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Distribution and species richness of caprellids (Crustacea: Amphipoda) from the Mexican Pacific

Lucy Coral Alarcón-Ortega†, Amílcar Leví Cupul-Magaña*, Alma Paola Rodríguez-Troncoso† and Fabio Germán Cupul-Magaña

Abstract

Background: The caprellid fauna from different localities along the Mexican Pacific coast: Sinaloa (3), Nayarit (15), Jalisco (9) and Colima (1) are presented herein.

Methods: A total of 1,093 specimens associated with diverse substrates (octocorals, hydroids, algae, coral rubble and sponge) were recorded.

Results: Eight species in four genera were identified: *Aciconula acanthosoma* Chess 1989; *Caprella mendax* Mayer 1903; *Caprella pitu* Sánchez-Moyano, García-Ascencio and Guerra-García 2014; *Caprella suprapiscis* Galván-Villa and Ayón-Parente 2015; *Paracaprella carballoi* Sánchez-Moyano, García-Ascencio and Guerra-García 2014; *Paracaprella isabelae* Sánchez-Moyano, García-Ascencio and Guerra-García 2014; *Paracaprella pusilla* Mayer 1890; and *Liropus isabelensis* Sánchez-Moyano, García-Ascencio and Guerra-García 2014.

Conclusions: The new records increase the known species richness in the region at local level, including extensions of the known ranges for all the species. These results highlight the need for a large scale survey along the Mexican Pacific coast, along with a more thorough sampling on a large number of substrata, in order to increase the knowledge of caprellid diversity in the area.

Keywords: Richness, Range extension, Distribution, Eastern Tropical Pacific, Skeleton shrimp

Introduction

Caprellids are small crustaceans commonly known as "skeleton shrimps", which are abundant and important members of the marine benthos, inhabiting a wide variety of substrates (e.g., bryozoans, macroalgae and sponge) as epibionts, with a high preference for hydroids and gorgonians in tropical regions (McCain, 1968; Guerra-García, 2006; Scinto et al., 2008; Alarcón-Ortega et al., 2012; Sánchez-Moyano et al., 2014; Soler-Hurtado and Guerra-García, 2016). They are also part of fouling communities (Thiel et al., 2003; Ros and Guerra-García, 2012; Alarcón-Ortega et al., 2015), and their distribution varies from intertidal to abyssal zones (Laubitz and Mills, 1972; Woods, 2009). They are fundamental in marine ecosystems as recyclers of organic matter and as an energy source at different trophic levels (Caine, 1989; Woods, 2009).

The caprellids from the Eastern Tropical Pacific (ETP) have been little studied. To date in this region a total of 16 species has been recorded: *Aciconula acanthosoma* Chess, 1989 from Mexico and Ecuador; *Abbysicaprella galatheae* McCain, 1966 from Costa Rica and Peru; *Caprella ungulina* Mayer, 1903 from Ecuador; *C. californica* Stimpson, 1856 from Mexico; *C. equilibra* Lamark, 1881 from Mexico, Panama and Ecuador; *C. scaura* Templeton, 1836 from Mexico and Costa Rica; *C. mendax* Mayer, 1903 from Mexico; *Paracaprella banardi* McCain, 1967 from Panama and *P. pusilla* Mayer, 1890 from Mexico and Panama (Mayer, 1903; Shoemaker, 1942; McCain, 1966; McCain, 1967; McCain and Steinberg, 1970; Laubitz, 1970; Alarcón-Ortega et al., 2012; Ros et al., 2014; Sánchez-Moyano et al., 2014; Soler-Hurtado and

* Correspondence: amilcar.cupul@gmail.com
†Equal contributors
Laboratorio de Ecología Marina del Centro de Investigaciones Costeras, Centro Universitario de la Costa, Universidad de Guadalajara, Av. Universidad de Guadalajara 203, C.P. 48280 Puerto Vallarta, Jalisco, Mexico

Guerra-García, 2016), plus recent descriptions, all from Mexico: *C. calderoni* Hendrickx and Ayón-Parente, 2014; *C. mercedesae* Hendrickx and Ayón-Parente, 2014; *C.pitu* Sánchez-Moyano et al., 2014; *C. suprapiscis* Galván-Villa and Ayón-Parente, 2015; *Liropus isabelensis* Sánchez-Moyano et al., 2014; *P. carballoi* Sánchez-Moyano et al., 2014 and *P. isabelae* Sánchez-Moyano et al., 2014 (Hendrickx and Ayón-Parente, 2014; Sánchez-Moyano et al., 2014; Galván-Villa and Ayón-Parente, 2015).

Despite the relevance of the distribution and richness of caprellid amphipods from the Mexican Pacific (MP) in particular Central Mexican Pacific (CMP) is almost unstudied and more information is required to fill the information gap. However, there are a few studies relating with the caprellid biota: Alarcón-Ortega et al. (2012) report for the first time a total of four species at six stations during 2011-2012 (*A. acanthosoma*, *C. equilibra, C.* aff. p*enantis* and *Paracaprella* sp.) and describe the feeding habitats of caprellids in this area; Sánchez-Moyano et al. (2014) report three new records and four new species (*A. acanthosoma, C. equilibra, C. mendax, C. pitu, P. carballoi, P. isabelae, L. isabelensis*) from 10 stations during two expedition in 2002 and 2008; Alarcón-Ortega et al. (2015) report the presence of one non-indigenous species from four stations between 2013-2014; Galván-Villa and Ayón-Parente (2015) describe a new species, *C. suprapiscis*, associated with scorpionfish. At this point, the caprellid studies have only been focused at the small-scale level during short and sporadic surveys, generating a little information about caprellid species and their distribution. Therefore the aim of the present study was to update the information on the biodiversity of caprellids in the MP, performing a large latitudinal survey from 19°06′17″ N to 25°26′09″ N along the Central Mexican coast (843 km) and surrounding islands (20.68 km^{-2}), including range extensions and ecological data of four genera and eight caprellid species in order to broaden the records of the distribution of these amphipods in the ETP. These findings are important in documenting the extensions of the known ranges of the species, but also increase knowledge of the biodiversity of the entire region.

Material and methods

The Central Mexican Pacific is considered as a transitional oceanographic area, and is seasonally influenced by three important current systems: the California Current carrying cold (~18 °C), low-salinity and high-nutrient water (Kessler, 2006; Pennington et al., 2006; Pantoja et al., 2012); the Gulf of California Current carrying warm waters with high salinity; and the Mexican Coastal Current carrying warm (~30 °C), clear and low-nutrient water (Wyrtki, 1965; da Silva et al., 1994; Palacios-Hernández et al., 2010; Pantoja et al., 2012). These oceanographic conditions drive an inter-annual variability of environmental conditions, which may allow the presence of different species within the area.

The specimens reviewed were collected from 28 stations (St.) along Sinaloa (3), Nayarit (15), Jalisco (9) and Colima (1) coasts (Table 1, Fig. 1) from September 2012 to June 2016. Samples were obtained by SCUBA diving, by scraping diverse substrates *(*e.g. algae, hydroids, hydrocorals, sand, sponge, coral rubble, turf and artificial material) from depths between 1 to 25 m into plastic bags. In the laboratory caprellids were separated using a Carl Zeiss Stemi DV4 stereoscopic microscope, examined under an Olympus optical microscope and preserved in 70% ethanol. The organisms were identified using specialized literature (Mayer, 1903; McCain, 1968; Chess, 1989; Laubitz, 1970; Sánchez-Moyano et al., 2014; Galván-Villa and Ayón-Parente, 2015). The classification system was based on that proposed by Myers and Lowry (2003) considering the Superfamily Caprelloidea, Family Caprellidae and Subfamily Caprellinae. Token specimens were deposited in the Laboratorio de Ecología Marina del Centro de Investigaciones Costeras, Centro Universitario de la Costa, Universidad de Guadalajara, México and Regional Collection of Marine Invertebrates, (ICML-EMU) at the Instituto de Ciencias del Mar y Limnología, UNAM, in Mazatlán, México. Abbreviations used for the collectors were: ATL; Adolfo Tortolero Langarica; KR, Karla Ríos; LCAO, Lucy Coral Alarcón Ortega and RSC, Rosa Sotelo Casas.

Results

A total of eight species of caprellids were documented.

Systematic account

Family Caprellidae Leach, 1814

Subfamily Caprellinae Leach, 1814

Genus *Aciconula* Mayer, 1903

Aciconula acanthosoma Chess, 1989

Aciconula acanthosoma Chess, 1989: 662–665, figs. 1–2. Sánchez-Moyano et al., 2014: 82, fig. 2. Soler-Hurtado and Guerra-García, 2016: 1–17, figs. 3–5.

Type locality: Santa Catalina Island, California

Distribution: USA: Santa Catalina Island, California (Chess, 1989). **Mexico:** Isla de los Pájaros and Isla Venado, Mazatlán, Sinaloa; Bahía Tiburón, Cerro Pelón and las Monas, Isla Isabel, Nayarit (Alarcón-Ortega et al., 2012; Sánchez-Moyano et al., 2014). **Ecuador:** Machalilla National Park, Manabí (Soler-Hurtado and Guerra-García, 2016).

Material examined: St. CB: 17 November 2015, on hydroids, 5 m depth, coll. LCAO, 1♀, 1♂ and 2 juveniles. **St. RE:** 17 November 2015, on hydroids, 7 m depth, coll. LCAO, 6♀, 3♂ and 8 juveniles. **St. CLI:** 15 September 2015, on green algae, at 7 m depth, coll.

Table 1 Locality and geographic coordinates of the sampling sites in the Mexican Pacific

Key station	Station (St.)	Area	State	Coordinates
CL	Cueva del Lobo	El Farallón	Sinaloa	25°26′07.70″ N; 109°22′39.95″ W
RE	Los Relices	El Farallón		25°26′09.51″ N; 109°22′29.88″ W
MM	Muelle Mazatlán	Mazatlán		23°10′51.76″ N; 106°25′14.52″ W
CLI	Cleofas I	Islas Marías	Nayarit	21°18′1.78″ N; 106°13′36.39″ W
CLII	Cleofas II	Islas Marías		21°18′1.93″ N; 106°13′37.16″ W
JG	Japanese garden	Islas Marías		21°17′54.1″ N; 106°13′27.4″ W
PO	Pocitas	Isla Isabel		21°50′ 32.27″ N; 105°53′02.95″ W
MS	Muelle San Blas	San Blas		21°32′38.72″ N; 105°17′32.70″ W
CO	Corbeteña Norte	Corbeteña		20°44′54.7″ N; 105°51′26.1″ W
CM	Cueva del Muerto	Islas Marietas		20°41′50.6″ N; 105° 34′58.1″ W
ZRS	Zona de Restauración Sur	Islas Marietas		20° 41′54.1″ N; 105° 34′58.1″ W
ZR	Zona de Restauración	Islas Marietas		20° 41′ 57.0″ N; 105° 34′55.6″ W
TA	Túnel Amarradero	Islas Marietas		20° 41′58.1″ N; 105° 33′57.1″ W
PP	Plataforma Pavonas	Islas Marietas		20° 42′ 50.2″ N; 105° 33′54.0″ W
PA	Playa del Amor	Islas Marietas		20° 42′ 14.1″ N; 105° 33′50.1″ W
PM	Punta de Mita	Punta de Mita		20°46′12.33″ N; 105°32′28.60″ W
BV	Bajo de las Viudas	La Cruz de Huanacaxtle		20°43′58.38″ N; 105°23′32.64″ W
NV	Nuevo Vallarta	Nuevo Vallarta		20°41′31.83″ N; 105°17′36.07″ W
AR	Los Arcos	Puerto Vallarta	Jalisco	20°32′39.10″ N; 105°17′33.71″ W
MI	Mismaloya	Puerto Vallarta		20°31′56.04″ N; 105°17′37.68″ W
COL	Colomitos	Puerto Vallarta		20°30′44.37″ N; 105°19′33.61″W
CH	Chimo	Cabo Corrientes		20°26′15.28″ N; 105°39′15.28″ W
AS	Arroyo Seco	La Huerta		19°18′35.92″ N; 104°57′19.41″ W
CU	Cuastecomatitos	Melaque		19°13′12.90″ N; 104°43′28.02″ W
LAB	Laboratorio 1	Melaque		19°13′52.50″ N; 104°45′21.34″ W
CUA	Cuastecomates	Melaque		19°13′45.33″ N; 104°43′59.18″ W
ME	Melaque	Melaque		19°13′04.61″ N;104°42′43.92″W
BO	La Boquita	Manzanillo	Colima	19°06′17.56″ N; 104°23′53.58″ W

ATL, 1 juvenile. **St. BV:** 25 March 2013, on turf, at 9 m, coll. LCAO, 1♀, 1♂ and 2 juveniles. **St. CM:** 14 January 2014, on turf, 6 m depth, coll. LCAO, 1♂ and 2 juveniles. **St. ZR:** 07 May 2013, collected from algae *Halimeda discoidea,* at 2 m coll. LCAO, 1♀. **St. ZRS:** 7 November 2013, on coral rubble, at 6 m depth, coll. LCAO, 1♀; 14 January 2014, on sponge, at 7 m depth, coll. LCAO, 1♀. **St. PP:** 22 January 2013, on turf, at 11 m depth, coll. LCAO, 1 ♀; 5 November 2013, on turf at 6 m depth, coll. LCAO, 1♀, 1♀; 22 February 2014, on encrusting coral *Porites panamensis* with epiphytic hydroids, at 6–12 m depth, coll. ATL, 2♀, 4♂, and 3 juveniles, (ICML-EMU 11786). **St. TA:** 28 January 2013, on turf, at 13 m depth, 1♀, 1♂; 15 January 2014, on sponge, at 7 m depth, coll. LCAO, 1♀, 2♂ and 2 juveniles. **St. PA:** 25 January 2013, on turf, at 6 m depth, coll. LCAO, 1♀, 2 juveniles; 15 January 2014, on turf, at 5.7 m depth, coll. LCAO, 1♀, 1♂. **St. AR:** 30 March 2014, on hydroids, 24 m depth, coll. LCAO, 1♀ and 2 juvenile; 30 March 2014, on algae *Padina* sp., 9 m depth, 8♀, 9♂ and 14 juveniles. **St. MI:** 20 September 2012, on hydroids, 6.40 m depth, coll. LCAO, 5♀, 5♂ and 5 juveniles (Fig. 2).

Diagnosis: Body length range 2.73–6.42 mm for males, and 2.6–4.86 mm for females. Body dorsally covered with acute spines. Head provided with four curved spines. Basis of gnathopod 2 provided with acute lateral projection. Gnathopod 2, palmar surface of propodus fitted with two distal triangular projections and mid excavation bordered proximally by strong spine, proximal surface with row of fine blunt serrations and single grasping spine. Pereopods 3 and 4 reduced with two articles. Pereopod 5 lacking grasping structures (typical of genus) (Chess, 1989).

Ecology: *Aciconula acanthosoma* was present on coral rubble, hydroids, macroalgae, gorgonians and sponge

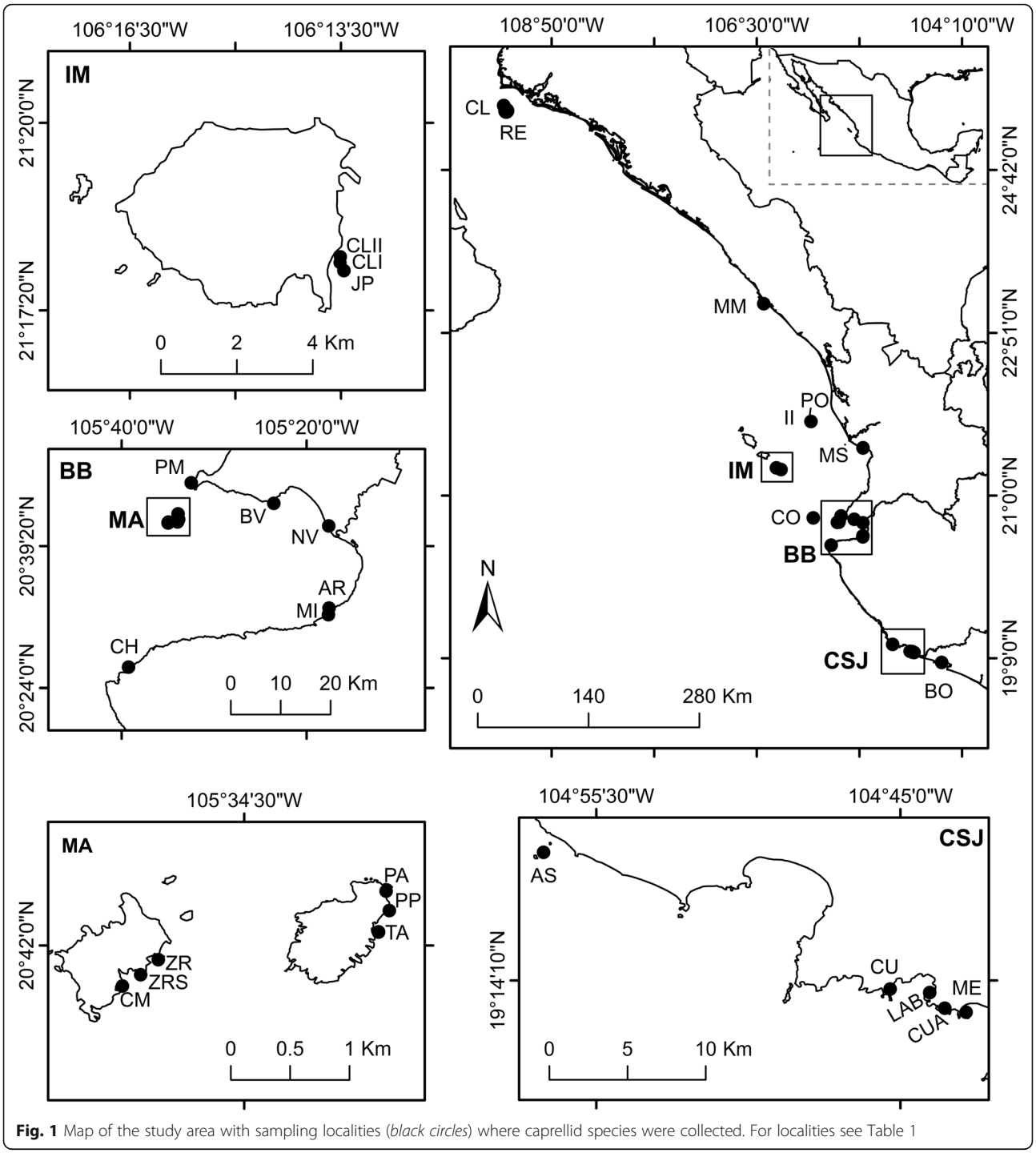

Fig. 1 Map of the study area with sampling localities (*black circles*) where caprellid species were collected. For localities see Table 1

being more abundant in turf, whilst Sánchez-Moyano et al. (2014) reported specimens were more abundant in sessile organisms (hydroids, gorgonians and bryozoans). The body is generally brown and covered with detritus mainly pereonite 5, and animals were observed feeding on this detritus with their first gnathopods. The principal dietary component of *A. acanthosoma* from the study area is mainly detritus, crustaceans and hydroids (Alarcón-Ortega et al., 2012). *A. acanthosoma* also is a dietary component of many fish species from the families Cottidae, Embiotocidae, Pomacentridae, Labridae, Labrisomidae, and Gobiidae (Chess, 1989). The species' abundance underwent seasonal variations, with higher numbers observed during the winter season, a similar pattern as reported by Chess (1989) and Soler-Hurtado and Guerra-García (2016).

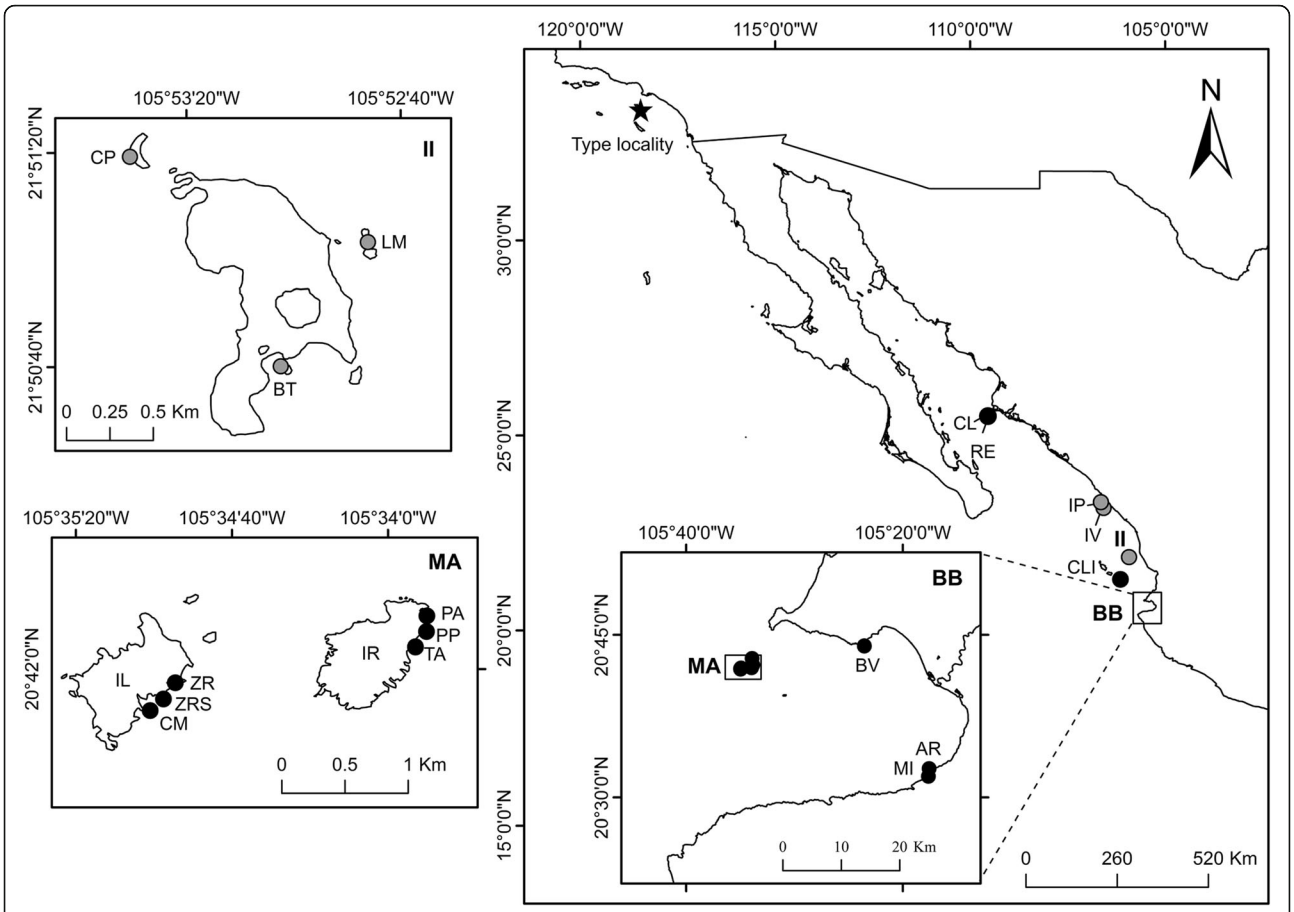

Fig. 2 Map of *Aciconula acanthosoma* distribution records along the Mexican Pacific coast. Localities: CL, Cueva del Lobo; RE, Los Relices; IP, Isla de los Pájaros; IV, Isla Venados; II, Isla Isabel; CP, Cerro Pelón; LM, Las Monas; BT, Bahía Tiburón; CLI, Cleofas I; BB, Bahía de Banderas; MA, Islas Marietas; CM, Cueva del Muerto; ZRS, Zona de Restauración Sur; ZR, Zona de Restauración, TA, Túnel Amarradero; PP, Plataforma Pavonas; PA, Playa del Amor; AR, Los Arcos; MI, Mismaloya. Filled star = type locality; gray circles = previous records from the Mexican Pacific; filled circle = new record

Caprella mendax Mayer, 1903

Caprella mendax Mayer, 1903, 114, pl. 5, fig. 9, 10, 11, pl. 8, 22. Laubitz, 1970: 59, fig. 18; Sánchez-Moyano et al., 2014: 89–93, figs. 6–8.

Examined material: St. CO: 13 October 2013, on gorgonians *Leptogorgia rigida,* 8 m depth, coll. LCAO, 13♀, 9♂, and 6 juveniles. **St. PM:** October 2013, on algae *Caulerpa* sp., 2 m depth, coll. LCAO, 1♂. **St. PP:** 19 March 2013, on hydroids *Lytocarpus nuttingui*, at 5 m depth, coll. LCAO, 7♀, 14♂ and 7 juveniles (IMCL-EMU 11787 B). **St. BV:** 06 February 2014, on *L. nuttingui*, at 9 m depth, coll. LCAO, 12♀, 15♂ and 6 juveniles (ICML-EMU 11787 A). **St. AR:** 30 March 2014, on hydroids, 24 m depth, coll. LCAO, 6♀, 10♂ and 5 juveniles; 20 September 2012, on hydroids, 6 m depth, coll. LCAO, 4♀, 4♂ and 3 juveniles. **St. MI:** 20 September 2012, on hydroids, 6 m depth, coll. LCAO, 4♀, 4♂ and 3 juveniles. **St. COL:** 09 June 2014, on hydroids, 11 m depth, coll. ATL, 2♀, 2♂. **St. CH:** 16 August 2014, on hydroids, 14 m depth, coll. LCAO, 11♀, 7♂ and 19 juveniles. **St. AS**: 28 April 2015, on hydroids and *L. rigida*, 6 m depth, coll. ATL, 14♀, 6♂ and 37 juveniles. **St. BO:** 10 December 2013, on hydroids, 2 m depth, coll. LCAO, 2♀, 2♂ and 2 juveniles (Fig. 3).

Type locality: California (the type locality was not specified, but the species was collected in Pacific Grove, Santa Barbara and San Diego).

Distribution: Canada: Vancouver Island and Strait of Hécate, British Columbia; San Juan Island, Washington (Laubitz, 1970; Caine, 1977), Humboldt Bay (Martin, 1977). **USA:** Dillon Beach, Moss Beach and Pacific Grove-Monterrey Bay, California (Dougherty and Steinberg, 1953); Santa Barbara, San Diego, California (Laubitz, 1970). **Mexico:** Isla de los Pájaros, Isla Venado and Estero de Urías in Mazatlán, Sinaloa (Sánchez-Moyano et al., 2014).

Diagnosis: Body length range 5.40–18.82 mm for males, 2.72–11.62 mm for females. Head without projections, body smooth with a small projection at the base of the second gnathopods. Antenna 1 longer than the pereonite 1, 2 and 3 combined with 16 articles in

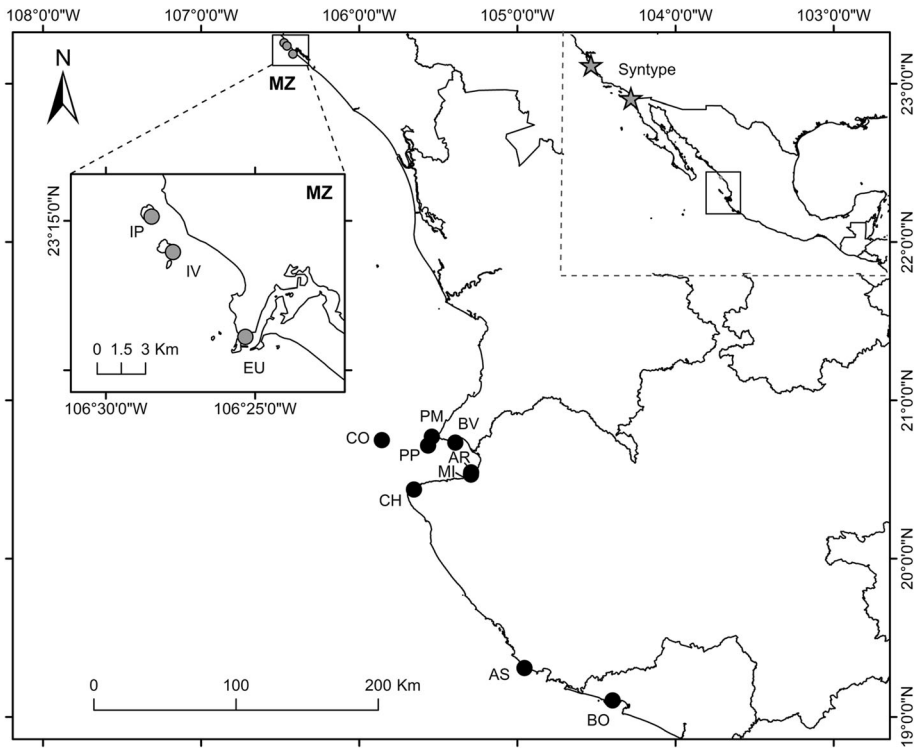

Fig. 3 Map of *Caprella mendax* distribution records along the Mexican Pacific coast. Localities: MZ, Mazatlán; IP, Isla de los Pájaros; IV, Isla Venado; EU, Estero Urías; CO, Corbeteña; PM, Punta de Mita; PP, Plataforma Pavonas; BV, Bajo Viudas; AR, Los Arcos; MI, Mismaloya; CH, Chimo; AS, Arroyo Seco; BO, La Boquita. Gray star = Syntype; gray circles = previous records from the Mexican Pacific; filled circle = new record

flagellum. Antenna 2 with abundant swimming setae. Ventral spine between the bases of Gnathopod 2 absent. Gnathopod 2, propodus with a proximal grasping spine with a small accessory spine and triangular projection distally. Basis of gnathopod 2 with an anterior denticulate carina. Gills present on pereonite 3 and 4, elliptical. Pereopods 5, 6 and 7 increasing in length, with propodus with proximal grasping spines and concave palm (Laubitz, 1970; Sánchez-Moyano et al., 2014).

Ecology: *Caprella mendax* has been collected from many substrates such as kelp forest, sand, boulders and hydroids from the intertidal zone to 80 m deep (Caine, 1977; Martin, 1977; Hammer and Zimmerman, 1979). *C. mendax* was the most abundant species collected in the study area, presenting high densities (7,297 ind.m^{-2}) on the hydroid *L. nuttingi* in the cold season, moreover, this species has been observed on seaweeds with epiphytic hydroids and on gorgonians (Sánchez-Moyano et al., 2014).

Caprella pitu Sánchez-Moyano et al., 2014

Caprella pitu Sánchez-Moyano et al., 2014: 17–26, figs. 9–14.

Material examined: **St. PO:** 16 August 2013, on gorgonian *L. rigida*, 2 m depth, coll. LCAO, 2♀ and 18 juveniles. **St. JP:** 26 April 2016, on *L. rigida*, 24 m depth, coll. LCAO, 1♂. **St. CLII:** 02 June 2016, on *Leptogorgia* sp., at 9 m depth, coll. ATL, 4♀. **St. CO:** 13 October 2013, on gorgonians *L. rigida,* 8 m depth, coll. LCAO, 5♀, 6 juveniles. **St. CM:** 07 November 2013, on *L. rigida,* at 4.87 m depth, coll. LCAO, 2♀, 1♂ and 8 juveniles. **St. ZR:** 07 November 2013, on *L. rigida,* at 2 m depth, coll. LCAO, 4♀, 2♂. **St. ZRS:** 7 November 2013, on *L. rigida*, at 5 m depth, coll. LCAO, 1♀ and 2 juveniles. **St. PP:** 22 January 2013, on *L. rigida* at 9 m, coll. LCAO, 1♀. **St. TA:** 08 May 2013, on *L. rigida* at 6 m depth, coll. LCAO, 10♀, 6♂. **St. PA:** 25 January 2013, on *L. rigida*, at 7 m depth, coll. LCAO, 1♀. **St. BV:** 28,May 2013, on gorgonian *L. cuspidata*, at 7 m depth, coll. LCAO, 11♀, 11♂ and 9 juveniles (ICML-EMU 11788 A); 12 November 2013, on *L. rigida*, at 5.5 m depth, coll. LCAO, 3♀, 2♂ and 3 juveniles. **St. AR:** 30 March 2014, on *L. rigida,* 24 m depth, coll. LCAO, 12♀, 4♂ and 46 juveniles. **St. MI:** 30 March 2014, on gorgonians *L. rigida,* 2 m depth, coll. LCAO, 12♀, 2♂ and 45 juveniles (ICML-EMU 11788B). **St. CH:** 16 August 2014, on *L. rigida,* 14 m depth, coll. ATL, 2♀ and 13 juveniles. **St. AS**: 28 April 2015, on *L. rigida*, 6 m depth, coll. ATL, 23♀, 7♂ and 126 juveniles. **St. CUA:** 11 December 2013, on *Leptogorgia* sp., 3 m depth, coll. LCAO, 10♀, 2♂ and 10 juveniles. **St. LAB:** 12 December 2013, on *L. cuspidata*, 3 m depth, coll. LCAO, 27 ♀, 22♂ and 19 juveniles (Fig. 4).

Type locality: Isla de los Pájaros, Mazatlán, Mexico (Fig. 4).

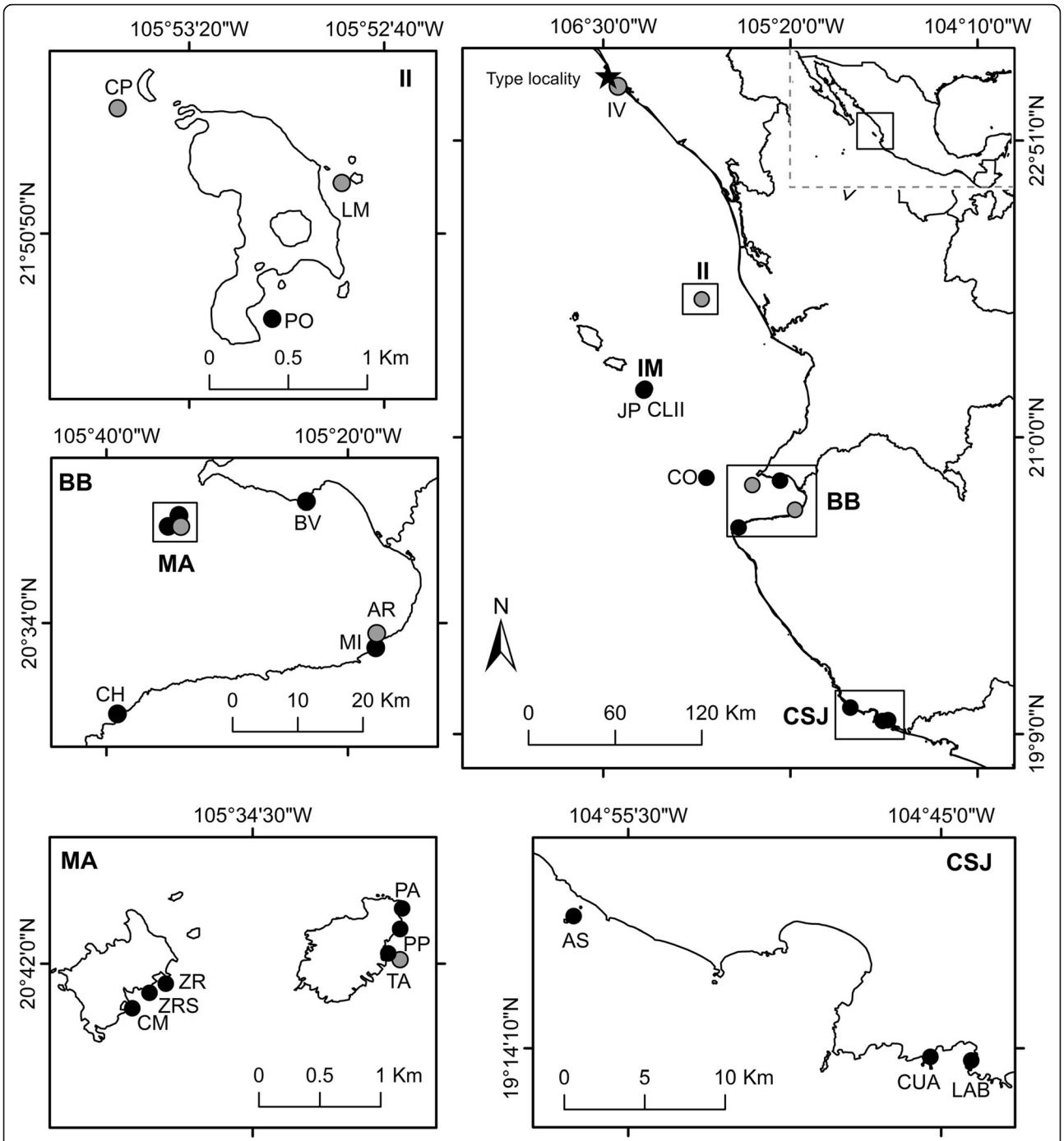

Fig. 4 Map of *Caprella pitu* distribution records along the Mexican Pacific coast. Localities: IV, Isla Venado; II, Isla Isabel; CP, Cerro Pelón; LM, Las Monas; PO, Pocitas; MA, Islas Marias; BB, Bahía de Banderas; CO, Corbeteña; MA, Islas Marietas; CM, Cueva del Muerto; ZRS, Zona de Restauración Sur; ZR, Zona de Restauración; TA, Túnel Amarradero; PP, Plataforma Pavonas; PA, Playa del Amor; BV, Bajo Viudas; AR, Los Arcos; MI, Mismaloya; CH, Chimo; AS, Arroyo Seco; CU, Cuastecomatitos; LAB, Laboratorio 1. Filled star = type locality; gray circles = previous records from the Mexican Pacific; filled circle = new record

Distribution: Mexico: Isla de los Pájaros and Isla Venado, Mazatlán, Sinaloa; Las Monas in Isla Isabel and Islas Marietas, Nayarit; Los Arcos, Jalisco (Sánchez-Moyano et al., 2014).

Diagnosis: Body length range 3.07–5.52 mm for males and 2.03–3.978 mm for females. Head provided with a short, triangular projection. Body stout and wide with tiny tubercles; in dorsal view, body wide, with lateral and

flat expansion mainly in pereonites 3 and 4. Peduncle of antenna 1 scarcely setose. Gnathopod 2 basis short with an anterior carina; palm of propodus with an acute projection medially and a rounded distal one. Pereiopods 3 and 4 absent. Gills rounded. Pereiopods 5–7 robust and increasing in length; carpus elongate and palm of propodus without grasping spines; dactylus short and robust (Sánchez-Moyano et al., 2014).

Ecology: *Caprella pitu* has been found on different species of gorgonians (*Leptogorgia* sp., *L. rigida, L. peruviana, L. alba, Pacifigorgia* sp. and *P.* cf. *agassizzi*), and was abundant in *L. rigida* between 2–25 m depth in coral reef areas (Sánchez-Moyano et al., 2014, *present study*). Moreover, *C. pitu*, shared its habitat with numerous brittle stars [*Ophiactis simplex, Ophiothela mirabilis, Ophiothrix (Ophiothrix) spiculata, O. (Ophiothrix) rudis*], mainly in BV. This species shows body pigmentation related to the coloration of the substrate they are sheltering in (clear with pink spots, purple or dark brown with yellow spots), possibly to avoid detection by predators.

Caprella suprapiscis Galván-Villa and Ayón-Parente, 2015

Caprella suprapiscis Galván-Villa and Ayón-Parente, 2015: 572–576, figs. 2–6.

Examined Material: St. BV: 25 March 2013, collected from gorgonian *Leptogorgia alba*, at 7 m depth, 4♀, 6♂ and 3 juveniles. 06 January 2014, from *L. alba*, at 8 m depth, 8♀, 9♂ and 10 juveniles, (ICML-EMU 11789) (Fig. 5).

Type locality: Isla Cocinas, Bahía Chamela, Jalisco, Mexico (Fig. 5).

Distribution: Mexico: Isla Cocinas, Isla Pajarera, Isla Colorada, and San Agustín in Bahía de Chamela, Jalisco (Galván-Villa and Ayón-Parente, 2015).

Diagnosis: Body length between 4.04–9.95 mm for males, 4.08–6.65 mm for females. Body slender and smooth except for the dorsal cephalic projection. Antenna 1 about half of the body length, peduncle scarcely setose. Propodus of gnathopod 2 elongate, length about 3 times width, dorsal surface slightly convex, dorsal and ventral margins finely setose, with one proximal projection provided with a robust seta 2/5 from proximal end of ventral margin palm; another projection in the middle, followed by "U" notch distally; dactylus falcate, setose on dorsal and lateral margins. Pereopods 3 and 4 absent, 5–7 increasing in length, scarcely setose (Galván-Villa and Ayón-Parente, 2015).

Ecology: *Caprella suprapiscis* has been reported living on the body of the fish *Scorpaena mystes*, associated with coral and rocky reefs between 5–7 m depth (Galván-Villa and Ayón-Parente, 2015). In the study area *C. suprapiscis* was found only on the octocoral *Leptogorgia alba*, sharing habitat with numerous brittle stars such as *O.* (*Ophiothrix*) *spiculata, O. simplex, O.* (*Ophiothrix*) *rudis* and *O. mirabilis* and also others caprellids (*C. mendax, A. acanthosoma* and *P. isabelae*), isopods and gastropods at 4.5–11 m depth. The body color differs

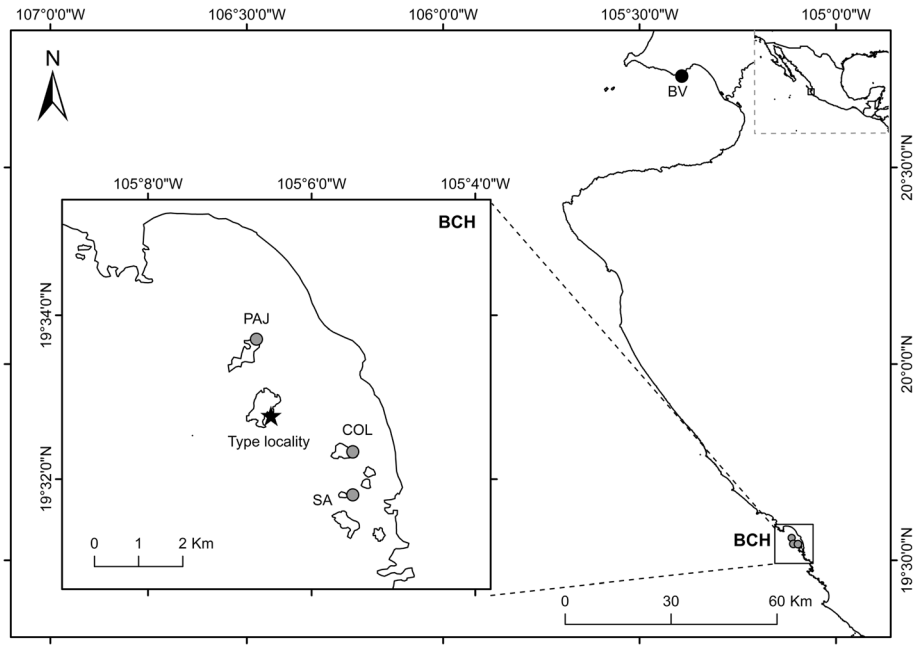

Fig. 5 Map of *Caprella suprapiscis* distribution records along the Mexican Pacific coast, and previous records in the area. PAJ, La Pajarera; COL, Colorado; SA, San Agustín; BV, Bajo de las Viudas. Filled star = type locality; *gray circles* = previous records from the Mexican Pacific; filled circle = new record

according to the substrate (Galván-Villa and Ayón-Parente, 2015); in the area, *C. suprapiscis* body pigmentation was clear with pink spots.

Genus *Liropus* Mayer, 1890

Liropus isabelensis Sánchez-Moyano et al., 2014

Sánchez-Moyano et al., 2014: 26–32, figs. 15–18.

Material Examined: CM: 14 January 2014, on turf, at 7 m depth, coll. LCAO, 3♀, 3♂, (ICML-EMU 11790). **ZR:** 07 May 2013, on coral rubble, at 3.90 m depth, coll. LCAO, 3♀, 5♂; 03 September 2013, on algae *Halimeda discoidea* at 1.8, depth, coll. LCAO, 2♀, 5♂. **ZRS:** 10 July 2013, on coral rubble at 4.6 m depth, coll. LCAO, 5♀, 3♂, 6 juveniles. **PP:** 08 May 2013, on coral rubble at 9 m depth, coll. LCAO, 1♀, 2♂. **TA:** 08 May 2013, on coral rubble, at 12 m depth, coll. LCAO, 4♀, 4♂. **PA:** 19 March 2013, on turf, at 3 m depth, coll. LCAO, 1♀, 5♂ and 2 juveniles (Fig. 6).

Type locality: Cerro Pelón, Isla Isabel, Nayarit, Mexico (Fig. 6).

Distribution: Mexico: Isla de los Pajáros, Mazatlán, Sinaloa; Bahía Tiburón, Isla Isabel, Nayarit.

Diagnosis: Body length range 1.94–2.27 mm for males, and 1.48–1.98 mm for females. Head rounded without projections; eyes present. Body dorsally smooth. Anterolateral acute and downward-directed projections on pereonite 2 and mediolateral projections on pereonite 3 in males. Flagellum of antenna 1 five-articulate. Gnathopod 2 basis slightly longer than pereonite 2; ischium and propodus elongate. Pereopods 3, 4 and 5 one-articulate. Abdomen without appendages in males (Sánchez-Moyano et al., 2014).

Ecology: *Liropus isabelensis* has been found on hydroids, gorgonians, bryozoans and seaweed with epiphytic hydroids (Sánchez-Moyano et al., 2014). This species was abundant mainly on coral rubble *Pocillopora* spp. and calcareous macroalgae *H. discoidea* but was also collected in turf and sponge, mainly associated with shallow water in coral reef ecosystems.

Genus *Paracaprella* Mayer, 1890

Paracaprella carballoi Sánchez-Moyano et al., 2014

Sánchez-Moyano et al., 2014: 32–39, figs. 19–22.

Material examined: St. PM: 06 July 2015, on algae *Padina* sp. with epiphyte hydroids, 3 m depth, coll. LCAO, 4♀, 5♂ and 3 juveniles, (ICML-EMU 11791). **St. ZRS:** 7 May 2013, on algae *H. discoidea,* at 3.9 m depth, coll. LCAO, 1♀, 3♂. **St. ZR:** 07 May 2013, on algae *H. discoidea*, 4.9 m depth, 1♀, 2♂ (Fig. 7).

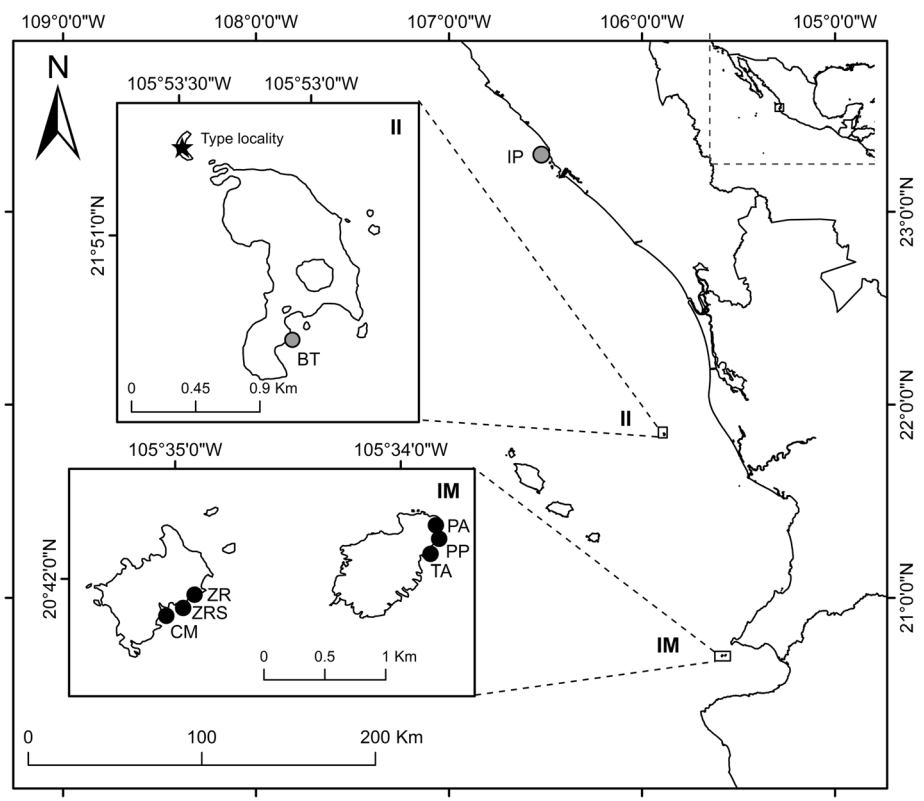

Fig. 6 Map of *Liropus isabelensis* distribution records along the Mexican Pacific coast, and the previous records in the area. IP, Isla de los Pájaros; II, Isla Isabel; BT, Bahía Tiburón; MA, Islas Marietas; BT, Bahía Tiburón; CM, Cueva del Muerto; ZRS, Zona de Restauración Sur; ZR, Zona de Restauración; TA, Túnel Amarradero; PP, Plataforma Pavonas; PA, Playa del Amor. Filled star = type locality; gray circles = previous records from the Mexican Pacific; filled circle = new record

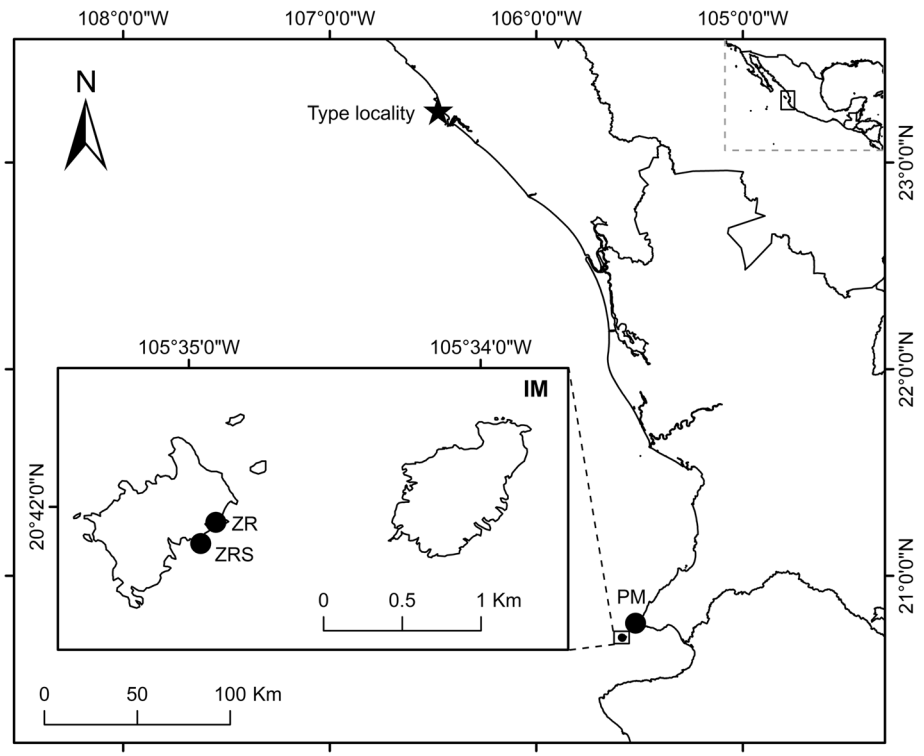

Fig. 7 Map of *Paracaprella carballoi* distribution records along the Mexican Pacific coast. Localities: PM, Punta de Mita; IM, Islas Marietas; ZRS, Zona de Restauración Sur; ZR, Zona de Restauración. Filled star = type locality; gray circles = previous records from the Mexican Pacific; filled circle = new record

Type locality: Isla de los Pájaros, Mazatlán, Mexico (Fig. 7).

Distribution: Only known from type locality.

Diagnosis: Body length range 2.53–4.31 mm for males, and 2.24–3.19 mm for females. Head rounded. Body dorsally smooth, except pereonite 2 with a rounded and narrow anterolateral projection (only in males). Flagellum of antenna 1 nine-articulate; peduncle scarcely setose. Antenna 2 a little shorter than the peduncle of antenna 1, swimming setae absent. Basis of gnathopod 2 with two distal short processes on lateral margin. Propodus of gnathopod 2 palm with rectangular projection proximally, carrying two proximal grasping spines and a distal robust tooth. Pereopods 3 and 4 two-articulate. Pereopods 5–7 without grasping spines. Abdomen with a pair of setose uni-articulate appendages (Sánchez-Moyano et al., 2014).

Ecology: A few specimens of *P. carballoi* were collected on algae *Padina* sp. and *H. discoidea* associated with coral reef ecosystems in two stations (ZR and ZRS) of this study. Moreover, the species has been found on octocorals *Leptogorgia rigida* and on seaweed *Zoonaria* cf. *farlowii* with small hydroids (Sánchez-Moyano et al., 2014).

Paracaprella isabelae Sánchez-Moyano et al., 2014

Sánchez-Moyano et al., 2014: 39–48, figs. 23–26.

Examined material: St. CLII: 02 June 2016, on hydroid, at 9 m depth, coll. ATL, 1♂. **St. CM:** 25 January 2013, on hydroids, 4 m depth, coll. LCAO, 1♀, 1♂; 14 January 2014, on algae *H. discoidea,* 4 m depth, coll. LCAO, 1♀, 1♂. **St. ZR:** 14 March 2013, on *H. discoidea*, at 2.13 m depth, coll. LCAO, 1♂. **St. ZRS:** 14 March 2013, on hydroid, at 4.5 m depth, coll. LCAO, 1♂. **St. PP:** 15 January 2014, on hydroids *L. nuttingi*, at 8 m depth, coll. LCAO, 1♀, 2♂. **St. TA:** 15 January 2014, on sponge *Aplysina gerarodegreeni*, at 5 m depth, coll. LCAO, 2 ♂. **St. PA:** 19 March 2013, on turf, at 8 m depth, coll. LCAO, 1♀, 2♂. **St. BV:** 28 May 2013, on sponge, at 7 m depth, coll. LCAO, 6♀, 6♂, (ICML-EMU 11792). **St. CH:** 16 August 2014, on hydroids, 14 m depth, coll. LCAO, 5♀, 2♂ and 7 juveniles. **St. AS:** 28 April 2015, on hydroids and *L. rigida*, 6 m depth, coll. ATL, 3♀, 1♂ and 1 juvenile. **St. CU:** 11 December 2013, on hydroids, 3 m depth, coll. LCAO, 1♂. **St. LAB:** 10 December 2013, on hydroids, 2 m depth, coll. LCAO, 1♂. **St. BO**10 December 2013, on hydroids, 2 m depth, coll. LCAO, 3♀, 4♂ (Fig. 8).

Type locality: Las Monas, Isla Isabel, Nayarit, Mexico (Fig. 8).

Distribution: Mexico: Cerro Pelón and Bahía Tiburón, Isla Isabel, Nayarit.

Diagnosis: Body length range 3.08–7.86 mm for males, and 2.31–5.15 mm for females. Head rounded and dorsally

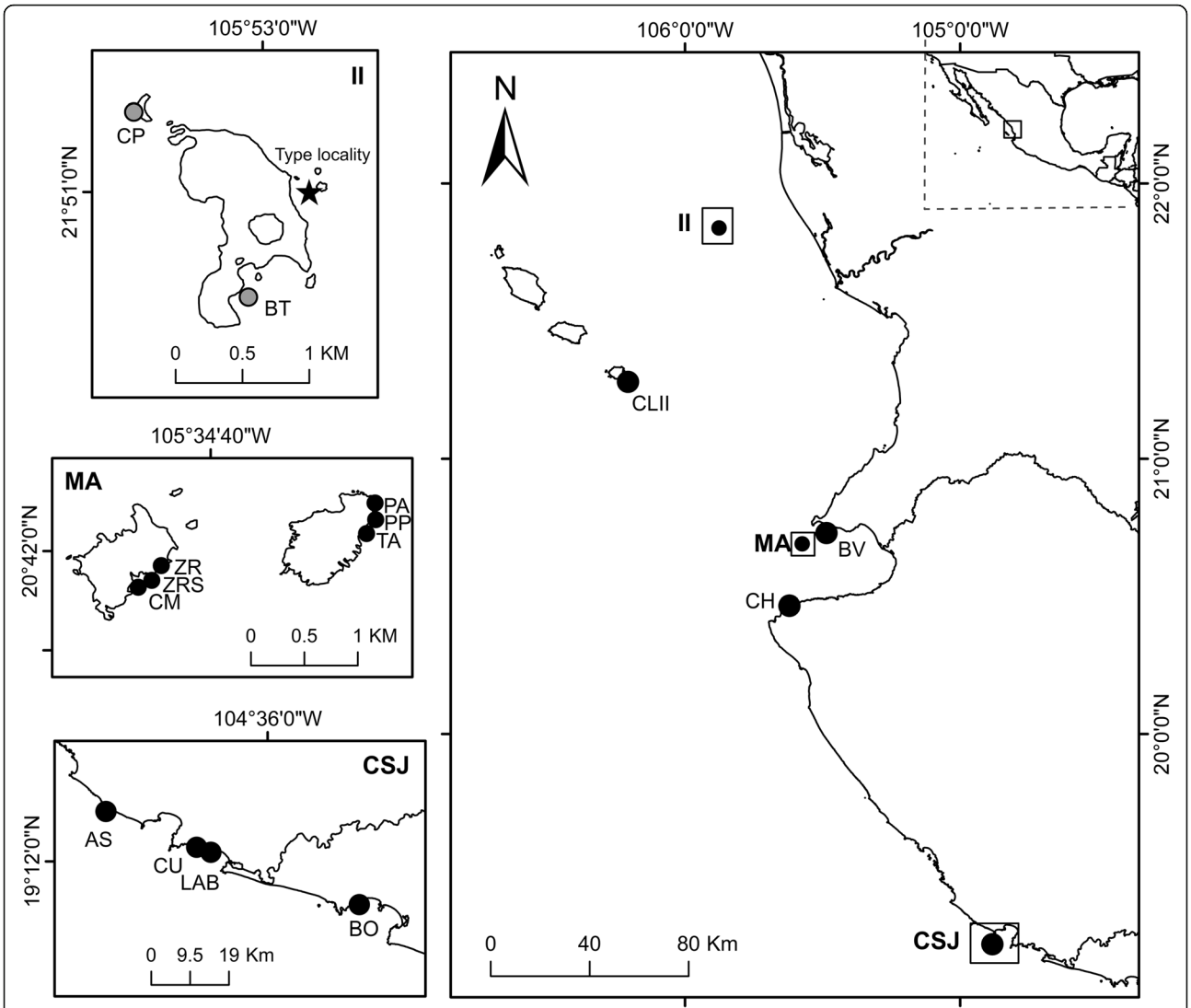

Fig. 8 Map of *Paracaprella isabelae* distribution records along the Mexican Pacific coast. Localities: Il, Isla Isabel; CP, Cerro Pelón; BT, Bahía Tiburón; MA; Islas Marietas; CM, Cueva del Muerto; ZRS, Zona de Restauración Sur; ZR, Zona de Restauración; TA, Túnel Amarradero; PP, Plataforma Pavonas; PA, Playa del Amor; CSJ, Costa Sur de Jalisco; AS, Arroyo Seco; CU, Cuastecomates; LAB, Laboratorio 1; BO, La Boquita. Filled star = type locality; gray circles = previous records from the Mexican Pacific; filled circle = new record

humped. Large bifid sharp-pointed anterolateral projection on anterior margin of pereonite 2 in males, simple and rounded in females. Pereonite 3 with a rounded anterolateral projection in males. Short ventral forward-directed projection between the gnathopods 2. Propodus palm of gnathopod 2 with rectangular projection proximally, bearing one proximal grasping spine and a distal long robust tooth in males. Pereopods 3 and 4 two-articulate. Pereopods 5–7 without grasping spines. Abdomen with a pair of setose uni-aticulate appendages in male (Sánchez-Moyano et al., 2014).

Ecology: *Paracaprella isabelae* does not present specific substrate preferences because the species was collected from different substrates such as hydroids, bryozoans (*Bugula* sp.), sponge, fishing net, turf, algae (*H. discoidea* and *Padina* sp.), gorgonians (*Leptogorgia* spp. and *M. austera*) and coral rubble (*Pocillopora* spp.), distributed on a depth range of 2–25 m depth, a similar pattern to that reported by Sánchez-Moyano et al. (2014). The feeding behavior of this genus is mainly scraping and predation, eating detritus and crustaceans, grasping inorganic materials from the substrata (Caine, 1974; Alarcón-Ortega et al., 2012).

Paracaprella pusilla Mayer, 1890

Paracaprella pusilla Mayer, 1903: 41, pl. 1, figs. 28–30; pl. 2 36, 37; figs. pl. 3, figs. 45–47; pl. 5; figs. 48,49; pl. 6, fig. 10; 1903: 67; pl. 7, fig. 52. Edmonson and Mansfield 1948: 208–2010, fig. 4. Steinberg and Dougherty, 1957:

283–284, figs. 16, 19, 24, 30. McCain, 1968: 82–86, figs. 41–42. Serejo, 1998: 381, fig. 7j, l. Ortiz et al. 2002: fig. 37. Foster 2004: 165, fig. 5a–f. Díaz et al., 2005: 3, 6–7, fig. 13. Guerra-García et al. 2006: 175–178, figs. 17–19. Krapp-Schickel et al. 2006: 175–178, figs 17–19. Escobar-Briones et al. 2007: 30, 47, 49, fig. 16. Bhave and Deshmukh, 2009: 112, figs. 1–2. Guerra-García et al. 2010: 304–305, fig. 8. Ros et al. 2013: 71, fig. 2. Alarcón-Ortega et al., 2015: 213, fig. 2.

Caprella nigra Reid 1951: 283–284, 289, fig. 58.

Examined material: St. MM: 04 December 2013, on red algae, >1 m depth, coll ATL, 1♀, 1♂. **St. MS:** 16 October 2013, on hydroid, at >1 m depth, coll. ATL, 4♀, 5♂ (ICML-EMU 11039 A); 21 November 2013, on sponge, at >1 m depth, coll. LCAO, 4♀, 4♂ (ICML-EMU 11039 B). **St. NV:** 03 June 2013, on hydroid, at >1 m, coll. LCAO, 1♀, 1♂ (ICML-EMU 11040 B); 21 July 2013, on bryozoans, >1 m depth, coll. LCAO, 1♀, 1♂. **St. ME:** 26 March 2014, associated with oyster farm on macroalge *Enteromorpha* sp., >1 m depth coll. KR, 2♀, 3♂ (ICML-EMU 11040 A) (Fig. 9).

Type locality: Rio de Janeiro, Brazil (Fig. 9).

Distribution: Mexico: Sinaloa, Nayarit and Jalisco (Alarcón-Ortega et al., 2015). **Panama:** Panama Canal (Ros et al., 2014). See Ros and Guerra-García (2012); Ros et al. (2014).

Diagnosis: Head without projections; smooth body with a large anterolateral projection on pereonite 2; presence of a small dorsal tubercle on pereonite 2. Peduncle of antenna 1 setose and usually longer than antenna 2. Antenna 2 without swimming setae but densely setose. Propodus of gnathopod 1 with one proximal grasping spine; basis of gnathopod 2 with a proximal knob and propodus with trapezoidal projection on the inner margin.

Ecology: *Paracaprella pusilla* has been collected from mangrove roots, seagrasses, hydroids, ascidians, bryozoans, sponge, gravel bottoms, ropes, mussels and oysters

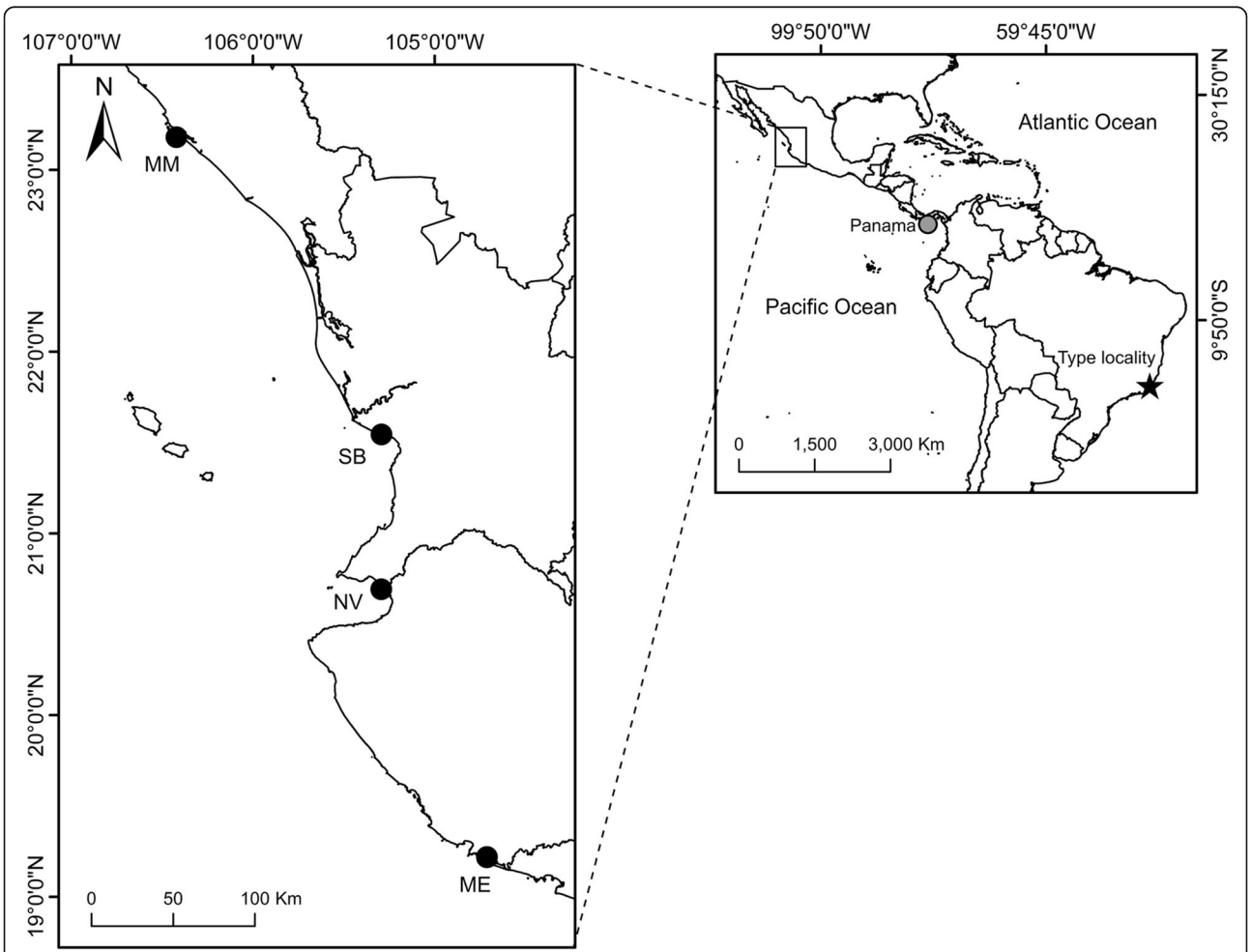

Fig. 9 Map of *Paracaprella pusilla* distribution records along the Mexican Pacific coast. Localities: MM, Marina Mazatlan; SB, San Blas; NV, Nuevo Vallarta; ME, Melaque. Filled star = type locality; gray circles = previous records from the Mexican Pacific; filled circle = new record

mainly associated with fouling communities such as docks, floating pontoon, ballast water (McCain, 1968; Caine, 1978; Díaz et al., 2005; Bhave and Deshmukh, 2009; Ros et al., 2014; Alarcón-Ortega et al., 2015). The feeding strategy of *P. pusilla* is a carnivorous one, and its diet consists mainly of crustaceans, detritus and hydroids; moreover, its feeding strategies may change between natural and artificial habitats (Ros et al., 2014).

Conclusion

The present study includes new distribution records of eight caprellid species, mainly associated with coral reef ecosystems in different localities along 840 km of the Mexican Pacific coastal region (Figs. 2, 3, 4, 5, 6, 7, 8 and 9; Table 2). These reports increase the species richness in the region: three species were added for Nayarit (*C. suprapiscis, C. mendax,* and *P. carballoi*), three from Jalisco (*P. isabelae, A. acanthosoma*, and *C. mendax*) and one from Colima (*P. isabelae*).

At the species level, we highlight the invasive species *Paracaprella pusilla* which presents a notably isjunct distribution in the northern tropical east Pacific (Fig. 9; Table 2). The vector of introduction of this species in the area is still unknown (Ros et al., 2014). Documenting the extent of invasive non-native species is important because they may constitute threats to the local native fauna. We also highlight the substantial southward extension of *C. mendax,* which has been previously reported in Mexico only from Mazatlán, Sinaloa. Other important records relate to *A. acanthosoma,* which seems to have wide distribution throughout the Southern California to the Tropical East Pacific (Chess 1987; Alarcón-Ortega et al., 2012; Sánchez-Moyano et al., 2014; Soler-Hurtado and Guerra-García, 2016). *C. suprapiscis* (Isla Cocinas, Jalisco) and *P. carballoi* (Isla de los Pájaros, Sinaloa) were previously only recorded from their type localities associated with coral communities; the records presented here expand their known distributions northward and southward, respectively (Figs. 5 and 7; Table 2). It is possible that these species present strong affinities to coral communities. The results of this study highlight the importance of reef ecosystems for caprellid diversity, potentially due to the provision of numerous microhabitats (including hydroids, algae, octocorals and coral rubble) which may promote species diversity (Guerra-García, 2006; Kramer et al., 2014). At this point, the caprellid biota is commonly distributed along the Mexican coast and probably the distributions of the species recorded may extend beyond this area. Therefore, an intensive sampling effort in a wide variety of substrates and habitats along the entire ETP is recommended in order to determine species richness, diversity and potential caprellid community distribution zones over the Pacific Ocean.

Table 2 Extension of known ranges (Km) of caprellid species from the Mexican Pacific

Species	Range extension	Distance (Km)	See figure
Aciconula acanthosoma	Isla de los Pájaros to El Farallón	~384.02 Km N	2
	Isla Isabel to Mismaloya	~158.16Km S	
Caprella mendax	Esteró Urías to La Boquita	~500.30 Km S	3
Caprella pitu	Los Arcos to Laboratorio 1	~156.56 Km S	4
Caprella suprapiscis	Isla Cocinas to Bajo de las Viudas	~92.47 Km N	5
Liropus isabelensis	Isla Isabel to Islas Marietas	~131.10 Km S	6
Paracaprella carballoi	Isla de los Pájaros to Islas Marietas	~298.78 Km S	7
Paracaprella isabelae	Isla Isabel to La Boquita	~341.80 Km S	8
Paracaprella pusilla	The Panama Canal to Mazatlán	~3272.77 Km N	9

N North, *S* South

Abbreviations

AR: Los Arcos; AS: Arroyo Seco; ATL: Adolfo Tortolero Langarica; BO: La Boquita; BV: Bajo de las Viudas; CH: Chimo; CL: Cueva del Lobo; CLI: Cleofas I; CLII: Cleofas II; CM: Cueva del Muerto; CMP: Central Mexican Pacific; CO: Corbeteña Norte; COL: Colomitos; CU: Cuastecomatitos; CUA: Cuastecomates; ETP: Eastern Tropical Pacific; JG: Japanesegarden; Km: Kilometers; KR: Karla Ríos; LAB: Laboratorio 1; LCAO: Lucy Coral Alarcón Ortega; m: meters; ME: Melaque; MI: Mismaloya; mm: millimeters; MM: Muelle Mazatlán; MP: Mexican Pacific; MS: Muelle San Blas; N: North; NV: Nuevo Vallarta; PA: Playa del Amor; PM: Punta de Mita; PO: Pocitas; PP: Plataforma Pavonas; RE: Los Relices; RSC: Rosa Sotelo Casas; S: South; TA: Túnel Amarradero; ZR: Zona de Restauración; ZRS: Zona de Restauración Sur

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Availability of data and materials

All data associated with these publications are contained herein; the specimens were deposited in the Laboratorio de Ecología Marina del Centro de Investigaciones Costeras, Centro Universitario de la Costa, Universidad de Guadalajara, Mexico and Regional Collection of Marine Invertebrates (ICML-EMU) at the Instituto de Ciencias del Mar y Limnología, UNAM, in Mazatlán, México.

Authors' contributions

All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing of interest.

Consent for publication

The authors freely consent to the publication of this paper.

Ethics approval and consent to participate
Not applicable.

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