

Rapid Communication

First record of non-indigenous *Paracaprella pusilla* Mayer, 1890 (Crustacea: Amphipoda: Caprellidae) in Golfo de Nicoya, Pacific Coast of Costa Rica

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Abstract

The caprellid *Paracaprella pusilla* from the Western Atlantic Ocean is reported for the first time in Golfo de Nicoya, Pacific coast of Costa Rica, representing the third registered invasion of this species in the Eastern Tropical Pacific (ETP), after Panama and Mexico. Individuals of *P. pusilla* at all stages of development, including juveniles, females (non ovigerous and ovigerous) and males, were sampled from submerged artificial structures at five locations along the coastal waters of Golfo de Nicoya between September 2014 and September 2017. This new report for the ETP indicates that the amphipod is well established in a tropical estuary of Costa Rica: Golfo de Nicoya, and represents the first caprellid reported from littoral waters of this country.

Key words: invasive species, Caprellidae, artificial structures, Pacific coast, Central America

Introduction

Costa Rica is part of the Eastern Tropical Pacific (ETP) region, which is one of the most diverse biogeographic provinces of the world, with high connectivity due to its oceanographic conditions (Alarcón-Ortega et al. 2017). In spite of this, the present knowledge of the Caprellidae from Central America is negligible. Caprellids were, until recently, included in the suborder Caprellidea Leach, 1814; however, a new suborder Senticaudata has been proposed by Lowry and Myers (2013) based on phylogenetic and cladistics analysis, including the family Caprellidae. Marine amphipods of the family Caprellidae have not been studied from the continental coasts of Costa Rica (Wehrtmann and Cortés 2009; Alarcón-Ortega et al. 2017); the only species reported are *Abbyssicaprella galathea* McCain, 1966, collected from the Pacific Ocean at depths between 3501–4004 m and *Caprella scaura* Templeton, 1836, collected from Coco Island (McCain 1966; McCain and Steinberg 1970).

Golfo de Nicoya, on the Pacific coast of Costa Rica, is an important tropical estuary that supports fishing activities that generate 30% of domestic seafood consumption. This estuary is divided into the upper shallow gulf (< 20 m in depth) and the lower deeper gulf (25–100 m in depth), and fishing efforts are regulated through the Marine Areas for Responsible Fishing (Brenes et al. 2001; García-Rojas and Vega-Bolaños 2016; Symonds et al. 2017). This study documents the first record of *Paracaprella pusilla* (Caprellidae) from the Golfo de Nicoya. *Paracaprella pusilla* is a caprellid native to the Western Atlantic Ocean, first described from Rio de Janeiro, Brazil (Mayer 1890), and its natural distribution corresponds to the coastal waters of Central and South America, including the Gulf of Mexico and the Caribbean, being a predominant species in Venezuela and Colombia (Díaz et al. 2005; Guerra-García et al. 2006). This species has become an invasive crustacean around the world including in Spain, the Mediterranean Sea, Africa, India, and the Pacific Ocean

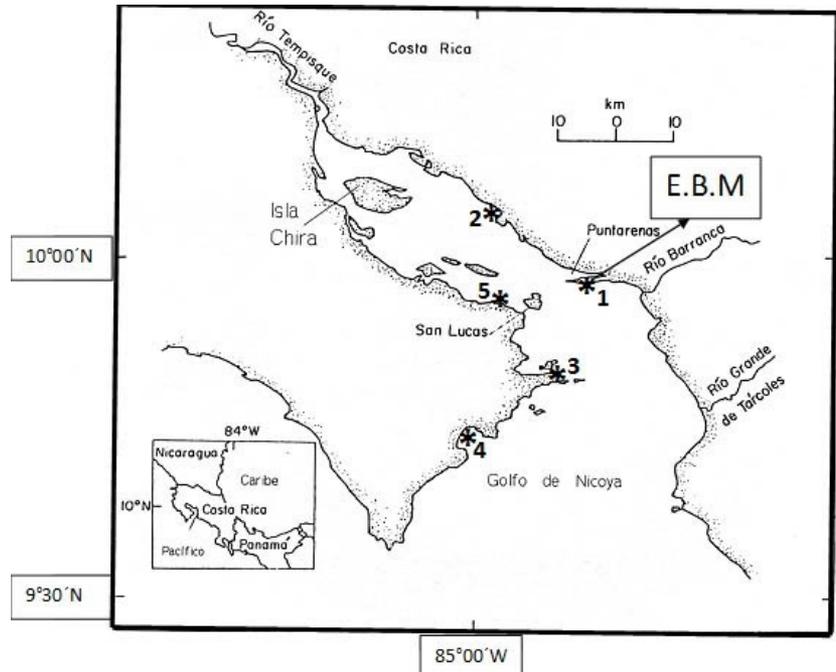


Figure 1. Golfo de Nicoya, Costa Rica, showing the geographical location of sampling stations where specimens of *Paracaprrella pusilla* were collected.

1) Dock-Puntarenas, 2) Punta Morales, 3) Punta Cuchillo, 4) Bahía Ballena: Pochote-Tambor, 5) Bouy 8-Playa Naranjo. E.B.M = Marine Biology Research Station, UNA.

Table 1. Descriptive information of sampling stations for caprellids from the Golfo de Nicoya.

Location	Coordinates		Type of submergible structure ^a	Record data	Substrata collected ^b
	Latitude, N	Longitude, W			
1. Dock: Puntarenas	9°58'27"	84°49'53"	Wp	March 12, 2015	Ma-Br
2. Punta Morales	10°04'15"	84°57'42"	Fb	September 30, 2014	Ma
3. Punta Cuchillo	9°49'56"	84°52'26"	Fr, Sm, Nr, Fg	September 6, 2015	Ma-Br
4. Bahía Ballena: Pochote-Tambor	9°44'01"	85°00'23"	Fr, Sm, Nr, Fg	November 28, 2014	Ma-Br
5. Bouy 8: Playa Naranjo	9°56'39"	84°57'35"	Fb	September 31, 2017	Ma

^aSubmerged structures: Fb = fishing buoy, Fr = fish culture raft, Wp = wooden pillars, Sm = synthetic mesh, Nr = nylon rope, Fg = fiberglass.

^bSubstrata: Ma = macroalgae, Br = bryozoan.

in Australia, Hawaii, Panama, and Mexico (Ros and Guerra-García 2012; Ros et al. 2014; Alarcón-Ortega et al. 2015). Panama and Mexico are, so far, the only countries of the ETP region where *P. pusilla* has been reported. The record is complemented with basic information about geographical distribution within the Gulf and population structure.

Material and methods

Submerged substrata of different constitutions were hand-scraped from different structures (i.e., fishing buoys, fish culture rafts, wooden pillars, synthetic mesh, nylon rope, and fiberglass) in five locations in Golfo de Nicoya at less than 1 m depth between

September 2014 and September 2017 (Figure 1; Table 1). Samples were transported in water containers to the Estación de Biología Marina (EBM), UNA, in Puntarenas, for caprellid isolation and preservation in ethanol 95%. Specimens were identified based on the descriptions provided by McCain (1968), Diaz et al. (2005), Guerra-García et al. (2006), and Alarcón-Ortega et al. (2015) and stored in the Museo de Zoología, Escuela de Biología, Universidad de Costa Rica, with the museum collection number MZUCR3523-01.

Every individual was digitalized under the stereomicroscope, and the total body length (TBL), measured from the front of the head to the end of pereonite 7, was estimated using the software Scopeimage 9.0 (<http://www.lifescientz.com/Digital-Imaging-Microscope-Software.htm>). TBLs were processed as mean \pm SD,

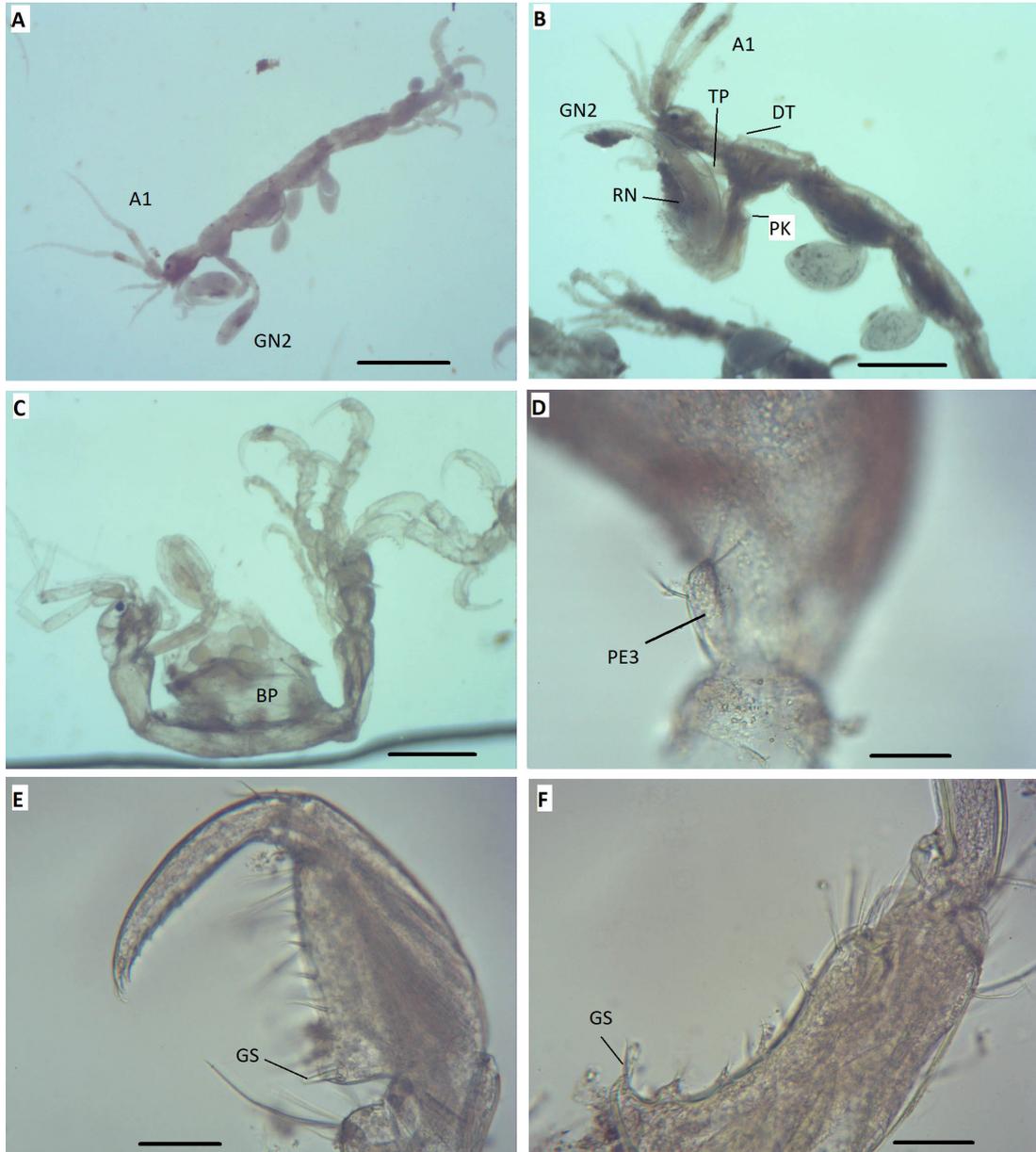


Figure 2. Diagnostic characters of *Paracaprella pusilla* collected from the Golfo de Nicoya, Costa Rica. A–B) Males with peduncle of antenna 1 setose (A1), triangular projection of pereonite 2 (TP), dorsal tubercle on pereonite 2 (DT), proximal knob on basis of gnathopod 2 (PK), rounded notch (RN) in propodus of gnathopod 2 (GN2). C) Ovigerous female with brood pouch (BP) in pereonites 3-4. D) Reduced pereopod 3 (PE3) with 2 setae on terminal article. E) Propodus of gnathopod 1 with one proximal grasping spine (GS). F) Female propodus of pereopod 6 with a pair of grasping spines. Scales: 2A–B= 1000 μ m; 2C= 500 μ m; 2D–E–F= 50 μ m. Photomicrographs by J. Alfaro-Montoya.

maximum and minimum for each location and sex (i.e., males, non-ovigerous females, ovigerous females, and juveniles). The criteria used for establishing the sexual categories were modified from Alarcón-Ortega et al. (2015) as follows: females with the presence of developing brood pouches; males by the absence of

brood pouches and pleura well developed in pereonite 3; and juveniles were below 2.0 mm TBL and when no clear sexual dimorphism was evident. Body sections of taxonomical importance were digitalized and measured under the microscope using Scopeimage 9.0.

Table 2. Population structure of *Paracaprella pusilla* collected from different localities of Golfo de Nicoya, Costa Rica.

Sexual condition	Location	Sample size	Total length (mm)	
			Mean \pm SD	Max–Min
Males	1. Dock-Puntarenas	n.r.	—	—
	2. Punta Morales	7	3.48 \pm 1.11	2.24–5.49
	3. Punta Cuchillo	30	3.71 \pm 1.40	2.08–7.18
	4. Pochote-Tambor	1	7.01	—
	5. Bouy 8: Playa Naranjo	1	2.39	—
Non-ovigerous females	1. Dock-Puntarenas	n.r.	—	—
	2. Punta Morales	6	2.75 \pm 0.53	1.74–3.14
	3. Punta Cuchillo	22	3.15 \pm 0.52	2.16–4.05
	4. Pochote-Tambor	1	2.94	—
	5. Bouy 8: Playa Naranjo	1	2.38	—
Ovigerous females	1. Dock-Puntarenas	n.r.	—	—
	2. Punta Morales	5	3.23 \pm 0.30	2.89–3.47
	3. Punta Cuchillo	3	3.40 \pm 0.95	2.73–4.08
	4. Pochote-Tambor	0	—	—
	5. Bouy 8: Playa Naranjo	0	—	—
Juveniles	1. Dock-Puntarenas	n.r.	—	—
	2. Punta Morales	1	1.66	—
	3. Punta Cuchillo	7	1.65 \pm 0.22	1.23–1.91
	4. Pochote-Tambor	1	1.54	—
	5. Bouy 8: Playa Naranjo	0	—	—

n.r.: data not registered.

Results

Caprellids were collected from every sampling station in the Golfo de Nicoya (Figure 1). The common biota associated with the sampled structures were macroalgae and bryozoans (*Bugula* sp., other unidentified species); other organisms living in these environments included cirripeds, decapods, gammarid amphipods, molluscs and polychaetes.

Interestingly, all caprellid specimens collected from the five stations belong to the same species, *Paracaprella pusilla* ($n = 86$). The specimens presented the following diagnostic characters: body smooth, head without projections; males with large triangular projection on antero-ventral margin of pereonite 2; a small anterodorsal tubercle on pereonite 2; the basis of gnathopod 2 with a proximal knob on posterior margin, and propodus with a shallow rounded notch at midlength. The peduncle of antenna 1 is setose and usually longer than antenna 2; propodus of gnathopod 1 with one proximal grasping spine; pleura more developed in pereonite 3 than 4; pereopods 3–4 are reduced with 2 articles, terminal article is small with 2 setae; female propodus of pereopods 5–7 with a pair of proximal grasping spines.

The species presented different stages of development from juveniles ($n = 9$), females (non ovigerous ($n = 30$) and ovigerous ($n = 8$)) and males ($n = 39$) at the five stations of the Golfo de Nicoya (Table 2),

including station 1: Dock-Puntarenas, where no quantitative data could be collected. The maximum size (TBL) recorded for males and females was 7.18 mm and 4.05 mm, respectively. The smallest ovigerous female was 2.73 mm, and the minimum size of juveniles collected was 1.23 mm. The species inhabits the upper and lower Gulf, but more individuals were collected at Punta Cuchillo, which is located in the lower Gulf.

Discussion

This contribution is the first record of *Paracaprella pusilla* from the Pacific coast of Costa Rica. The species, at different stages of development, was identified at five locations from the Golfo de Nicoya, representing the third report for the Eastern Tropical Pacific. To our knowledge, no native or invasive caprellids have been reported from littoral waters of Costa Rica (Wehrtmann and Cortés 2009; Alarcón-Ortega et al. 2017).

A higher number of individuals were collected at Punta Cuchillo (lower deeper gulf). The lower Golfo de Nicoya presents more stable salinities, around 30–32 ppt, than the lower section (Brenes et al. 2001), and it is influenced by the poor water quality of the Barranca River and the Grand River of Tarcoles (Symonds et al. 2017). However, this particular region is part of the Paquera-Tambor Marine

Area for Responsible Fishing that has been defined as an important ecological area based on its microalgae productivity and zooplankton grazing (García-Rojas and Vega-Bolaños 2016).

The presence of different stages of development is an indicator of the positive acclimation of this amphipod to the Golfo de Nicoya. No other caprellid species were found in the submerged artificial structures sampled in this study. *P. pusilla* has specific morphological adaptations for inhabiting artificial fibrous substrates (Alarcón-Ortega et al. 2015).

Maximum body sizes (i.e., total body length – TBL) reported for *P. pusilla* in the Eastern Tropical Pacific fluctuate from 6 to 10.66 mm for males, and 4 to 5.72 mm for females (Ros et al. 2014; Alarcón-Ortega et al. 2015). In the Western Atlantic Ocean, the maximum TBL reported is between 6 to 7 mm for males and 4–4.5 mm for females (Mayer 1903; McCain 1968; Ros et al. 2014). Therefore, maximum sizes collected in the Golfo de Nicoya (7.18 and 4.05 mm for males and females, respectively) are similar to sizes from the Atlantic Ocean, but smaller than sizes reported from the Northern Eastern Tropical Pacific at an oyster farm (Alarcón-Ortega et al. 2015).

Concerning the dispersion of this species, we have analyzed plankton samples from these waters and only one caprellid was found in one sample. Ballast water was suggested as the introduction vector through the Panama Canal for a possible Caribbean origin of the Panama population of *P. pusilla* (Ros et al. 2014). However, molecular analysis is required to confirm the origin of the Pacific Ocean populations.

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