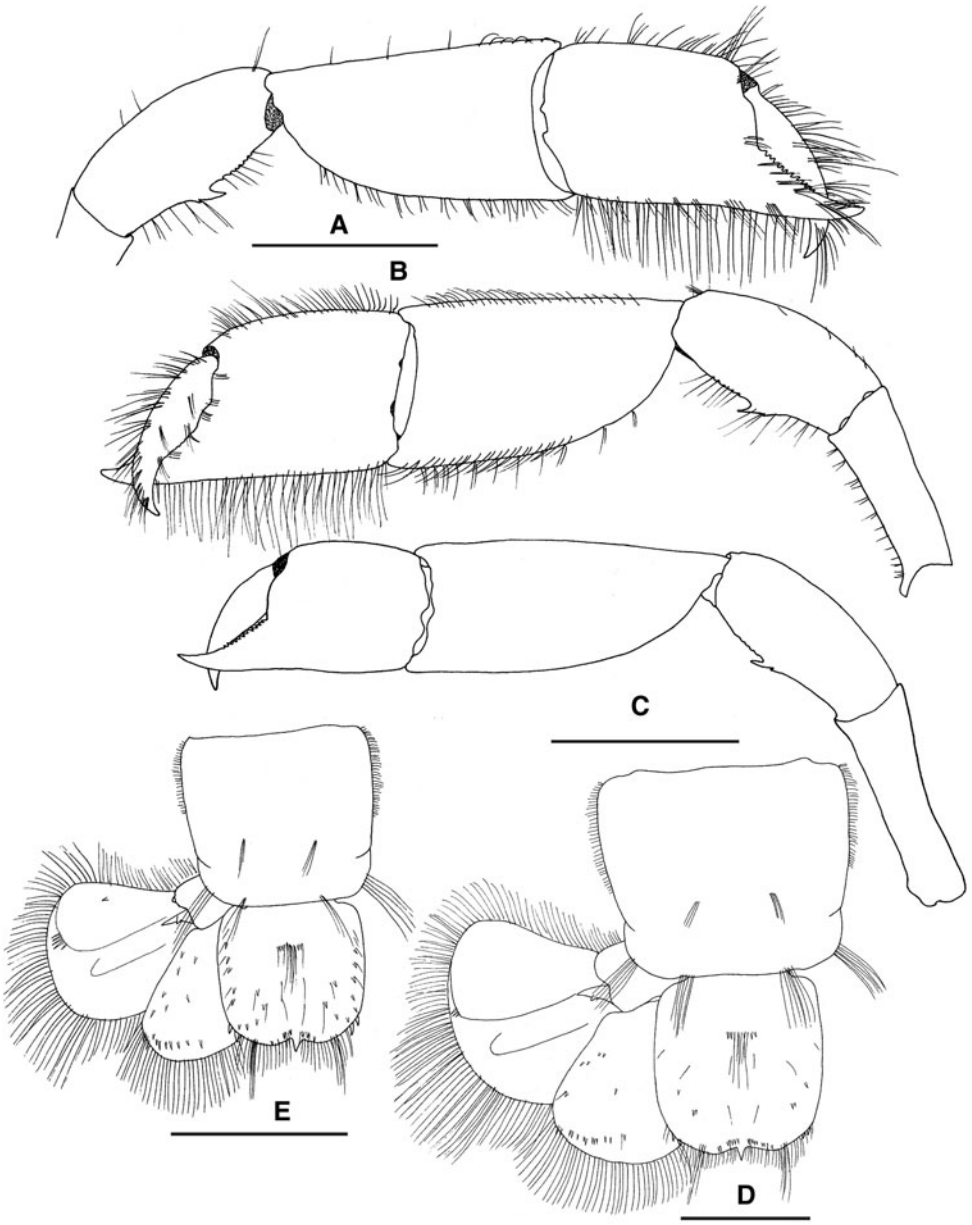

Fig. 3. *Neotrypaea tabogensis* (Sakai, 2005). (A–C) female (carapace length (CL) 5.7 mm) (EMU-9590); (D) male (CL 6.3 mm) (EMU- 9874); (E) holotype male (CL 4.1 mm) (ZMUC CRU-3772): (A) major cheliped, outer view; (B) major cheliped, inner view; (C) minor cheliped, outer view; (D, E) telson and uropods, dorsal view. Scale bars: 2.0 mm.

bearing a small, triangular embedded appendix interna on the mesial margin of the endopod.

Female pleopod 1 uniramous (Figure 4G), 2-segmented. Pleopod 2 biramous (Figure 4F). Pleopods 3–5 as in male (Figure 4H). Telson (Figure 3D) about as long as wide, gradually narrowing posteriorly; posterolateral angles rounded, each with 2 spiniform setae; posterior margin convex, slightly concave medially, 1 small triangular median spine; dorsal surface medially with a transverse row of setae in proximal third, some minute spiniform setae on distal third near the lateral margins, a row of few spiniform setae near the median posterior margin. Uropodal exopods each with 1 small dorsal spine, truncate distally, larger than endopod, dorsal surface bearing line of spiniform setae. Uropodal endopods rounded distally, slightly longer than telson, dorsal surface with a row of spiniform setae near the posterior margin.

REMARKS

The original description by Sakai (2005) is based on a single male from Taboga, Bahía de Panama. The material from Jalisco examined herein included mature (ovigerous) females, males, and juveniles. The male specimens were compared to the Sakai (2005) illustrations and description. In addition, the holotype of *Callianassa tabogensis* from Panama was available for re-examination. The males from Jalisco are very close to the holotype of *C. tabogensis* and only small differences were observed, in particular in the major cheliped. Males from Jalisco feature a proportionally slightly longer carpus than *C. tabogensis*, the cutting edge of the dactylus has a considerably longer tooth than the holotype, and the ventral margin of the merus features a shallow, distal denticulate lobe not found in *C. tabogensis* from Panama. The ventral margin of major cheliped carpus and propodus of both large and small

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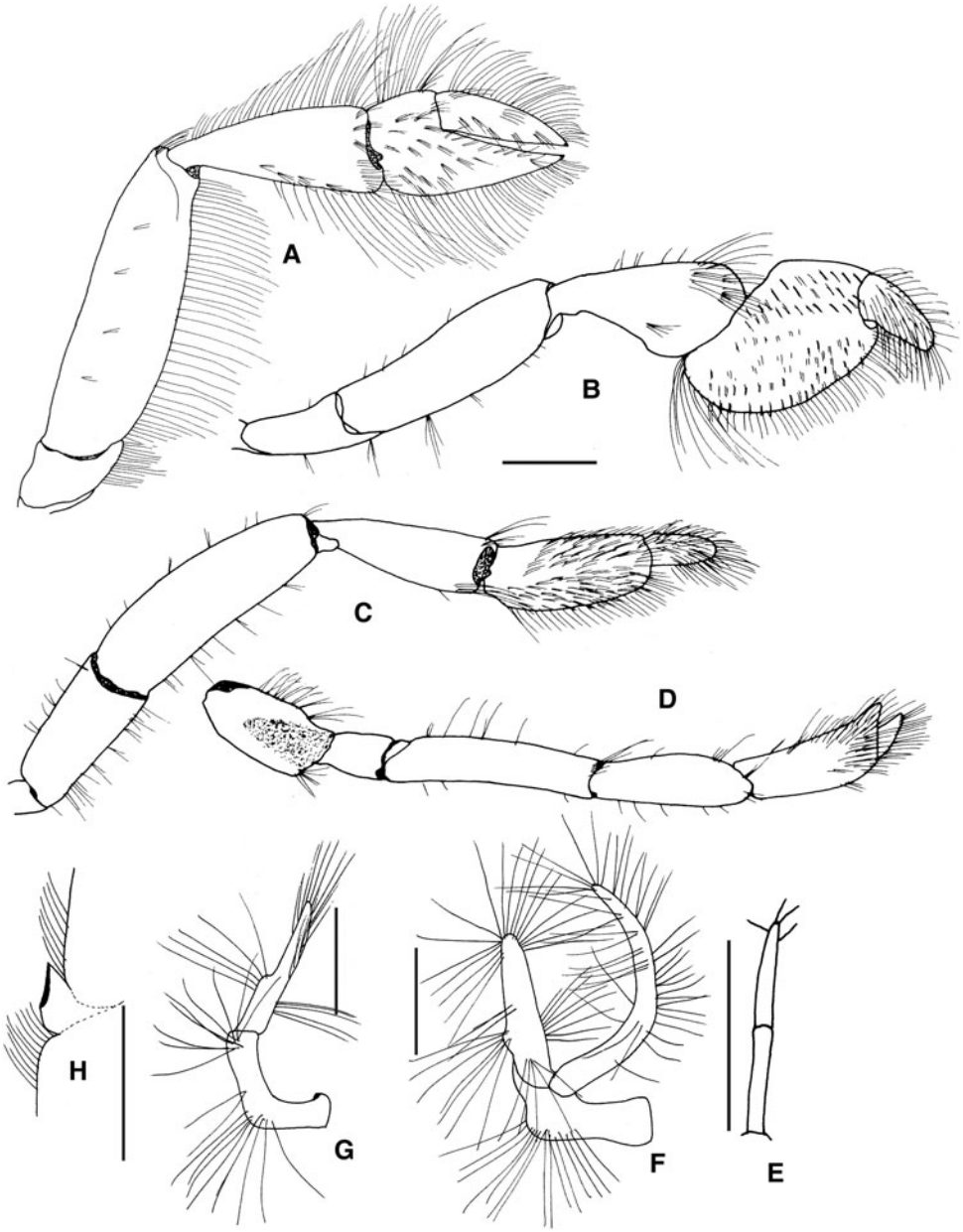

Fig. 4. *Neotrypaea tabogensis* (Sakai, 2005). (A–E) male (carapace length (CL) 6.3 mm) (EMU- 9874); (F–H) female (CL 5.7 mm) (EMU-9590): (A), second pereopod, outer view; (B) third pereopod, outer view; (C) fourth pereopod, outer view; (D) fifth pereopod, outer view; (E) first pleopod; (F) second left pleopod; (G) first left pleopod; (H) appendix interna, third left pleopod. Scale bars: 1 mm.

males from Jalisco is minutely granulated, a character not seen in the holotype of *C. tabogensis* (see Figure 2D, E). There are, however, too many similarities between the material from Panama and Jalisco for considering the latter as belonging to a different, undescribed species. Additional material from or near the type locality in Panama, specially a large series of mature males, would be necessary in order to re-evaluate the status of the material from Jalisco, including a comparative molecularly based analysis.

The diagnosis provided by Manning & Felder (1991; 771) for the genus *Neotrypaea* Manning & Felder, 1991, includes the following characters: no rostral spine; antennular peduncle longer (and stouter) than antennal peduncle; no exopod on maxilliped 3, ischium–merus operculiform, merus projecting beyond its articulation with carpus; chelipeds unequal, ventral hook on merus; pleopod 1 uniramous; pleopod 2 biramous, without appendices internae; pleopods 3–5 foliaceous, appendices internae stubby, embedded in endopod margin. The characters seen in the specimens examined herein and in the figures provided by Sakai (2005; figures 11, 12) indicate that *tabogensis* belongs to the genus *Neotrypaea sensu* Manning & Felder (1991). The material also keys out to *Neotrypaea* in keys provided by Manning & Felder (1991; 766) and Poore (1994; 101) for the Callianassidae. Sakai (2011; 409) included *tabogensis* in the genus *Trypaea* Dana, 1852, which he considered a junior synonym of *Neotrypaea*. We prefer, however, to include *tabogensis* in *Neotrypaea*, thus following the criteria used by Manning & Felder (1991) for American representatives of '*Callianassa*' Leach, 1814.

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Callichirus cf. *seilacheri* (Bott, 1955)
(Figures 5–7)

Callianassa seilacheri Bott, 1955; 47, figure 7a–g.
Callichirus seilacheri.- Manning & Felder, 1986; 439, figure 3, 1991; 775, figure 6, Lemaitre & Ramos, 1992; 357, Hendrickx, 1995a; 157, 1995b; 390, Sakai, 1999; 62, figure 12a–f, 2005; 129, 2011; 422, figure 64F–H, Tudge *et al.*, 2000; 144, figures 1D, 2I (not 2H), Felder & Robles, 2009; 330 (table 1).

MATERIAL EXAMINED

1 adult ♀, TL 52.2 mm, CL 12.2 mm, near mouth of Estero de Pérula, Bahía Chamela, Jalisco, Mexico; 19°05′35″N 105°08′03″W, sandy intertidal, EMU-9592, 28/11/2011. 1 adult ♀, TL 53.5 mm, CL 15.5 mm, same locality, LEMA-CR-53. 2 adult ♂, TL 53.5–97.7 mm, CL 15.6–20.3 mm, and 1 adult ♀, TL 22.0 mm, CL 90.8 mm, Isla de la Piedra, Mazatlán, Sinaloa, Mexico, 23°11′11″N 106°24′38″W, sandy intertidal, EMU-9593, 10/11/2011.

DESCRIPTION OF MEXICAN MATERIAL

Carapace (Figure 5A, B) with dorsal oval; anterior margin with three short, blunt triangular projections; rostrum exceeded by total length of eyestalks. Eyestalks flat, triangular, sharp tip, distally upwardly curved, reaching proximal third of

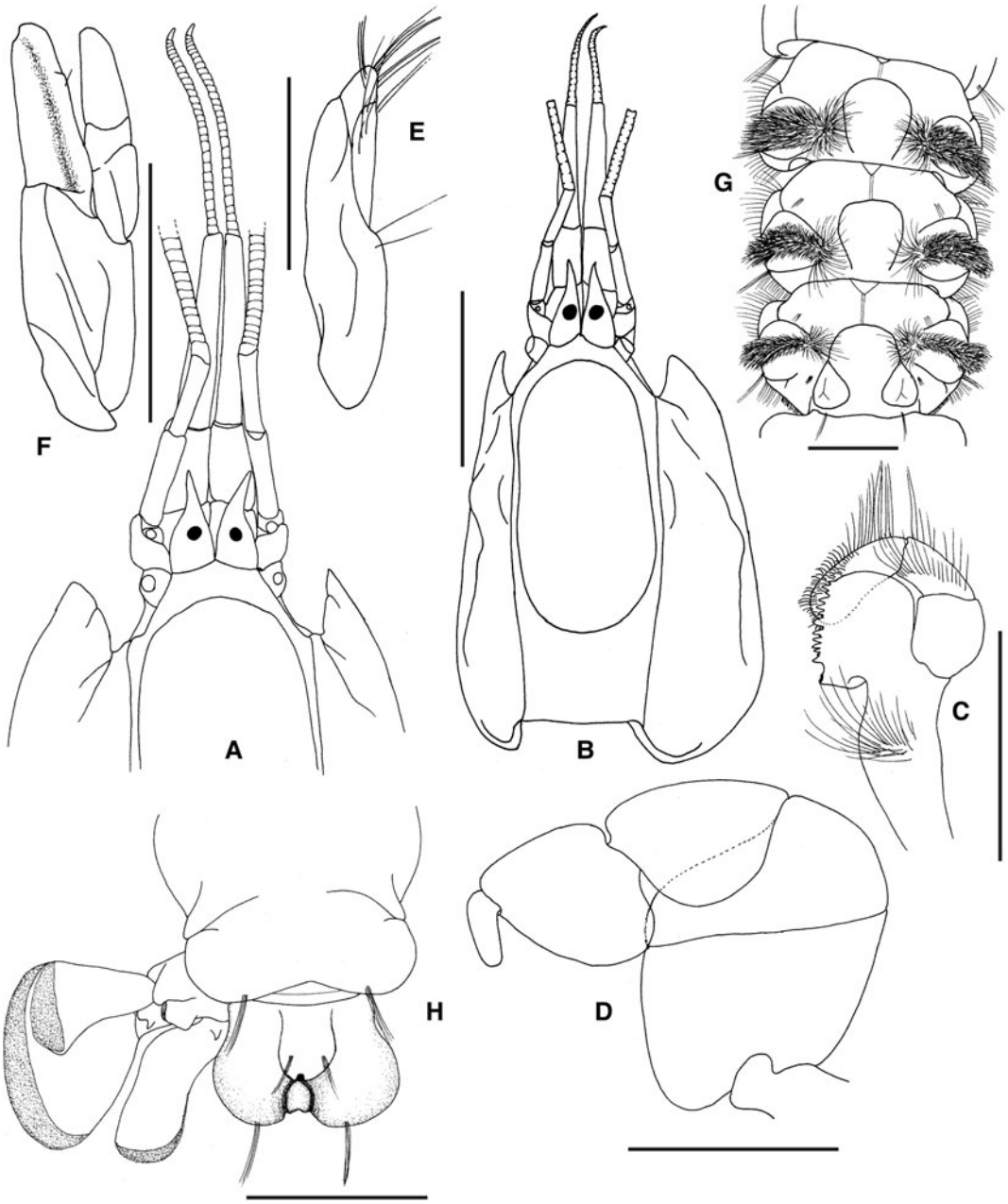

Fig. 5. *Callichirus* cf. *seilacheri* (Bott, 1955). (A, E, F) male (carapace length 20.3 mm) (EMU-9593); (B) female (12.2 mm) (EMU-9592); (C, D, G, H) female (15.5 mm) (LEMA-CR-53): (A) anterior region of carapace and cephalic appendages, dorsal view; (B) carapace and cephalic appendages, dorsal view; (C) left mandible, inner view; (D) third maxilliped, inner view; (E) male first pleopod; (F) male second pleopod; (G) third to fifth abdominal somites, dorsal view; (H) telson and uropod, dorsal view. Scale bars: A, B, D, F H, 5 mm; C, E, 2.5 mm.

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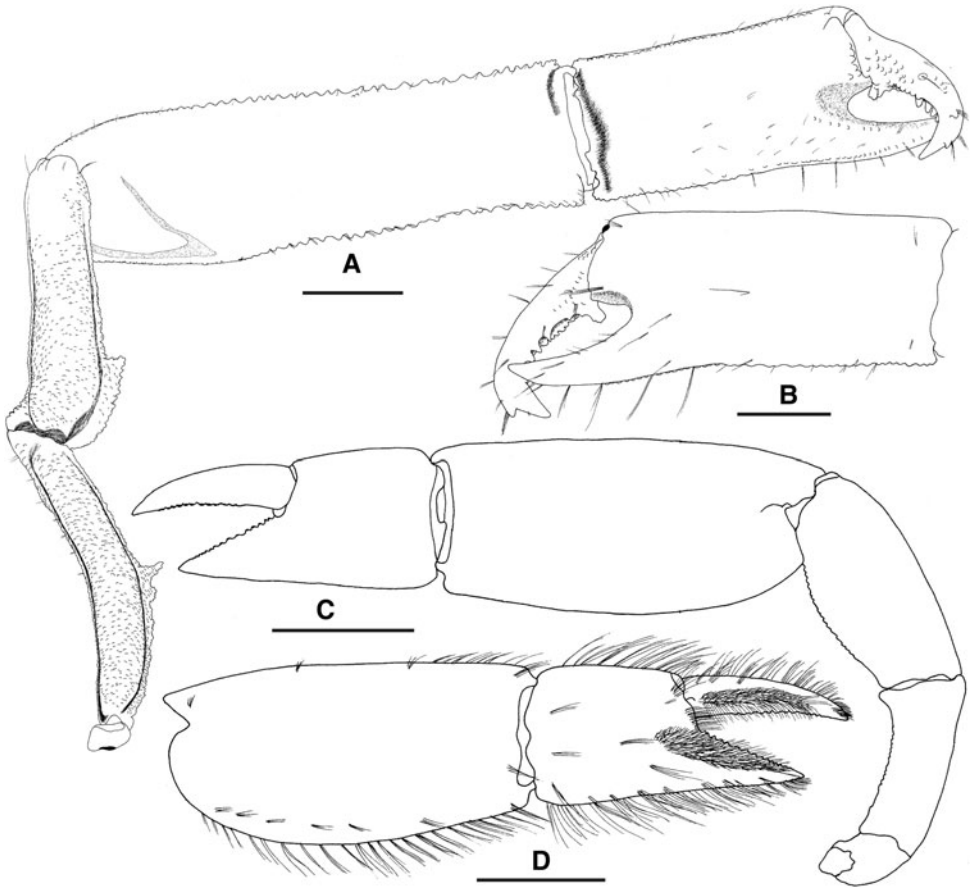

Fig. 6. *Callichirus* cf. *seilacheri* (Bott, 1955), male (carapace length 20. 3 mm) (EMU-9593): (A) major cheliped, inner view; (B) major chela, outer view; (C) minor cheliped, inner view; (D) carpus and chela, minor cheliped, outer view. Scale bars: 5 mm.

penultimate antennular segment, cornea pigmented brown (specimens in ethanol).

Antennular peduncle (Figure 5A, B) 3-segmented, long setae ventrally, ultimate segment twice as long as penultimate, penultimate slightly longer than basal segment. Antennal terminal segment as long as penultimate, reaching proximal third of penultimate antennular segment.

Mandible (Figure 5C) with 3-segmented palp, setae on last two segments. Cutting edge with 10 teeth and with minute teeth interspaced among them. Third maxilliped (Figure 5D) with ischium–merus subquadrate, without exopod; ischium slightly broader than long; merus subtriangular, 1.7 times wider than long, not projecting beyond articulation with carpus; carpus subtriangular, rounded on ventral margin; propodus subrectangular, rounded on ventral margin; dactylus pediform, about 0.6 length of propodus.

First pereopods unequal and dissimilar (in both males examined), subequal in female, very similar in armature. Fingers of male major cheliped (Figure 6A, B) gapping; dactylus strongly curved, exceeding length of fixed finger, tip bifid, prehensile margin with one proximal strong molar tooth fringed with some small tubercles, median surface concave, inner margin with 5–6 small teeth, outer margin with 4 moderately strong teeth on distal half, dorsal surface with 1 strong tubercle on distal third, inner surface with numerous granules or tubercles on proximal third, outer surface with short longitudinal row of small granules proximally; propodus 1.3 times length of dactylus, a row of granules on dorsal margin, ventral margin with submarginal row of granules on proximal half and a row of granules on distal half, a short longitudinal row of granules on inner surface at base of fixed finger, some granules on distal margin of propodus at articulation with dactylus; fixed finger with prehensile margin unarmed; carpus 1.9 times as long as propodus, dorsal and ventral margins with row of granules, granules more conspicuous than on palm, a large, V-shaped decalcified area on inner face, near articulation with merus; merus about 0.5 times length of carpus, decalcified longitudinal groove on dorsal and ventral margins, grooves vanishing distally, ventral margin wider proximally, with row of granules decreasing in size distally and a strong tooth on proximal third, dorsal margin with proximal protuberance and row of granules decreasing in size distally on proximal half, inner and outer surfaces covered with minute granules; ischium curved, slightly longer and more slender than merus, dorsal and ventral margins with row of granules and decalcified longitudinal groove, ventral margin bearing two median teeth, anterior stronger than posterior, inner and lateral surfaces covered with small granules. Minor cheliped (Figure 6C, D) with dactylus slightly longer than palm, exceeding in length to fixed finger; prehensile margin of dactyl with row of corneous teeth and a row of setae; palm subrectangular, slightly longer than high, dorsal and ventral margins with tufts of long setae, dense patch of setae extending from palm distal part onto fixed finger; fixed finger with row of

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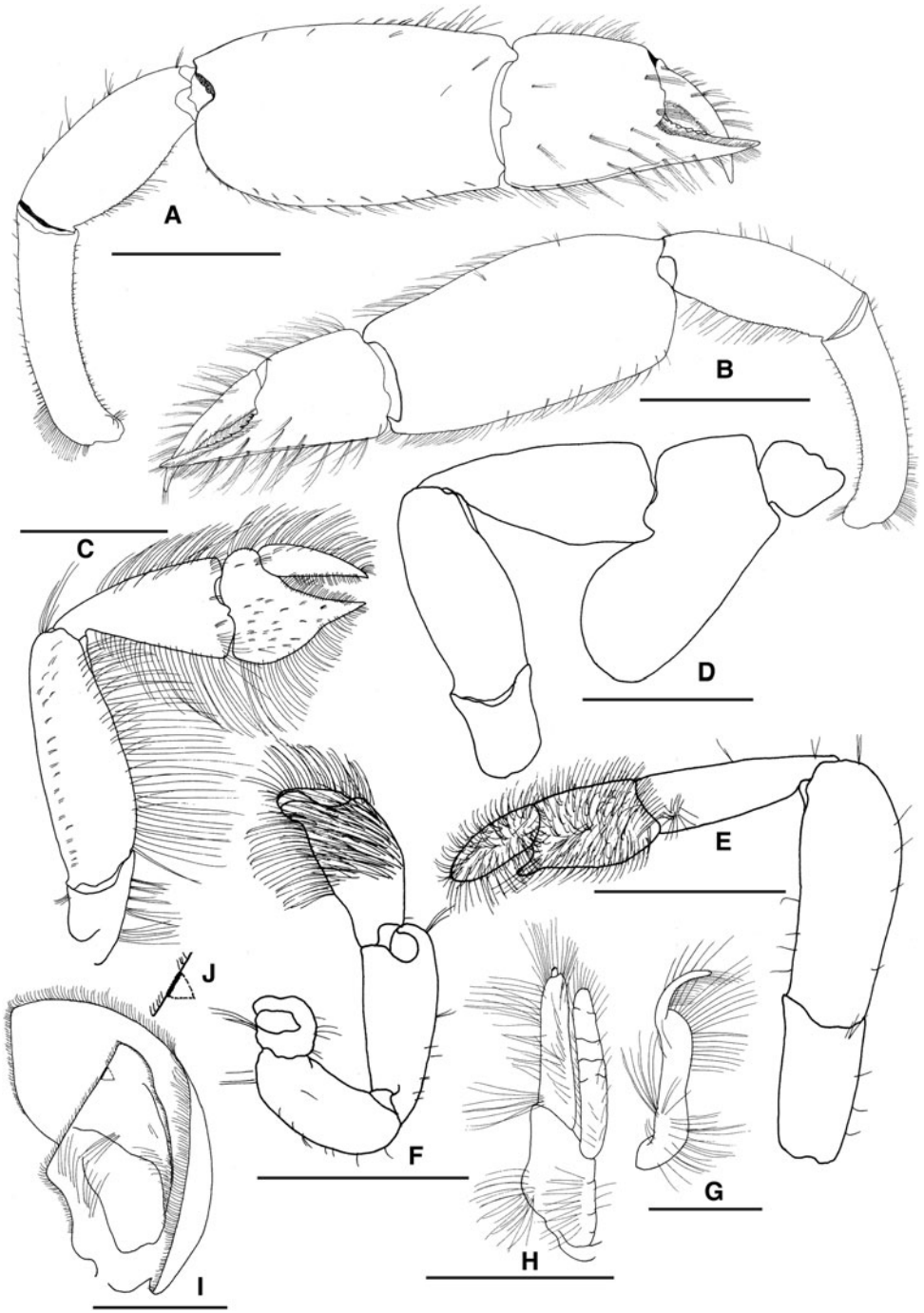

Fig. 7. *Callichirus* cf. *seilacheri* (Bott, 1955), female (15.5 mm) (LEMA-CR-53): (A) major cheliped, inner view; (B) minor cheliped, inner view; (C) second pereopod; (D) third pereopod; (E) fourth pereopod; (F) fifth pereopod; (G) first pleopod; (H) second pleopod; (I) third pelopod; (J) appendix interna, enlarged. Scale bars: A F, H–J, 5 mm; G, 2.5 mm.

corneous teeth on prehensile margin; dactylus with submarginal, longitudinal patch of dense setae; carpus twice as long as high, convex on ventral margin proximally, dorsal and ventral margin with tufts of long setae; merus twice as long as high, 1.3 times length of ischium, ventral margin with row of minute teeth or granules; ischium slender, broader distally, ventral margin armed with minute denticles or tubercles.

Female major cheliped (Figure 7A) with dactylus as long as palm, longer than fixed finger, prehensile margin with 9–10 rounded teeth, palm subrectangular, slightly broader than long, a row of long setae on dorsal and ventral margins, outer and inner surfaces with scattered tufts of setae, fixed finger with prehensile margin concave proximally and with 8–10 rounded teeth on proximal half, median stronger, a row of long setae along outer surface; carpus less than twice as long as high, tufts of setae on dorsal and ventral margins, setae more scattered on the latter; merus 2.3 times longer than high, 0.7 times length of carpus, dorsal and ventral margins convex, ventral margin with row of small denticles or granules; ischium slender, slightly longer than merus, dorsal margin almost straight, unarmed, ventral margin with row of minute denticles or granules and 2 moderately strong

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proximal tubercles. Minor cheliped (Figure 7B) with dactylus 1.3 times as long as palm, longer than fixed finger, prehensile margin with some small rounded teeth; fixed finger prehensile margin with 12–18 corneous teeth decreasing in size distally; both fingers with row of long setae running near prehensile margin on inner and outer surfaces, dorsal and ventral margins with tufts of long setae; palm subrectangular, slightly longer than broad, almost as long as dactylus, ventral and dorsal margins with tufts of long setae; carpus twice as long as high, 1.3 times length of chela; merus 0.7 length of carpus, ventral margin slightly convex, with row of minute denticles or granules and tufts of long setae, dorsal margin unarmed; ischium slender, curved, slightly longer than merus, broader distally, ventral margin with row of minute denticles or granules, dorsal margin unarmed, with row of setae, proximally longer.

Second pereopod (Figure 7C) chelate, long and dense setae on lower and upper margins of propodus and carpus, merus with long setae on ventral margin, one tuft of setae dorsodistally; ischium about as long as broad, with tufts of long setae on ventral margin; merus 3.0 times as long as high, 4.0 times as long as ischium; carpus 1.8 times as long as high, about 0.7 times as long as merus, chela 0.8 times length of carpus, dactylus about twice as long as palm. Third pereopod (Figure 7D) with ischium 1.3 times as long as broad; merus 2.3 times as long as high, 2.5 times as long as ischium; carpus triangle-shape, 2.4 times as long as high, 1.1 times as long as merus; propodus heeled, twice as long as high, posteroventral margin roundly protruded, lateral surface setose; dactylus triangular in shape, 0.7 times as long as palm. Fourth pereopod (Figure 7E) subchelate; ischium twice as long as high; merus about twice as long as ischium; carpus 0.7 times as long as merus, broadened distally; propodus 0.5 times as long as carpus, lateral surface setose; dactylus oval, slightly longer than propodus, outer surface setose. Fifth pereopod (Figure 7F) subchelate; merus 3.0 times as long as ischium; carpus 1.3 times as long as merus; propodus 0.7 length of carpus, forming a short claw with dactylus; dactylus 0.5 length of propodus, incurved.

Male first pleopod (Figure 5E) 2-segmented, distal segment tapering distally, with setae. Male second pleopod bilobed (Figure 5F), not segmented, without appendix interna and appendix masculina, exopod short. Female first pleopod (Figure 7G) uniramous; second pleopod (Figure 7H) biramous, endopod not segmented, with minute distal appendix interna, exopod slightly annulated. Pleopods 3–5 with appendices internae stubby, embedded in margin of endopod (Figure 7I, J). Ornamentation of pleomeres 3–5 as illustrated (Figure 5G). Telson (Figure 5H) broader than long, rounded, forming two large posterolateral lobes and a much smaller median, depressed lobule, posterior margin of the latter concave, a pit at anterior margin of the median lobule. Uropodal endopod and exopod exceeding telson by more than half its length.

TAXONOMIC REMARKS

The shape of major cheliped, uropodal endopod, and telson, as well as the ornamentation of the pleomeres 3–5 as described by Manning & Felder (1986) for the re-establishment of the genus *Callichirus* fit with the examined material.

The original description of *Callianassa seilacheri* by Bott (1955; 47) is rather superficial and the illustrations are of poor quality. As far as it can be seen, however, the shape of the anterior part of the carapace, including the eyes, the chela of pereopods 1 and 2, and the peculiar shape of the propodus and dactylus of pereopod 3 match the examined material. Unfortunately, the illustration of the telson provided by Bott (1955; figure 7c) is rather useless. The female paratype of *C. seilacheri* was re-examined and partly illustrated by Manning & Felder (1986; 441, figure 3; chelipeds, third maxilliped, anterior carapace, telson, and pleomeres 3–5), and by Sakai (1999; 62, figure 12; pleomeres 3–5 and telson). The telson of our material (Figure 5H) matches the general shape of the paratype telson, including the presence of the small, depressed posteromedian lobule and the concave margin. The armature and distribution of tufts of setae on the pleomeres (Figure 5G), the third maxilliped (Figure 5D), the anterior part of carapace (Figure 5A) are also excellent matches. In addition, Sakai (1999) provided figures of a male from northern Peru (propodus and fixed finger of male major chela, and pleopods 1–2). Pleopods 1–2 of our material coincide with Sakai's illustrations. Sakai (2011; 421) also figured the male pleopods 1 and 2 of yet another male from northern Peru, but these appear notably different from the 1999 illustrations. The general shape of the propodus and dactylus of the major chela of the Peruvian male also roughly fits with our specimens (Figure 6A, B), but the Peruvian chela is comparatively much longer, likely related to sexual dimorphism (Hernáez & Wehrtmann, 2007). Our material also fits well with the diagnosis provided by Sakai (1999). Finally, the appendix interna of pleopod 3 figured by Manning & Felder (1991; 773, figure 6) from a male collected in Peru is also a very good match to our material (Figure 5E).

Although it seems reasonable to identify our material with *C. seilacheri*, small differences were observed. In our male specimen the propodus of major cheliped is proportionally shorter and stouter than in the specimen from Peru illustrated by Sakai (1999; figure 12c, d), but this is not relevant considering the variation in size of the appendage reported previously (Rodrigues, 1985; Hernáez & Wehrtmann, 2007). Also the armature of the dactylus is slightly different, and our specimen has the prehensile margin armed with a relatively small proximal tooth, and the inner and outer margins are armed with teeth, while Sakai's specimen has the prehensile margin with a large proximal tooth and the rest of the margin is unarmed. Our specimen also features a gap between the dactylus and the fixed finger, while this gap is lacking in Sakai's illustration.

Callianassa garthi Retamal, 1975, was described from nine specimens collected in southern Chile (36°45′S 73°10′W). The type material includes 3 males (TL, 123–130 mm; CL 30–35 mm) and 2 females (TL, 85–90 mm; CL, 23–25 mm) (Retamal, 1975). It was not reported again, except by Retamal (1981: 53) who reproduced the original figure of the male holotype, by Manning & Felder (1991; 776) in a list of species of *Callichirus*, by Tudge *et al.* (2000; 144) who included the species in a checklist of valid species of Ctenochelidae and Callianassidae, and by Thatje (2003: 119) who only enlisted the species. Sakai (1999; 62, 2005; 129) considered *C. garthi* and *C. seilacheri* to be conspecific, although he was apparently not able to examine the type material of *garthi* (held in the Museo de Zoología, Universidad de Concepción, Chile). Illustrations provided by Retamal (1975) are indeed very similar to what we were able to observe in our material. Major differences are in the size

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(longer in the Chilean type) and proportions of the male major cheliped segments and of second pleopod (different in size in male and female in the Mexican material vs equal in the Chilean material), and in the shape of the posterior margin of the telson (a median spine is described in the Chilean type). On the other hand, large series of specimens of *C. seilacheri* were reported from northern Chile by Hernáez & Wehrtmann (2007) and by Hernáez *et al.* (2008) who performed population studies. Unfortunately, no illustrations of this material were provided and specimens were not kept. Further studies on this northern Chile population are presently under way in order to compare it with Central American material (P. Hernáez, personal communication July 2012). Part of the results of this study have since been presented (Guzmán & Hernáez, 2013) and this reinforces the idea that *C. garthi* is indeed a valid species.

On the other hand, our current knowledge on the distribution patterns of species of *Callichirus* along the west coast of America (i.e. *C. seilacheri* in El Salvador and Mexico, *C. garthi* in Chile) also reinforces the idea that two different species are involved. When current studies on populations of these two species are completed, the synonymy proposed by Sakai (1999; 62, 2005; 129) will probably not be justified. Consequently, in this contribution *C. garthi* is not considered a junior synonym of *C. seilacheri*. Furthermore, material of yet two undescribed species of *Callichirus* from the west coast of America is under study and, together with a review of the present status of *C. seilacheri* and *C. garthi* (Felder & Robles, 2009; 335, figure 1; Peiro *et al.*, 2011; R. Robles, personal communication July 2012), will probably bring new light on this genus in the eastern Pacific. Although we do not believe that our material might eventually belong to *C. garthi* (the Chilean species), the minor differences observed in our material when compared to the illustrations of the type material of *C. seilacheri* leave some doubts regarding a definitive identification, all the more because of the undescribed species occurring in the region.

DISTRIBUTION

From El Salvador to Mexico (Baja California; probably Jalisco, this study). Records from Chile probably belong to another species, *C. garthi*, if this species is eventually withdrawn from the synonymy of *C. seilacheri*.

Neocallichirus cf. *grandimana* (Gibbes, 1850) (Figures 8–12)

Callianassa grandimana Gibbes, 1850; 194.
Neocallichurus grandimana.-Lemaitre & Ramos, 1992; 349, figure 5, Sakai, 2005; 164 (complete synonymy).

MATERIAL EXAMINED

One inmature ♂, TL 31.7 mm, CL 8.4 mm, Estero de Pérula, Bahía Chamela, Jalisco, Mexico, 19°35′09″N 105°08′08″W, sandy-mud, EMU-9876, 07/3/2013. One inmature ♀, TL 30.3 mm, CL 7.0 mm, Estero de Pérula, Bahía Chamela, Jalisco, Mexico, 19°35′09″N 105°08′08″W, sandy-mud, EMU-9594, 29/Nov/2011. One inmature ♀, TL 21.0 mm, CL 5.6 mm, same locality, EMU-9595.

DESCRIPTION

Rostrum obtusely triangular, reaching half of the eyestalks (Figures 8A, 9A); frontal margin of carapace armed with triangular anterolateral projections; dorsal oval conspicuous; cervical groove located approximately in posterior 0.20 (0.33 in females) of carapace; linea thalassinica entire (Figure 8A, B). Eyestalks slightly longer than broad, equal to (shorter in females) antennular basal segment, convex on dorsal surface; cornea large and rounded, located laterosubdistally, pigmented black in ethanol specimens.

Antennular peduncle (Figures 8A, B, 9A) shorter than antennal peduncle, ultimate segment about 1.3 times as long as penultimate. Antennal ultimate segment as long as penultimate (1.2 times its length in females); scaphocerite oval and vestigial.

Third maxilliped (Figures 8C, D, 9B) with ischium–merus subrectangular, elongate; ischium subrectangular, 1.5 times as long as broad, crista dentata with row of 19 (16 in females) denticles; merus subtriangular, slightly shorter than broad, with longitudinal row of bristle-like spines on inner surface; carpus subtriangular, slightly longer than merus and almost as broad as propodus; propodus broadened, about as long as carpus and about as long as broad, ventral margin broadly convex, distal margin with median notch (visible only on outer face); dactylus digitiform, 0.6 (0.8 in females) times as long as propodus; no exopod.

First pereopods forming markedly dissimilar chelipeds. Major (right) cheliped of male (Figure 10A, B), heavy; ischium missing; merus about 1.8 times as long as high, dorsal margin slightly convex and smooth, ventral margin slightly arched, with a row of proximal minute denticles; carpus short, about 1.5 times higher than long, upper margin straight with few tufts of short setae on inner side, lower margin with few tufts of setae, entirely arched on proximoventral margin; chela about 1.8 times as long as high, slightly higher proximally; palm about 1.2 times as high as long (length measured along upper margin), outer face smooth, glabrous except for scattered tufts of short setae, inner surface with scattered tufts of setae, outer and inner distal margins with small calcareous denticles, upper margin broadly arcaded, with tufts of setae on inner side, lower margin almost straight, with tufts of long setae; fixed finger about 0.5 times as long as palm, prehensile margin slightly concave, with row of calcareous denticles on proximal half; dactylus incurved downwards distally, prehensile margin with 3 large calcareous teeth on proximal half.

Major cheliped of female (Figure 11A, B) not as heavy and massive as in male; differing from that of male as follows: merus spindle-shaped, slightly longer than ischium, about twice as long as high, dorsal margin slightly convex and smooth, ventral margin slightly arched, with a row of minute denticles; carpus almost 1.5 times as long as high, slightly longer than merus. Chela heavy, 1.5 times as long as carpus; palm 0.8 length of propodus, about as long as high, dorsal and ventral margins fringed with tufts of setae; fixed finger 0.6 times as long as palm; prehensile margin of dactylus with 2 proximal denticles.

Minor cheliped (Figures 10C, 11C) similar in both sexes, much less massive and more slender than major cheliped; ischium narrow, dorsal margin unarmed, ventral margin minutely denticulate; merus weakly spindle-shaped, slightly shorter (male) or longer (female) than ischium, dorsal and ventral margins slightly convex and unarmed; carpus slightly longer than merus, about 1.5 times as long as high, strongly arched on proximoventral margin. Chela 1.2 (female) to 1.5 (male) times longer than carpus; palm about 1.3 times as

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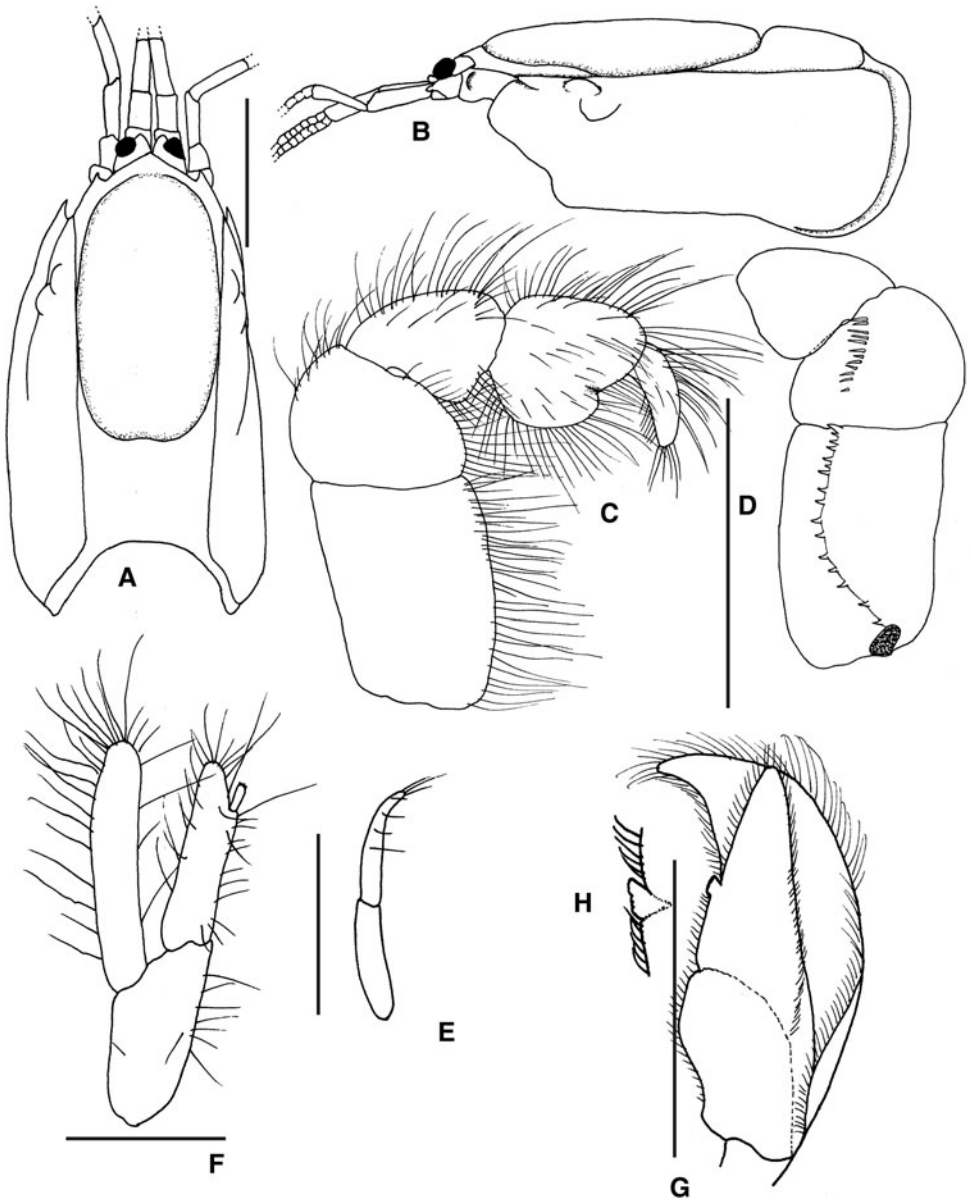

Fig. 8. *Neocallichirus* cf. *grandimana* (Gibbes, 1850), female (carapace length 7.0 mm) (EMU-9594): (A) carapace and cephalic appendages, dorsal view; (B) same, lateral view; (C) third maxilliped, external view; (D) same, ischium, merus and carpus, inner view; (E) first left pleopod; (F) second left pleopod; (G) third pleopod; (H) appendix interna, enlarged. Scale bars: A–D, G, 2.5 mm; E, F, 1 mm.

long as high, superior margin with row of setae; palm and fixed finger with row of tufts of setae. Fixed finger shorter than dactylus, tip curved upward; prehensile margin minutely denticulate. Dactylus about as long as palm, tip curved downward; upper margin with tufts of setae; cutting edge minutely denticulate in proximal half.

Second pereopod chelate (Figures 10D, 12A); ischium about as long as broad; merus 3.0 times as long as high, 4.0 times as long as ischium; carpus 1.8 times as long as high, about 0.5 times as long as merus, chela slightly shorter than carpus, dactylus about twice as long as palm. Third pereopod (Figures 10E, F, 12B) with ischium 1.3 times as long as broad; merus 3.0 times as long as high and 2.5 times as long as ischium; carpus 1.8 times as long as high and 0.8 times as long as merus, strongly divergent on dorsal and ventral margins; propodus bean-shaped, about as long as high, posteroventral margin roundly protruded, lateral surface setose; dactylus triangular in shape, 0.6 times as long as palm, pointed at tip. Fourth pereopod subchelate (Figures 10G, 12C); ischium 4.0 times as long as high, merus 1.5 times as long as ischium; carpus 0.7 times as long as merus; propodus 0.8 times as long as carpus, lateral surface setose; dactylus 0.6 length of propodus and setose on external surface. Fifth pereopod subchelate (Figure 12D); merus 4.5 times as long as ischium, carpus 0.7 times as long as merus, slightly convex on dorsal margin subdistally, propodus as long as carpus, forming a short fixed finger ventrodistally; dactylus hooked towards external side of fixed finger, tip incurved.

Pleomeres smooth, glabrous dorsally; pleura 2–5 each with a tuft of setae laterally. Pleomere 6 (Figure 12E) slightly broader than long, laterally converging to posterior margin. First pleopod uniramous in both sexes, 2-segmented; distal segment shorter than proximal, both segments with some setae, setae longer distally on anterior lobe (Figure 9C);

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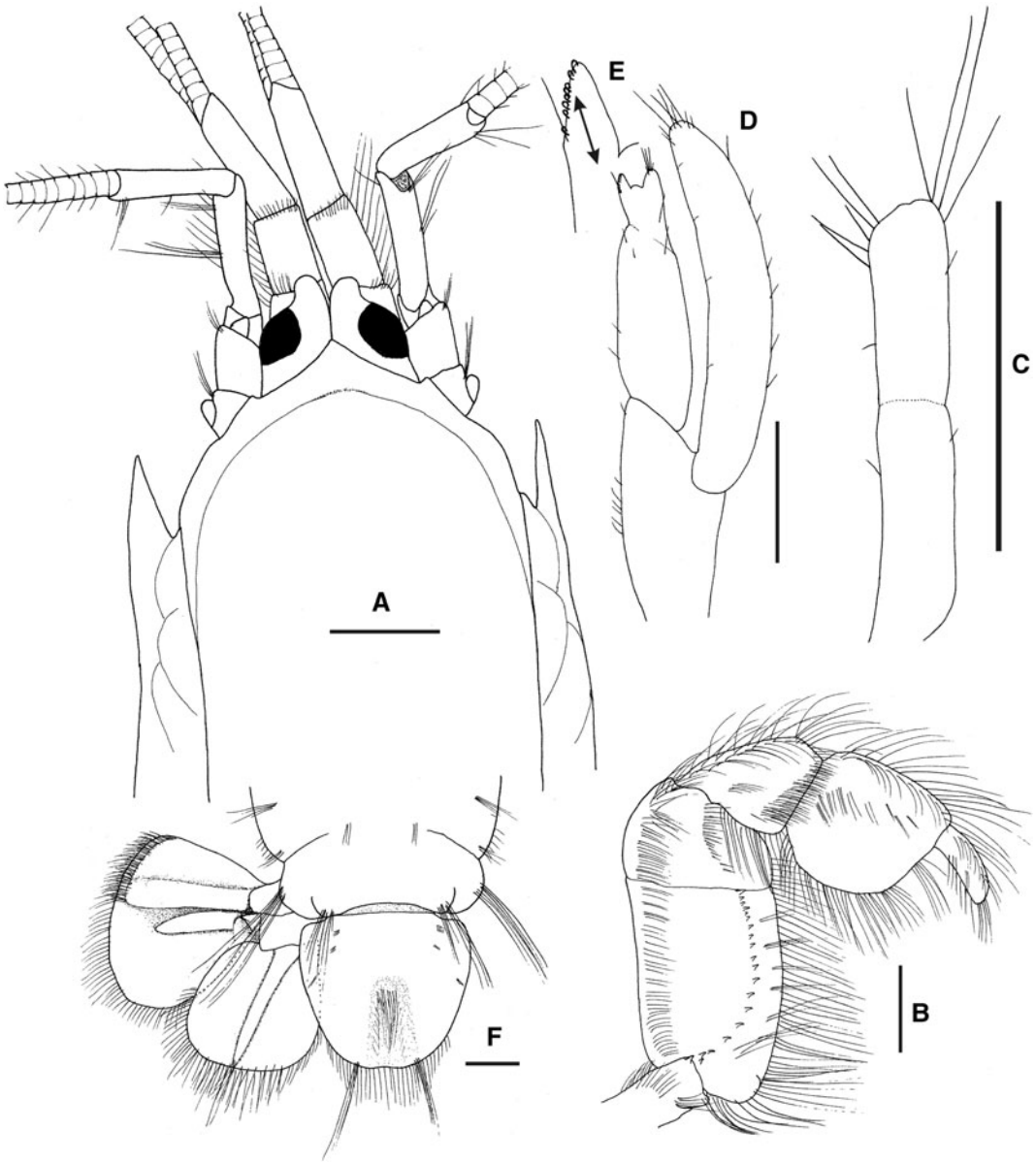

Fig. 9. *Neocallichirus* cf. *grandimana* (Gibbes, 1850), male (carapace length 7.0 mm) (EMU-9876): (A) anterior portion of carapace and cephalic appendages, dorsal view; (B) third maxilliped, inner view; (C) first pleopod; (D) second pleopod; (E) appendix masculina, augmented; F, telson and uropod, dorsal view. Scale bars: 1 mm.

in female (Figure 8E) both segments narrow and elongate, proximal segment nude, terminal segment with few setae. Second pleopod biramous; in male, exopod longer than endopod, with setae short on outer margin, distal setae longer, endopod with distal lobe demarcated by weak transverse suture, appendix masculina poorly demarcated, appendix interna poorly demarcated, bearing 8 diminute subdistal coupling hooks and 1 setae (Figure 9D, E); in female (Figure 8F), exopod with marginal setae, endopod with well developed appendix interna. Third to fifth pleopod (Figure 8G, H) biramous, foliaceous, each with appendix interna. Telson (Figures 9F, 12E) trapezoid, lateral margins slightly convex proximally, convergent posteriorly to posterolateral angle, posterior margin convex with a shallow, unarmed median concavity; dorsal surface with a median transverse row of setae and a shallow, longitudinal furrow fringed with tufts of short setae. Uropodal endopod broad, trapezoidal; dorsal surface with a median longitudinal ridge; exopod broadly rounded distally, almost as long as broad, longer than endopod; dorsal surface with two longitudinal ridges.

REMARKS

Only two species of *Neocallichurus* have been reported from the East Pacific: *N. grandimana* (Gibbes, 1850), an Atlantic species reported for Panama, Ecuador and Colombia (Gorgona Island) (Sakai, 2005), and *N. mortenseni* Sakai, 2005, known from a single female collected along the Pacific coast of Panama and maybe from juveniles from Pacific Costa Rica (Dworschak, 2013).

Comparison of our material with the description of the neotype of *C. grandimana* by Manning (1987) and with the illustrations of a single specimen from Isla Gorgona, Colombia, by Lemaitre & Ramos (1992) leaves little doubt that these are very similar in many aspects. Lemaitre & Ramos (1992) concluded that this species is

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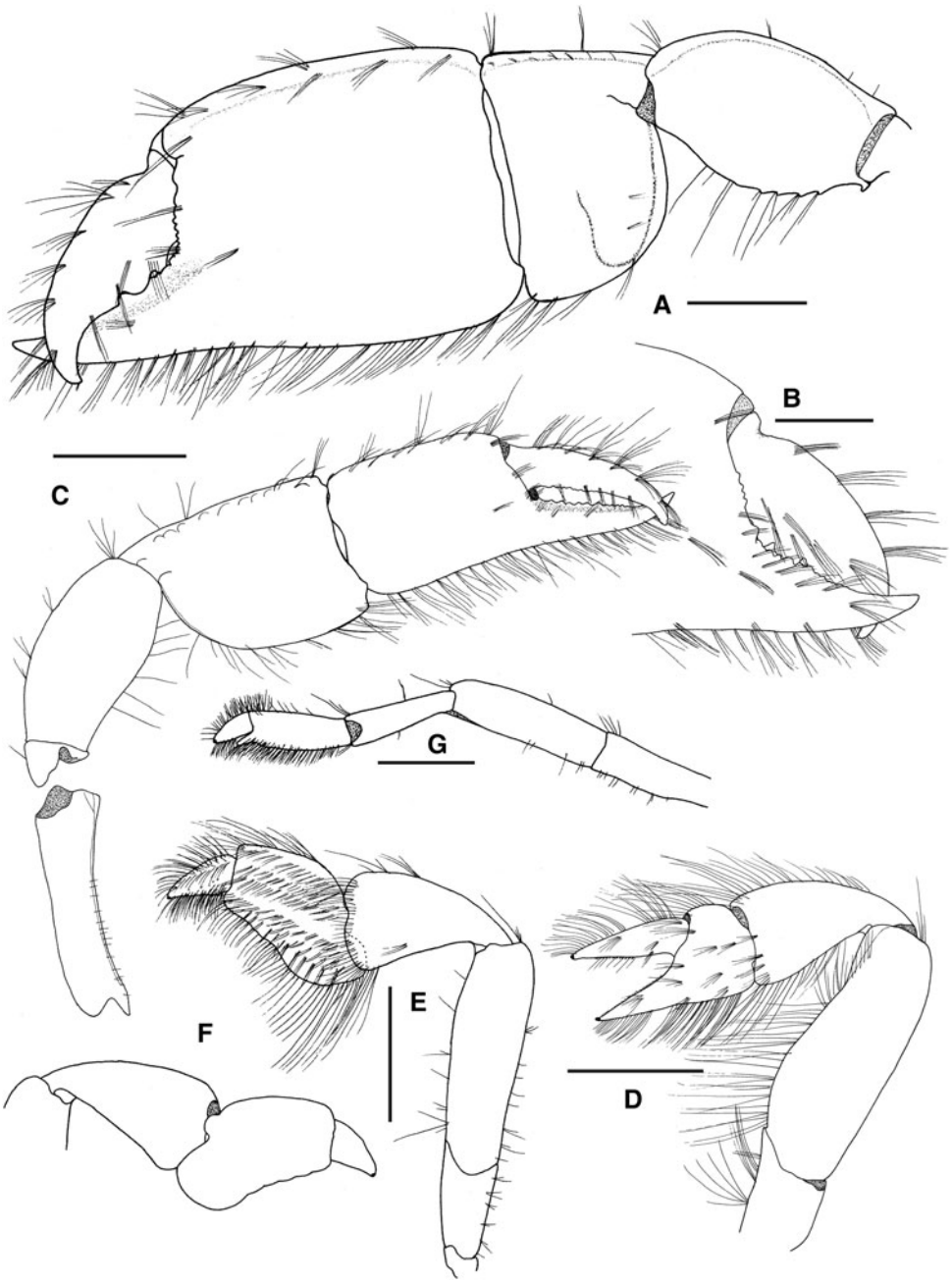

Fig. 10. *Neocallichirus* cf. *grandimana* (Gibbes, 1850), male (carapace length 7.0 mm) (EMU-9876): (A) major cheliped, inner view; (B) anterior portion of major cheliped, outer view; (C) minor cheliped, inner view; (D) second left pereopod, outer view; (E) third right pereopod, inner view; (F) same pereopod, outer view (omitted setae); (G) fourth left pereopod, outer view. Scale bars: 2 mm.

amphi-American and present in Colombia and Ecuador. The present record would add yet another locality for this Atlantic species along the Pacific coast of America. It must be considered, however, that an amphi-American distribution for shallow-water, tropical species is not very likely to occur except if the species was introduced. Considering the great similarity between material from both sides of the continent, a molecularly based analysis including material from a wide latitudinal and longitudinal range would be necessary to determine the affinity and hypothetical conspecificity of the two populations.

In addition there are two undescribed species of *Neocallichirus* from Nicaragua (Felder & Robles, 2009) and one of these might eventually prove to be conspecific with our material of this genus. It would, however, need additional material and a detailed comparison of it before being able to make a final decision regarding the affinity of our specimens.

Infraorder GEBIIDEA
Family UPOGEBIIDAE
Upogebia dawsoni Williams, 1986

Upogebia dawsoni Williams, 1986; 14, figure 5, Lemaitre & Ramos, 1992; 357, Hendrickx, 1993; 308, 1995a; 158, 1995b; 390, 2005; 170, Sakai, 2006; 72.

MATERIAL EXAMINED

1 inmature ♀, TL 9.9 mm, CL 2.8 mm, Estero de Pérula, Bahía Chamela, Jalisco, Mexico, 19°35′09″N 105°08′08″W,

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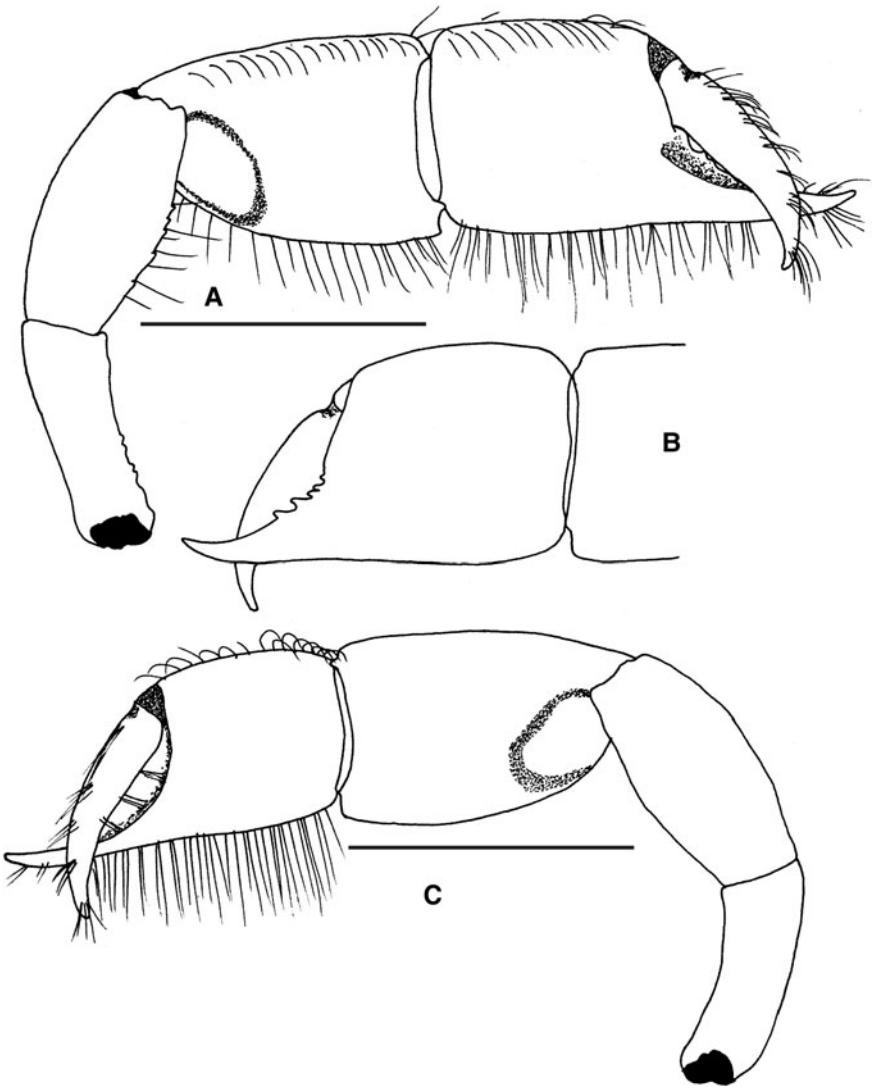

Fig. 11. *Neocallichirus* cf. *grandimana* (Gibbes, 1850), female (carapace length 7.0 mm) (EMU-9594): (A) major cheliped, inner view; (B) chela and anterior portion of carpus of major cheliped, outer view; (C) minor cheliped, inner view. Scale bars: 2.5 mm.

intertidal, sandy-mud bottom, LEMA-CR-54, 29/11/2011. 6 adult ♂, TL 14.1–25.9 mm, CL 4.3–10 mm, 3 adult, ♀, TL 22.0–24.6 mm, CL 6.3–7.1 mm, 4 ♀ ovigerous, TL 17.6–22.8 mm, CL 4.7–7.4 mm, same locality, EMU-9877. 6 adult ♂, TL 1–29.4 mm, CL 5.6–7.5 mm, 3 adult ♀, TL 19.8–20.4 mm, CL 5.4–5.7 mm, 7 ovigerous ♀, TL 22.4–27.6 mm, CL 5.6–7.1 mm, same locality LEMA-CR-56, 7/03/2013.

DISTRIBUTION

Known from the Gulf of California and Jalisco, Mexico, to Costa Rica and Panama (Williams, 1986; Hendrickx, 2005; Sakai, 2006).

REMARKS

Within Mexico, this is only the second record from the coast of Jalisco and outside the Gulf of California (Williams, 1986; Hendrickx, 2005). Brusca & Hendrickx (2008) mentioned that *U. dawsoni* and *Neotrypaea uncinata* (H. Milne-Edwards, 1837) are common in Estero Morua, Sonora (see García *et al.*, 2003).

DISCUSSION

Classification of mud shrimps still remains a controversial issue and further studies are needed (including morphological, molecular and larval development approaches). The recent assignment of the 'thalassinideans' to two different suborders makes difficult to assess the number of 'mud shrimps' described to date. According to P. Dworschak (personal communication, March 2011), a recent estimation put the figure at ~650 species worldwide (vs 615 species as accounted for by De Grave *et al.*, 2009). With only 35 species on records, the Mexican Pacific is, therefore, rather poor as far as these organisms are concerned. The record of *Callianidea typa* H. Milne Edwards, 1837 for La Paz (Baja California Sur, Mexico; intertidal) by Lockington (1878; 302) and cited by Sakai (2011; 203) is certainly an error, as confirmed by Poore (1997).

The genus *Neotrypaea* is exclusively American and all the species in this genus (five according to Tudge *et al.*, 2000, plus *N. tabogensis* described in 2005) are from the East Pacific. *Neocallichirus* is much more specious (18 species according to Tudge *et al.* (2000), 21 according to Sakai (2005), 25 according to De Grave *et al.* (2009) and 29

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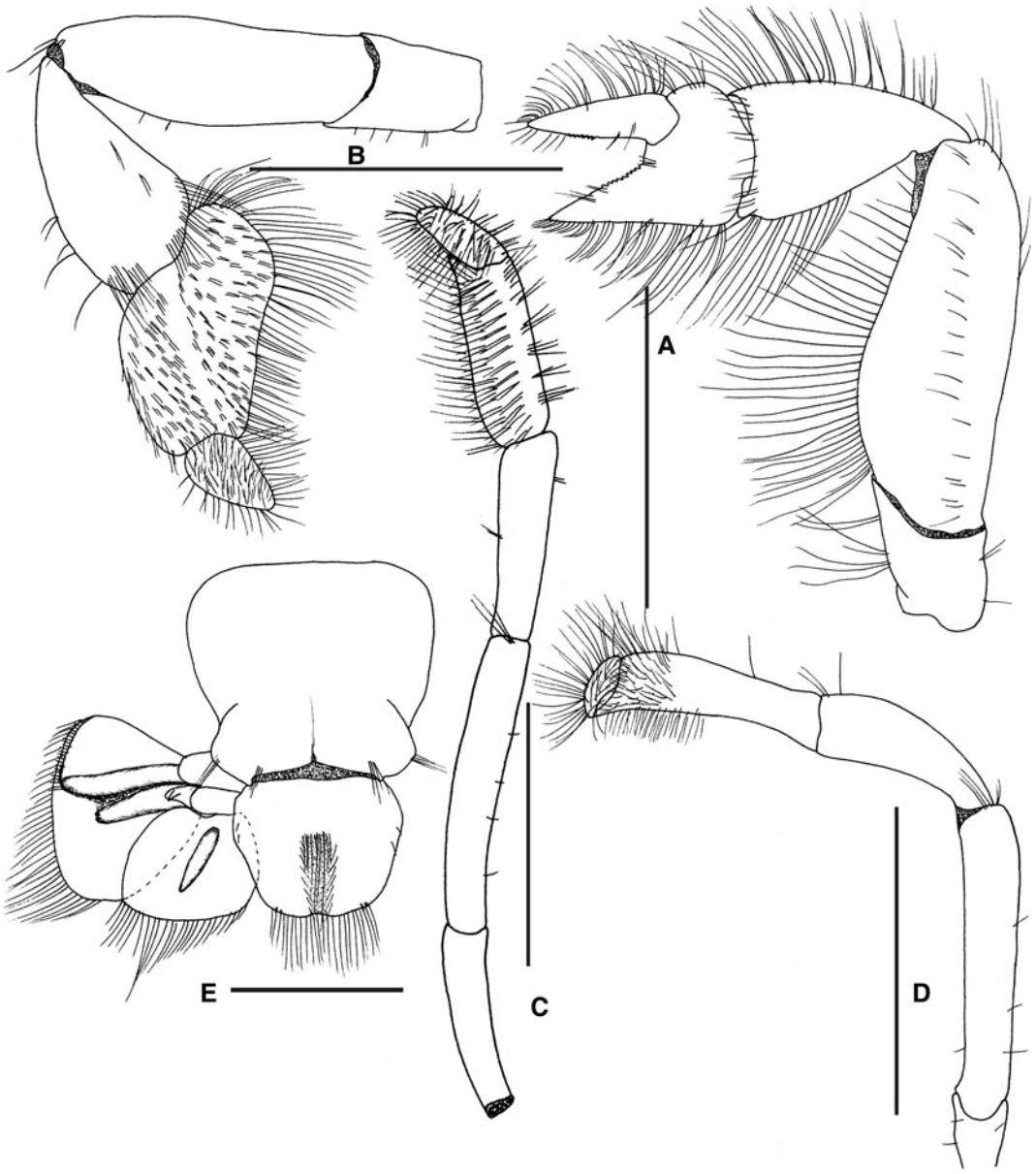

Fig. 12. *Neocallichirus* cf. *grandimana* (Gibbes, 1850), female (carapace length 7.0 mm) (EMU-9594): (A) second right pereopod, inner view; (B) third right pereopod, inner view; (C) fourth right pereopod, inner view; (D) fifth right pereopod, inner view; (E) telson and uropod, dorsal view. Scale bars: 2.5 mm.

according to Sakai (2011)) and is represented in the East Pacific by two species only. Most of the other species are from the Indo-West Pacific (Sakai, 2005), and as many as seven species are known from the West Atlantic (from Florida to Brazil) (Sakai, 2011). *Neocallichirus grandimana* has been described for the West Atlantic (type locality, Florida) and reported from Bermuda to Brazil, and in the East Pacific (i.e. Panama, Ecuador and Gorgona Island, Colombia). We consider, however, that the amphi-American distribution of this species needs to be confirmed by a combination of morphological and molecular approaches.

According to Sakai (2005) and De Grave *et al.* (2009), the genus *Callichirus* contains five species (six if *C. garthi* is withdrawn from the synonymy of *seilacheri*), three of these from the Atlantic Ocean. Tudge *et al.* (2000), however, included as many as 14 species in it. This variation is essentially due to the fact that Sakai (2005) placed four of these 14 species into the genus *Podocallichirus* Sakai, 1999, and two in *Neochallichirus* Sakai, 1988. Furthermore, Sakai (2011; 466) subdivided *Podocallichirus* into four new genera, leaving only *P. madagassus* Lenz & Richters, 1881 (the type species) in it. *Callichirus* sensu Sakai (2011) contains only four species.

Within the East Pacific the genus *Upogebia* is undoubtedly the best known of all mud shrimps. Extensive reviews of these organisms by Williams (1986, 1997) led to the recognition of 19 (15 described as new) species in the region, of which 11 species (plus one transferred to *Pomatogebia* Williams & Ngoc-Ho, 1990) have currently been recorded in Pacific Mexico (Appendix).

Although the coastal habitats where mud shrimp live are generally easy to reach and often located close to fishing villages or camps where small boats can be hired, records in the literature are still scarce. Undoubtedly, this is due to the difficulty of sampling these organisms. In addition to

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accessing the mudflats at low tide either by boat or by foot, these organisms live in burrows and are very sensitive to any kind of perturbation. As emphasized by Manning (1975), the most efficient way to capture mud shrimps while still in their holes is by using the 'Yabby' pump when the water level is low but still covers the entrance of the burrows. The 'Yabby' pump is a suction device that provokes the drawing of the water and the organisms from their burrows. This device, however, is seldom used in Mexico, which certainly may account for the lack of records of these organisms. Deep-water species are also difficult to collect. Trawling devices do not generally collect infauna species, and box cores (now commonly used for infauna samples) cover a very small area, thus limiting the probability to capture these shrimps.

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APPENDIX

List of species of mud shrimps (Axiidea and Gebiidea) currently recorded from the Pacific coast of Mexico. Taxonomic sequence follows De Grave *et al.* (2009) for genus and Ahyong *et al.* (2011) for family levels. Sources included only the contributions examined during this study and some data from the EMU collection (unpublished data).

Taxa	Sources
Axiidea de Saint Laurent, 1979	
Axioidea Huxley, 1879	
Axiidae Huxley, 1879	
Acanthaxius caespitosa (Squires, 1979)[1]	Hendrickx, 2005a; unpublished data
Axiopsis baronai Squires, 1977	Hendrickx, 1987
Axiopsis serratifrons (A. Milne Edwards, 1873)	Hendrickx, 2008
Calocarididae Ortmann, 1892	
Calocarides lev (Zarenkov, 1989)	Kensley, 1996
Calocarides quinqueseriatus (Rathbun, 1902)	Hendrickx, 2008
Callianassidae Dana, 1852	
Biffarius debilis Hernández-Aguilera, 1998[2]	Hernández-Aguilera, 1998; Hendrickx, 2005b
Callichirus cf. *seilacheri* (Bott, 1955)	Felder & Robles, 2009; this study
Neocallichirus cf. *grandimana* (Gibbes, 1850)	This study
Neotrypaea biffari (Holthuis, 1991)[3]	Campos & de Campos, 1989
Neotrypaea californiensis (Dana, 1854)[3]	Sakai, 2005; Campos, 2006; Wicksten, 2012
Neotrypaea gigas (Dana, 1852)[3]	Sakai, 2005; Campos, 2006; Wicksten, 2012
Neotrypae rochei (Bouvier, 1895)[3]	Manning & Felder, 1991
Neotrypaea tabogensis (Sakai, 2005)[3]	This study
Neotrypaea uncinata (H. Milne Edwards, 1837)[3]	García *et al.* 2003
Corallianassa xutha (Manning, 1988)[4]	Hérnandez-Aguilera, 2002; Hendrickx, 2005b
Lepidophthalmus eiseni (Holmes, 1904)[5]	Felder, 2003
Lepidophthalmus bocourti (A. Milne Edwards, 1870)	Felder, 2003; Hendrickx & Lopez, 2012
Callianideidae Kossmann, 1880	
Callianidea laevicauda Gill, 1859[6]	Hendrickx, 2005b
Calocarididae Ortmann, 1891	
Calastacus stilirostris Faxon, 1893	Faxon, 1893
Eiconaxiidae Sakai & Ohta, 2005	
Eiconaxius baja Kensley, 1996	Kensley, 1996
Strahlaxiidae Poore, 1994	
Neaxius vivesi (Bouvier, 1895)	Hendrickx, 2005a; unpublished data
Callianassoidea Dana, 1852	
Ctenochelidae Manning & Felder, 1991	
Callianopsis goniophthalma (Rathbun, 1902)	Hendrickx, 1995a
Gebiidea de Saint Laurent, 1979	
Laomediidae Borradaile, 1903	
Naushonia macginitiei (Glassell, 1938)	Goy & Provenzano, 1979
Upogebiidae Borradaile, 1903	
Pomatogebia rugosa (Lockington, 1878)	Lemaitre & Ramos, 1992
Upogebia baldwini Williams, 1997	Williams, 1997
Upogebia burkenroadi Williams, 1986	Williams, 1986
Upogebia dawsoni Williams, 1986	Williams, 1986
Upogebia galapagensis Williams, 1986	Villalobos-Hiriart *et al.*, 1989
Upogebia jonesi Williams, 1986	Williams, 1986
Upogebia lepta Williams, 1986	Williams, 1986
Upogebia macginitieorum Williams, 1986	Campos & de Campos, 1989; Campos, 2006; Wicksten, 2012

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Appendix Continued

Taxa	Sources
Upogebia ramphula Williams, 1986	Williams, 1986
Upogebia spinigera (Smith, 1871)	Salgado-Barragán & Hendrickx, 1996–1997
Upogebia thistlei Williams, 1986	Williams, 1986; unpublished data
Upogebia veleronis Williams, 1986	Williams, 1986

[1]Cited as *Guayanacaris caespitosa* by Sakai (2011: 120); [2]cited as *Trypaea debilis* by Sakai (2011: 396); [3]all included in the genus *Trypea* by Sakai (2011: 387); [4]cited as *Corallichirus xuthus* by Sakai (2011: 424). *Corallichirus* accepted as a valid genus by Tudge *et al.* (2000: 144).; [5]cited as *Lepidophthalmoides eiseni* by Sakai (2011: 442); [6]cited as *Paracallianidea laevicauda* by Sakai (2011: 206).

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