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. 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 parageneric 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: 433) and four families of Gebiidea (192 species). Ahyong et al. (2011), however, provided a different classification, recognizing two superfamilies (i.e. Axiioidea and Callianassioidea) 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 Kensey & 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
(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 ‘jabby 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 Chamelá, Jalisco; and Estero de Pérula, Bahía Chamelá, 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 Mexico (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. grandimana*, 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 bifarii* – Holthus, 1991; 242 (partim).
*Trypaea tabogensis* – Sakai, 2011; 409.

**MATERIAL EXAMINED**

Holotype: Ψ TL 21.0 mm, northern coast of Taboga, Bahía de Panamá (MZUC-CRU-3772, Zoological Museum, Copenhagen). 3 ovigerous Ψ, TL 21.5–23.2 mm, CL 5.0–5.7 mm, Estero de Pérula, Bahía Chamelá, Jalisco, Mexico, 19°36’16”N 105°08’05”W, intertidal, muddy bottom, LEMA-CR-52, 28/11/2011. 2 ovigerous Ψ, TL 23.2–26.6 mm, CL 5.7–5.9 mm, same locality, EMU-9590. 3 Ψ, 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 Chamelá, Jalisco, Mexico, 19°35’09”N 105°08’06”W, intertidal, sandy mud, EMU-9591, 29/11/2011. 7 adult Ψ, TL 20.4–29.0 mm, 11 ovigerous Ψ TL, 18.5–29.5 mm, Estero de Pérula, Bahía Chamelá, Jalisco, Mexico, 19°35’06”N 105°08’07”W, intertidal, sandy, EMU-9873, 06/03/2013. 1 adult Ψ, TL 29 mm, CL 6.3 mm, Estero de Pérula, Bahía Chamelá, Jalisco, Mexico, 19°35’06”N 105°08’07”W, intertidal, sandy, EMU-9873, 06/03/2013. 1 adult Ψ, TL 23.2–30.2 mm, CL 4.6–6.4 mm, 1 ovigerous Ψ, TL 32 mm, CL 6.2 mm, Estero de Pérula, Bahía Chamelá, Jalisco, Mexico, 19°35’06”N 105°08’07”W, intertidal, sandy, EMU-9873, 06/03/2013. 2 adult Ψ, TL 32 mm, CL 7.4 mm, 3 ovigerous Ψ, TL 27–33 mm, CL 6–7 mm, Estero de Pérula, Bahía Chamelá, 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 flagellum. Antennal one, terminal segment 2 times length of penultimate segment. Third maxilliped (Figure 1D, E) with ischium–merus operculiform, without exopod; basis with 1 spine on inner face; ischiurn as long as broad, with crista dentata on inner face (11–13 denticles); merus subtriangular, 1.3 times wider...
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 slightly 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; palm 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
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

Fig. 2. *Neotrypaea tabogensis* (Sakai, 2005). (A–C) male (carapace length (CL) 6.3 mm) (EMU-98574); (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.
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, Bahia 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
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 *Tympaea* 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.

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

*Callianassa seilacheri* Bott, 1955; 47, figure 7a–g.

**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, Islas 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...
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 interspersed 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
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, unarmored, ventral margin with row of minute denticles or granules and 2 moderately strong...
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 conical 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 un armed; ischium slender, curved, slightly longer than merus, broader distally, ventral margin with row of minute denticles or granules, dorsal margin un armed, 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) bira mous, 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 postero lateral 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 max illi ped, 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 (Herna´ez & 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 specim en 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; Herna´ez & 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′57″S–16°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. (2006; 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.
Neocallichirus grandimana (Lemaitre & Ramos, 1992; Gibbes, 1850) type material of C. seilacheri in our material when compared to the illustrations of C. garthi 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.

**Neocallichirus grandimana**.-Lemaitre & Ramos, 1992; 349, figure 5, Sakai, 2005; 164 (complete synonymy).

**MATERIAL EXAMINED**

One immature ♂, TL 31.7 mm, CL 8.4 mm, Estero de Pérula, Bahía Chamaela, Jalisco, Mexico, 19°35′09″N 105°08′08″W, sandy-mud, EMU-9876, 07/3/2013. One immature ♀, TL 30.3 mm, CL 7.0 mm, Estero de Pérula, Bahía Chamaela, Jalisco, Mexico, 19°35′09″N 105°08′08″W, sandy-mud, EMU-9594, 29/Nov/2011. One immature ♀, 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; lineae thalassinicae 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 ischiu–merus subrectangular, elongate; ischiu 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; ischiu–merus 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 ischiu, 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; ischiu narrow, dorsal margin unarmored, ventral margin minutely denticate; merus weakly spindle-shaped, slightly shorter (male) or longer (female) than ischiu, 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
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, poster-oventral 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);
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, unarmmed 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 Neocallichirus 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
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

**Material Examined**
1 immature ♀, TL 9.9 mm, CL 2.8 mm, Estero de Pérula, Bahía Chamela, Jalisco, Mexico, 19°35′09″N 105°08′08″W,
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 1.1–29.4 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 typha* 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...
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 Neocallichirus 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 Pomatogeobia 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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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.
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 which 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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and


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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).

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1 Cited as *Guayanacaris caespitosa* by Sakai (2011: 120); 2 cited as *Trypaea debilis* by Sakai (2011: 356); 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).