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Author(s): Octavio Esquivel Garrote, Eduardo Suárez-Morales, and Alvaro Morales-Ramírez
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A new species of *Pontella* (Calanoida, Pontellidae) from an oceanic island of the eastern tropical Pacific

Octavio Esquivel Garrote, Eduardo Suárez-Morales, and Alvaro Morales-Ramírez

(OEG, AMR) Centro de Investigación en Ciencias del Mar y Limnología (CIMAR) y Escuela de Biología, Universidad de Costa Rica (UCR), San José, Costa Rica,
(ESM) El Colegio de la Frontera Sur (ECOSUR), Av. Centenario Km 5.5, A.P. 424, Chetumal, Quintana Roo 70014, Mexico

Abstract.—During a survey of the epipelagic zooplankton of the Isla del Coco, an oceanic island off the coast of Costa Rica, eastern tropical Pacific, female and male specimens of a pontellid calanoid copepod belonging to the genus *Pontella* were collected. It was recognized as an undescribed species belonging to the *Pontella fera* species-group. It is most closely related to *P. tenuiremis* Giesbrecht, 1889 and *P. fera* Dana, 1849. The new species, *P. cocoensis*, can be distinguished from these and other congeners by having a unique combination of characters including: 1) the female genital double-somite has a longer lateral process than that illustrated by Giesbrecht (1893) for *P. tenuiremis*, 2) the lateral genital process bears two subdistal rounded protuberances; 3) the right margin of the genital double-somite is swollen and lacks a process; 4) the presence of modified, arrow-shaped setae on several segments of the female antennule; 5) a short, telescoped female anal somite; and 6) a thumb-like process with a rounded protuberance on the medial surface of the first exopodal segment of the male leg 5. The mouthparts, with sparsely spinulate setae on both the maxilla and maxilliped, and bicuspidate teeth on the mandibular edge, suggest that this new species is omnivorous. This is the first species of *Pontella* described from Costa Rican waters.

Keywords: zooplankton, copepod, tropical plankton, biodiversity, pelagic crustaceans

The morphological and taxonomic knowledge of the pelagic copepod family Pontellidae has been hampered by a certain degree of morphological variability, with several instances of overlapping characters and heteromorphy (Fleminger & Hulsemann 1974, Fleminger et al. 1982, Jeong et al. 2014). In the case of the genus *Pontella* Dana, 1846, currently containing 43 species (Boxshall & Halsey 2004, Razouls et al. 2014, Walter & Boxshall 2014), a number of taxonomic studies in different regions of the world have contributed to solve these problems (Fleminger 1956, 1967, Silas & Pillai 1973, Mulyadi 2000, 2002, Jeong et al. 2008a). These efforts include the redescription of several species whose original descriptions lack enough detail for accurate comparative analyses (Mulyadi 2002, El-Sherbiny & Ueda 2008). The nominal species *P. fera* Giesbrecht, 1893 and *P. securifer* Brady, 1883 have been advanced as possibly containing cryptic species that remain unnamed (Jeong et al. 2008a, 2008b). Hence, records and new specimens of some of these species should be revised or examined in order to determine their true taxonomic status. Subtle variations, particularly those related to sex characters (genital

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double-somite, fifth legs, and male right antennule) could have been overlooked and in fact represent undescribed species.

From zooplankton samples obtained in the oceanic waters adjacent to the protected natural park of Isla del Coco, an oceanic island off the coast of Costa Rica, male and female specimens of an undescribed species of the genus *Pontella* were collected. A full description and illustrations of this species, including the mouthparts and swimming legs 1–4, are herein provided. A comparative analysis is presented with respect to closely related species of the *P. fera* species-group; comments on the morphology of the mouthparts are also provided.

Material and Methods

The zooplankton samples analyzed were obtained over coral reef areas at Chatham Bay, Isla del Coco National Marine Park on March 16, 2012. Samples containing specimens of *Pontella* were collected in daytime (12:30 h) by horizontal neuston trawls with a standard plankton net (0.5 mm mesh size). The zooplankton samples were fixed and preserved with 4% formaldehyde buffered with sodium borate. Copepods were sorted from the original samples and transferred to 70% ethanol with a drop of glycerin for further analysis. Voucher specimens were deposited in the collection of Crustacea of the University of Costa Rica, San José, Costa Rica (UCR) and in the collection of Zooplankton at El Colegio de la Frontera Sur, Chetumal, Mexico (ECO-CHZ).

Systematics

Order Calanoida Sars, 1902
Family Pontellidae Dana, 1853
Pontella Dana, 1846
Pontella cocoensis, new species
Figs. 1–4

Material examined.—Adult female from Isla del Coco, Eastern Tropical Pacific, 16 March 2012, coll. Octavio Esquivel, specimen partially dissected, vial deposited in the collection of Crustacea, Museum of the University of Costa Rica (cat. UCR-3273). One adult male, same date, site, and collector; specimen partially dissected, ethanol-preserved, vial (UCR-3273). One adult male, same date, locality and collector; specimen dissected on several slides sealed with Entellan®, deposited at El Colegio de la Frontera Sur, Chetumal, Mexico (ECO-CHZ-09089). One adult female, same collection data; specimen partially dissected, ethanol-preserved, vial and slides (ECO-CHZ-09090).

Type locality.—Chatham Bay, Isla del Coco, Costa Rica, Eastern Tropical Pacific (5°32′N, 87°04′W), about 530 km southwest of the west coast of Costa Rica and 648 km west of the Panama coast.

Etymology.—The species epithet makes reference to the name of the type locality, the oceanic island Isla del Coco, a marine protected area off the Costa Rica coast.

Female.—Body length of two adult female specimens: 3.02 mm and 3.11 mm, measured from anterior cephalosome to posterior margin of caudal rami. Cephalosome with usual hook-like process on both sides, widest at level of fully separated first pedigerous somite. Posterior corners of fifth pedigerous somite slightly asymmetrical, subacute, reaching proximal 1/4 of genital double-somite (Fig. 1A). Cephalosome with triangular forehead, dorsal lenses present, separated by the length of 1.5 lens diameters. Rostrum bifid, basally thickened, distally acute, directed ventrally, gap between rostral rami wide (Fig. 2G, H). Genital double somite roughly cylindrical, asymmetrical, ventral surface flat (Figs. 1A, B, 2D, E). Left margin moderately swollen from proximal 1/3, right margin of somite with lateral protuberances, proximal half spinulose. Dorsal surface ornamented with proximal patch of small spinules. Digitiform distolateral process present; process posteriorly directed, with two small

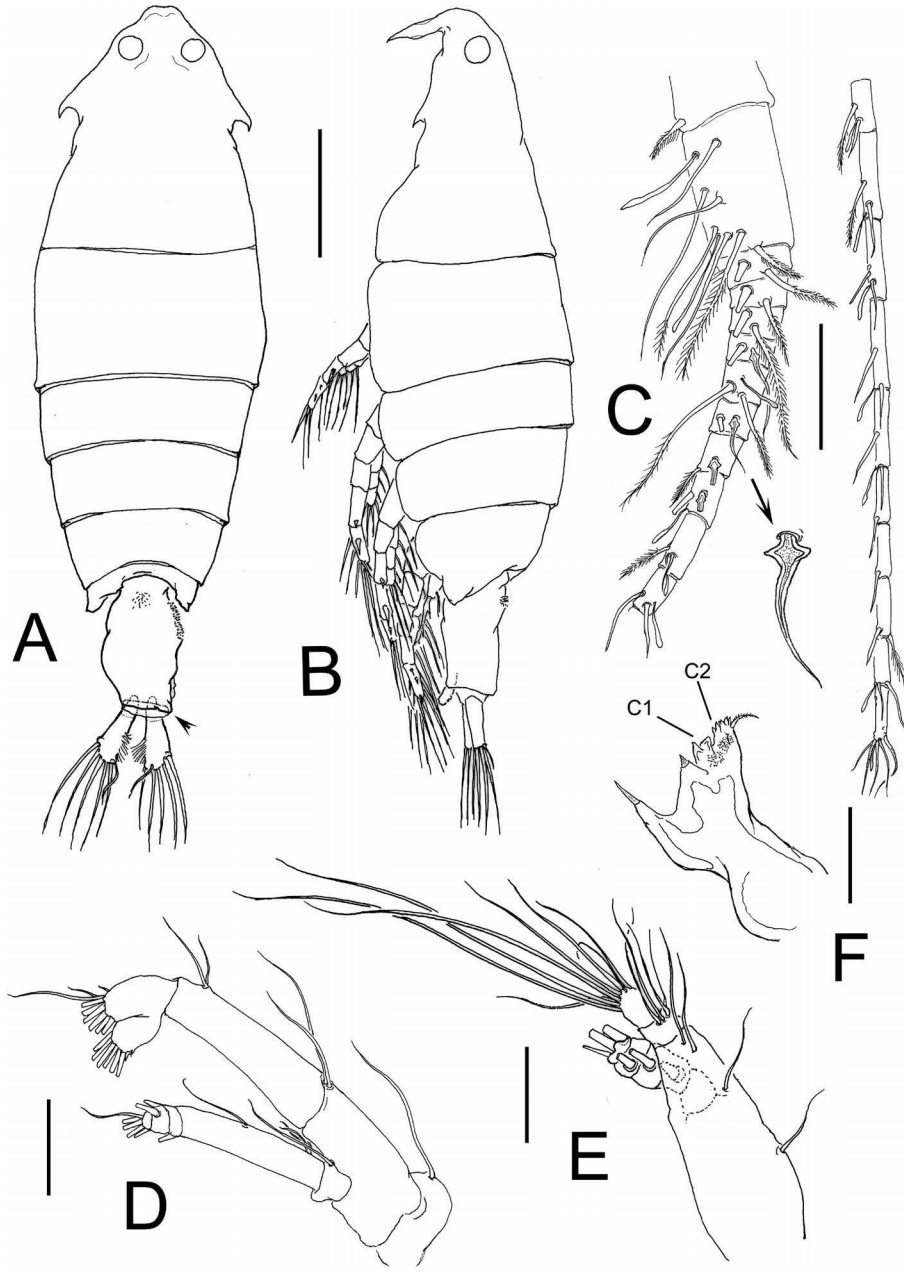

Fig. 1. *Pontella cocoensis* from Isla del Coco, Costa Rica. Adult female holotype. A, habitus, dorsal view; B, same, lateral view; C, antennule (in two sections) segments 1–12 and 13–22, with enlargement of modified seta (arrow); D, antenna; E, mandible palp; F, mandible edge showing dentition and bicuspidate teeth C1 and C2 (sensu Ohtsuka & Onbé 1991). Scale bars: A, B = 0.5 mm, C = 0.25 mm, D–F = 0.1 mm.

rounded subdistal processes on inner margin (Fig. 2E, F). Caudal rami slightly symmetrical, right ramus larger than left one; inner margin pilose, each ramus with five distal and one dorsal setae (Figs. 1A, 2D).

Antennules (Fig. 1C) symmetrical, 22-segmented. Segments armed as follows

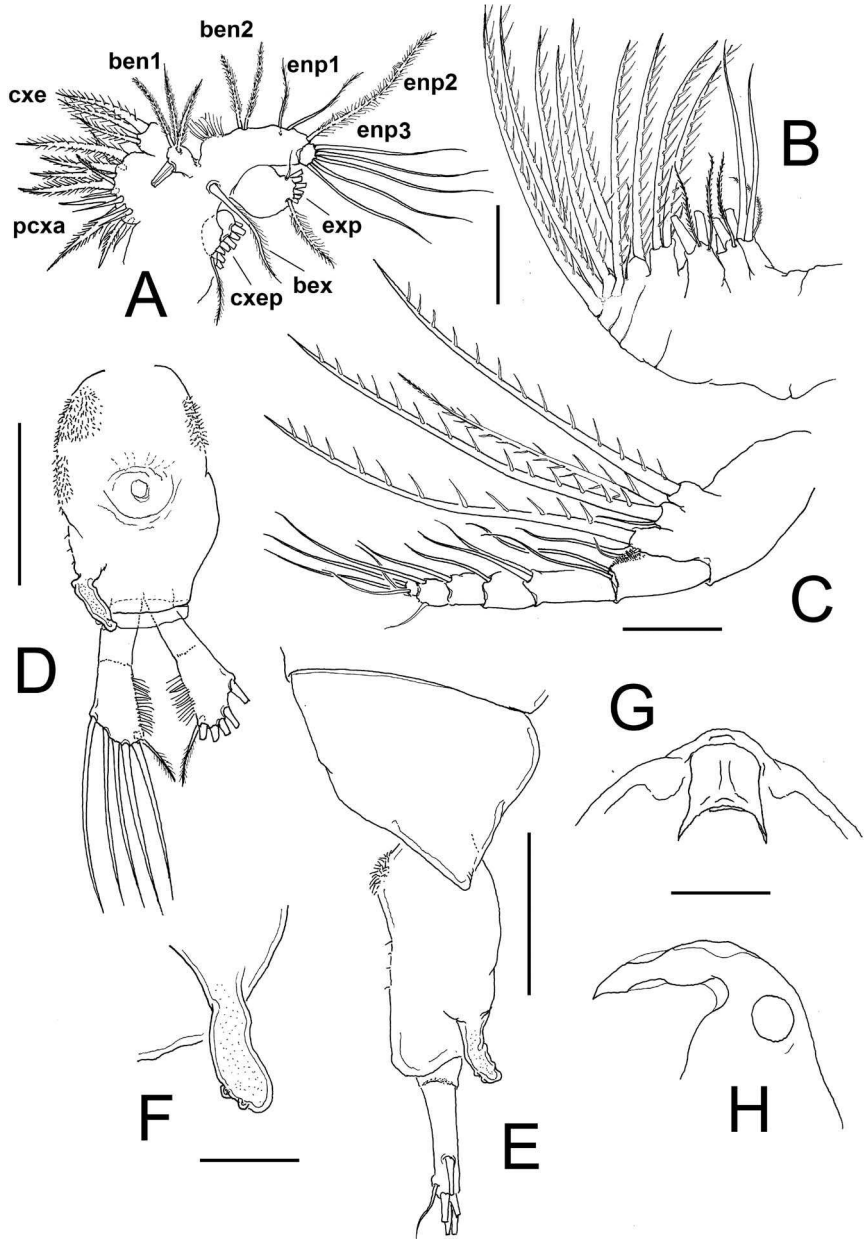

Fig. 2. *Pontella cocoensis* from Isla del Coco, Costa Rica. Adult female holotype. A, maxillule showing armature of praecoxal arthrite (pcxa), coxal endite (cxe), coxal epipodite (cxep), first basal endite (ben1), second basal endite (ben2), basal exite (bex), exopod (exp), and endopod (enp1–3); B, maxilla; C, maxilliped; D, urosome showing details of lateral process of genital double-somite, ventral view; E, same, lateral view; F, detail of lateral process; G, rostrum, ventral view; H, same, lateral view. Scale bars: A–C, F = 0.1 mm, G,H = 0.2 mm.

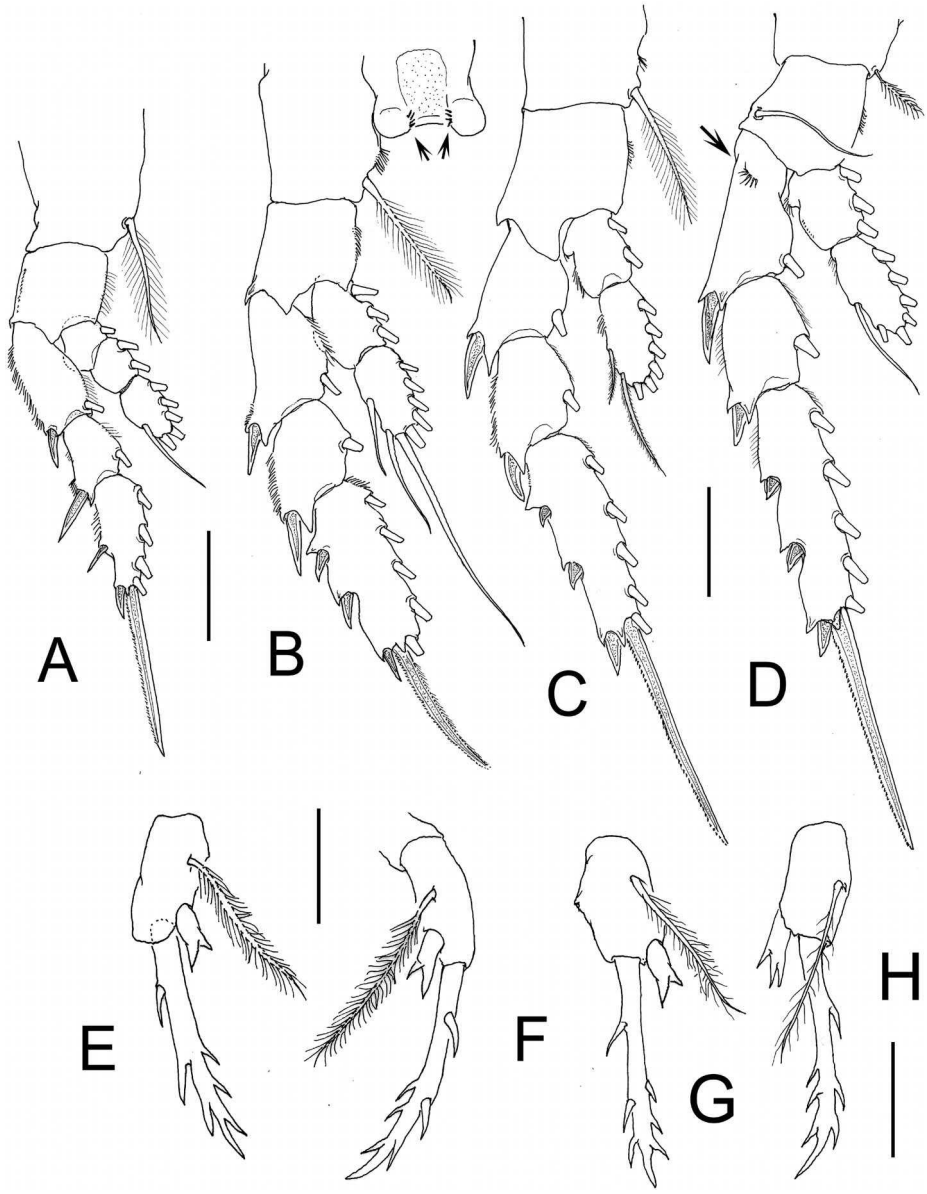

Fig. 3. *Pontella cocoensis* from Isla del Coco, Costa Rica. Adult female holotype. A, leg 1; B, leg 2; C, leg 3; D, leg 4; E, right fifth leg; F, Left fifth leg; (paratype specimen) G, variant form of left fifth leg with trilobed endopodal ramus. H, right fifth leg of same specimen. Scale bars: A–H = 0.1 mm.

(Arabic numbers = setae; Roman numerals = spines, ae = aesthetascs): 1 (1), 2 (7+2ae), 3 (2), 4(2), 5(2), 6 (2), 7(2+1ae), 8(2), 9(2), 10(2+1ae), 11(2+ae), 12(2+1ae), 13 (2+1ae), 14(2+1ae), 15(2+1ae), 16(2+1ae), 17(2+1ae), 18(1), 19(1), 20(2), 21(2+1ae), 22(5+1ae). Modified, arrowhead-shaped setal elements (Fig. 1C) on segments 6, 8–10.

Antenna (Fig. 1D) biramous: coxa with long medial seta. Basis and coxa partially fused, basis with two distal setae. Exopod five-segmented, first exopodal segment bearing long inner seta reaching halfway

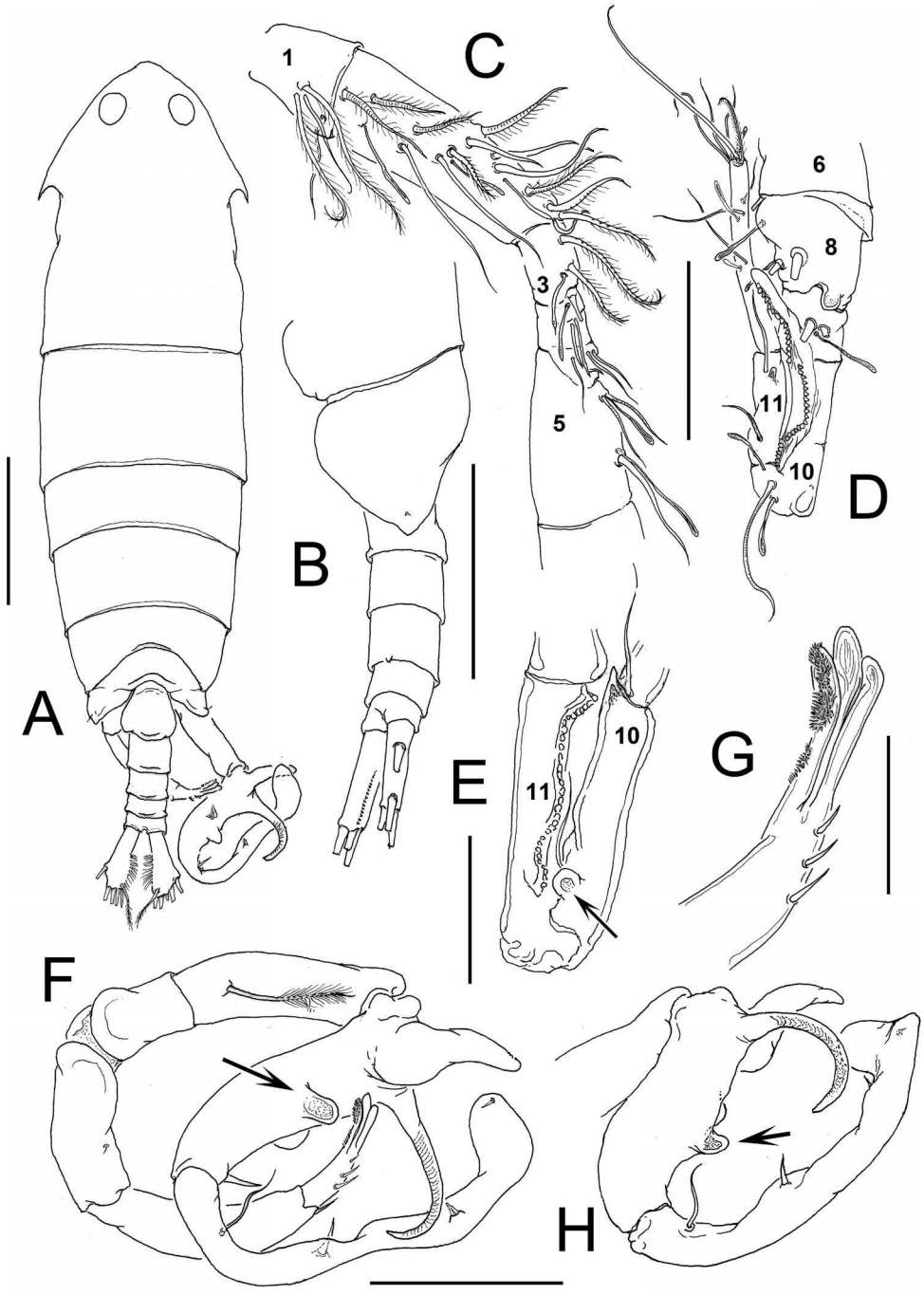

Fig. 4. *Pontella cocoensis* from Isla del Coco, Costa Rica. Adult male allotype. A, habitus, dorsal view; B, urosome, lateral view; C, right antennule, proximal segments, functional segments numbered; D, same, distal segments; E, detail of rounded process on inner margin of penultimate segment; F, fifth leg; G, detail of distal part of left fifth leg; H, same, paratype specimen. Scale bars: A,B = 0.5 mm, C,D,F,H = 0.25 mm, E,G = 0.1 mm.

of succeeding segment, second segment elongate, bearing three setae, two proximal and one medial, segments 3–5 with setal formula: 1, 2, 5. First endopodal segment elongate, armed with two small subdistal setae. Second endopodal segment with two distal lobes, inner lobe bearing 8 setae, outer lobe with 6 setae and 1 small outer spine.

Mandibular palp (Fig. 1E) biramous, basis subrectangular, armed with 4 setae. Endopod 2-segmented, setal formula 4, 8; exopod 5-segmented, setal formula: 0,1,1,1,3. Gnathobase heavily chitinized, armed with 6 teeth and short spinulose dorsal seta; third (C1 in Fig 1F), fourth (C2 in Fig. 1F) and fifth teeth bicuspidate. Bases of teeth with patches of small spinules (Fig. 1F).

Maxillule (Fig. 2A) typical of pontellids, with praecoxal arthrite well developed and carrying 15 setae, 11 on anterior or distal position plus 4 on posterior surface; coxal endite with 3 subequal apical stout setae; coxal epipodite with 9 plumose setae; basis with 1 long plumose seta representing basal exite; first and second basal endites with 4 and 2 setae, respectively. Basis fused to endopod, endopodal segments 1 and 2 each with 2 and 1 setae, respectively, plus 5 apical setae on distal segment. Exopod 1-segmented with 8 setae.

Maxilla (Fig. 2B) uniramous, first praecoxal endite bearing 4 setae, second with 3 setae (one of them shorter and thinner than the others); two coxal endites, first one with 4 setae, second with 3 setae. Basis with 1 long and 1 short setae, endopod with 6 long, strong sparsely spinulated seta plus short, slender seta.

Maxilliped (Fig. 2C) uniramous, with praecoxa and coxa fused, three syncoxal endites well developed, with setal formula 1, 3, 3; endite setae strong, sparsely spinate along inner margin. Basis fringed with medial row of spinules and 2 distal setae. Endopod 5-segmented, setal formula of endopod as: 2, 1, 1, 2, 4.

Leg 1 with 3-segmented endopod and 3-segmented exopod; legs 2–4 with 2-segmented endopods and 3-segmented exopods (Fig. 3A–D). Coxal plates smooth except for P2, which has 4–5 spinules on middle margin of anterior surface (arrowed in Fig. 2B). Coxae of legs 1–4 with strong, plumose inner coxal seta, shortest in P4. Basis outer seta present in leg 4, absent in legs 1–3. Leg 4 with row of setules on anterior surface of first exopodal segment (arrowed in Fig. 3D). Outer spines of third exopodal segment of legs 3 and 4 remarkably small.

Setal and spine formula (Arabic numbers = setae, Roman numerals = spines) of legs 1–4 as:

	coxa	basis	exopod	endopod
leg 1	0-1	0-0	I-1;I-1;II,I,4	0-1;02;1,2,3
leg 2	0-1	0-0	I-1;I-1;III,I,5	0-3;2,2,4
leg 3	0-1	0-0	I-1;I-1;III,I,5	0-2;2,2,4
leg 4	0-1	1-0	I-1;I-1;III,I,5	0-3;2,2,3

Leg 5 (Fig. 3E–G) biramous, symmetrical; coxa and intercoxal sclerite fused. Basis subrectangular, with long plumose seta reaching midlength of exopodal segment. Endopod 1-segmented, distally bifurcate, about 0.3 times as long as exopodal ramus, inner endopodal process smaller than outer process. One of the paratype specimens with trifurcate endopodal process (Fig. 3G). Exopod 1-segmented, elongate, with 3 outer and 3 inner spiniform processes plus distal acute process.

Male.—Body (Fig. 4A) slightly smaller than female, specimens measuring 2.8 mm and 2.6 mm, measured to distal margin of caudal rami. Prosome about 4.5 times as long as urosome (caudal rami excluded), dorsal surface of cephalosome smooth. Fifth pedigerous somite with slightly asymmetrical lateral expansions (Fig. 4A), each side with small lateral sensillum. Urosome (Fig. 4A, B) with 5 somites. Genital somite asymmetrical, left side swollen; right side unmodified. Anal somite symmetrical, half as long as preceding

somite. Caudal rami slightly asymmetrical, left ramus shorter than right ramus, armed as in female.

Right antennule (Fig. 4C, D) with 12 segments, geniculate between functional segments 10–11, reaching middle of third pedigerous somite. Antennular segments armed as follows (Arabic numbers = setae; p = spines or processes; ae = aesthetasc; Roman numerals = ancestral segments): I(4), II–IX (14+3ae), X–XI (2+ae), XII (1+ae), XIII (1+ae), XIV (1+ 2ae), XV–XVI (3+2ae), XVII (2,p+ae), XVIII–XIX (2+ae), XX (1), XXI–XXIII (1,2p), XXIV–XXVIII (8+3ae). Rounded process on segment XVII; segments XVIII–XIX (functional segment 9) and XX (10) forming anvil-shaped process bearing row of acuminate teeth (Fig. 4D). Segment XXI–XXIII (11) with proximal rounded process (arrowed in Fig. 4E) plus distal spiniform process. Left antennule as in female.

Leg 5 (Fig. 4F, G) asymmetrical, uniramous, typical of pontellids. Left leg 5 relatively short, slender, basis and coxa fused, subrectangular, with single minute seta on medial surface. Exopod 2-segmented, segment 1 cylindrical, about 1.5 times as long as basipod, with short spiniform seta on outer distal margin. Second exopodal segment (Fig. 4G) with three short setal elements on outer margin, segment bearing three digitiform processes apically, middle process longest, inner process covered with dense patch of spinules; remaining two processes smooth.

Right leg 5 coxa subquadrate, naked, basis cylindrical, with long plumose seta inserted in proximal 1/3 of segment. Exopod with two segments, forming robust, widely open chela; first exopodal segment bearing four different processes, proximal strong conical process curving inward (thumb), adjacent second proximal process slender, hook-like, with inner surface ornamented with shallow cuticular ridges, medial processes on segment represented by thumb-like process (arrowed in Fig. 4F), and an adjacent low rounded protuberance. Distal spiniform element present on distal position of first exopodal segment. Second exopodal segment forming distally elongate finger of chela, segment distally broadened, spatulate, unbranched, armed with slender proximal seta, two spiniform elements on inner surface plus one short distal seta (Fig. 4F).

Remarks.—Fleminger (1986) divided the species of *Pontella* from the Indo-West Pacific into three species groups (*alata*, *andersoni*, and *fera*). In a revision of the taxonomy of the genus in Indonesian waters, Mulyadi (1997, 2003) defined the characters of six species groups: *alata*, *andersoni*, *fera*, *danae*, *labuanensis* and an unassigned group. Our specimens of *P. cocoensis* from the eastern Pacific are assignable to the *P. fera* species group (see Mulyadi 2003) except for the weakly developed rostral lenses. The taxonomy of this species group has been subject to a more detailed examination because of its variation in characters such as the posterior corners of the prosome, the details of the processes of the genital double-somite, and the number and structure of the processes of the exopod of the right fifth leg of the male, thus leading to the definition of at least two groups contained in the nominal *P. fera* (Zheng et al. 1982). One of them is currently assumed to represent a separate, unnamed species (Jeong et al. 2008a). A similar situation could be expected in reference to other species in this group, such as *P. tenuiremis* Giesbrecht, 1889 with respect to the new species, *P. cocoensis*. Members of this group appear to have a range of morphological overlapping that has caused uncertainty in the identification of species. In a survey of the pontellids of the Central South Pacific, Sherman (1964) reported specimens that could not be identified from published taxonomic reports, including a "...*Pontella* sp. that appeared to be closely related to *P. tenuiremis* and *P. fera*."

The new species from Costa Rica is most closely related to *P. tenuiremis* Giesbrecht, 1889, by their sharing of several characters that have been used to define the species by different authors: absence of rostral lenses in both the male and the female; a 2-segmented female urosome with a long, cylindrical genital double-somite with a swollen left margin and a digitiform process on the right margin; and a flat ventral genital surface (see Wilson 1942, 1950, Grice 1962). The structure of the male and female fifth legs is also very similar to *P. tenuiremis* as depicted by Giesbrecht (1893) and Grice (1962). Our specimens are compared with the available illustrations and descriptions of *P. tenuiremis* (Giesbrecht 1893, Wilson 1950, Grice 1962) but also with the two known morphotypes of the closely related *P. fera* (Jeong et al., 2008a) and with *P. chierchiae*, another member of the *P. fera* species-group.

In our female specimens from Costa Rica, the posterior corners of the fifth pedigerous somite are slightly asymmetrical, thus differing from Giesbrecht's (1893) *P. tenuiremis*, which are clearly symmetrical and shorter than in the new species. In *P. cocoensis* the left margin of the genital double-somite has two protuberances (Fig. 1D), a proximal and a distal one, but the distal protuberance appears to be smaller and differently shaped in Giesbrecht's (1893) illustrations of *P. tenuiremis*. The left margin of the genital double-somite has a marked subdistal protuberance as depicted by Giesbrecht (1893), this protuberance is absent in *P. cocoense*, in which the margin is uniformly swollen (Fig. 1D). Most importantly, the right margin of the genital double-somite in the Costa Rican specimens differs from Giesbrecht's (1893) description of *P. tenuiremis*. The digitiform process arising from the distal lateral surface of this double-somite is clearly longer in *P. cocoensis* than in *P. tenuiremis* (Giesbrecht 1893). In the latter species the process does not reach the distal margin of the double-somite, whereas in the new species it reaches the distal margin of the anal somite. Moreover, it has two small rounded subdistal processes on the inner margin (arrowed in Fig. 2F), thus diverging from the smooth condition of this process in *P. tenuiremis*. Also, the anal somite is clearly longer in *P. tenuiremis*, about 0.35 times as long as the genital double-somite (Giesbrecht 1893:fig. 3), whereas it is very short, partially telescoped into the genital double-somite in the new species (Fig. 1A). Otherwise, the genital double-somite of our specimens resembles Giesbrecht's (1893) description of *P. tenuiremis*, including the pilose proximal margins and the oblique distal margin of the somite, with the right distal corner of the genital double-somite, forming a subacute, posteriorly directed process (arrowed in Fig. 1A). In both *P. cocoensis* and *P. tenuiremis* the ventral margin of the genital double-somite is flat (Figs. 1B, 2E), thus diverging from the two morphotypes of *P. fera* (Jeong et al. 2008a).

The presence of modified, arrowhead-shaped setal elements on segments 6 and 8–10 (Fig. 1C) of the female antennule has not been previously reported in *P. tenuiremis* (Giesbrecht 1893) or in *P. fera* (Mulyadi 2002, Jeong et al. 2008a). The segmentation and armature of the legs 1–4 of *P. cocoensis* are similar to those recently depicted by Jeong et al. (2008a) for *P. fera*, except for the presence of an ornamented coxal plate of leg 2, with two rows of spinules (arrowed in Fig. 3B), and a curved row of long spinules on the anterior surface of leg 4 first exopodal segment (Fig. 3D), both characters absent in *P. fera*.

The female fifth legs are similar in *P. cocoensis*, *P. tenuiremis*, and *P. fera*; they share an exopodal ramus with three inner and three outer spiniform elements plus a distal one (Giesbrecht 1893, Mulyadi 2000, Jeong et al. 2008a). The endopodal ramus is bifurcate and identical to Giesbrecht's (1893) illustration of *P. tenuiremis* and also

to the available depictions of *P. fera* (Zheng et al. 1982, Jeong et al. 2008a), with the outer process being slightly larger than the inner one. However, we found a variant in one of our specimens, which had a trifurcate distal endopod process on the left ramus (Fig. 3H); the same variation was reported by Zheng et al. (1982) for *P. fera* from Chinese waters.

The male geniculate antennule of *P. tenuiremis* has not been completely described in the literature, but it is clear that it resembles that of *P. fera* and *P. cocoensis*, including a similar segmentation pattern and a rounded process proximally on the penultimate (functional segment 11) antennulary segment (Giesbrecht 1893, Sillas and Pillai 1973: fig. 19f, Zheng et al. 1982: fig. 45-1h, Mulyadi 2000). Also, the denticulated process on the middle segments of the male right antennule of both *P. tenuiremis* and *P. cocoensis* is similar to that of *P. fera* as described and depicted by Mulyadi (2000: fig. 6c) and Zheng et al. (1982: fig. 45-1h). The rounded process on the functional segment 10 of the male right antennule (arrowed in Fig. 4D) is advanced as a distinctive character of the new species *P. cocoensis*; this structure has not been observed in the other related species of *Pontella*.

The male fifth legs of the three species, *P. tenuiremis*, *P. fera*, and *P. cocoensis* share some important characters, including a left leg with a terminal exopod forming a trifurcate structure with digitiform elements, the middle one being longest. In both *P. tenuiremis* and *P. cocoensis* the innermost of these elements is heavily ornamented with setules and the other two are smooth (Grice 1962: fig. 34.7; Fig. 4G). This pattern differs from both types of *P. fera*, in which these three elements are smooth (Sillas & Pillai 1973, Zheng et al. 1982, Mulyadi 2000, 2002). The presence of two subdistal setae on the last exopodal segment of the male left fifth leg is distinctive in *P. tenuiremis* (Giesbrecht 1893, Grice 1962), thus diverging from both *P. cocoensis* and both types of *P. fera*, with three such setae (Giesbrecht 1893, Zheng et al. 1982, Mulyadi 2002; see Fig. 4G).

In the right, chelate leg, the first exopodal segment of *P. cocoensis* has the same general structure as that known in the two morphotypes of *P. fera* (Zheng et al. 1982, Mulyadi 2000) and *P. tenuiremis* (Giesbrecht 1893, Grice 1962) with two elongate proximal processes, one of which is curved, and two medial protuberances. The shape of the two medial processes of this segment shows some important variation among these species; for *P. tenuiremis* Giesbrecht (1893: fig. 26) depicted a low, small, subtriangular protuberance and a low rounded protuberance and Grice (1962: fig. 34.7) a blunt thumb-like process, more similar to that found in *P. cocoensis* (arrowed in Fig. 4F, H) together with a low rounded protuberance also like in the new species. In this respect, the medial processes of the new species and also those of the specimen reported by Grice from Equatorial waters of the Pacific are almost identical. A different combination of medial processes is found in morphotypes I and II of *P. fera*, either with a low rounded protuberance accompanied by a long, digitiform process or with two subequal hemispheric processes, respectively (see Jeong et al. 2008a). Hence, the combination shown by *P. cocoense* appears to be unique and suggests that Grice's (1962) record could be tentatively assignable to *P. cocoensis*.

An additional difference of *P. cocoensis* with respect to *P. fera* is in the distal part of the second exopodal segment of the right male fifth leg; in the latter species this segment is complex, apically branched, forming two or three flat lobe-like processes of different sizes (Mulyadi 2000: fig. 6f, Mulyadi 2002: fig 36f) or distally tapered, naked, with two spatulate processes (Silas & Pillai 1973, Pillai 1975, Zheng et al. 1982: fig. 45-1i). In *P. tenuiremis* and *P. cocoensis* this structure

is represented by a wide unbranched spatulate lobe armed with a distal spiniform element (Grice 1962: fig. 37.6; also present in Fig. 4F). A variant form, with a tapered distal end (Fig. 4H) was observed in one specimen.

The new species has some affinities with *P. chierchiae* Giesbrecht, 1889, also assignable to the *P. fera* species group by its possession of the distinctive characters outlined by Mulyadi (2003). The new species differs from *P. chierchiae* in the structure of the posterior corners of the female fifth metasomal somite, which are distinctively bifurcate in *P. chierchiae*; also, the endopod of the female fifth leg is unbranched in *P. chierchiae* vs. a branched condition in the new species. The structure of the male fifth leg of both species is similar, but differs in several aspects; in *P. cocoensis* the middle process of the first exopodal segment of the right leg is unarmed, whereas it has a short spine in *P. chierchiae* (Jeong et al. 2008a). The proximal elongate process of the same segment is distally curved in the new species and almost straight in *P. chierchiae*; also, the adjacent proximal process is slender in *P. chierchiae* and strong and conical in *P. cocoensis*. The left leg has a distal exopodal segment with three distal round-tipped spines and a spiral-shaped process (see Jeong et al. 2008a: fig. 7D), thus clearly differing from the new species.

The mandibular dentition found in our specimens agrees with the general pattern described by Fleminger (1956) for the genus and with the dentition depicted by Fleminger (1957: fig. 13) for this species. In addition, the mouthparts of *P. cocoensis* as described here are assignable to Ohtsuka & Onbé's (1991) Type I mouthparts, with sparsely spinulated maxillar and maxillipedal setae, a relatively narrow mandibular edge armed with bicuspidate, subacute teeth C1 and C2. This type corresponds to an omnivorous more than a raptorial predator as found in other pontellids (Lillelund & Lasker 1971, Ohtsuka 1985).

Pontella in the eastern tropical Pacific

The genus is most diverse in the Indo-Pacific (Silas & Pillai 1973, Mulyadi 2000, 2003, Othman & Toda 2006), a region harboring many endemic or presumably endemic species of pontellids as a result of the complex geological history and biogeographic processes related to that area (Fleminger 1986). In contrast, in the eastern tropical Pacific (see Razouls et al. 2014) only a few species of *Pontella* have been previously recorded: *P. agassizi* Giesbrecht, 1895, *P. chierchiae* Giesbrecht, 1889, *P. danae* Giesbrecht, 1889, *P. fera*, *P. securifer* Brady, 1883, *P. valida* Dana, 1853, *P. whiteleggei* Krämer, 1896, and *P. tenuiremis* (Wilson 1942, 1950, Palomares-García et al. 1998, Suárez-Morales and Gasca 1998, Álvarez-Silva 2003). Although recorded by Wilson (1942) from off northern Peru, the presence of the Atlantic species *P. lobiancoi* (Canu, 1888) in the eastern Pacific is deemed doubtful (Razouls et al. 2014).

Pontella tenuiremis, the most closely related species to *P. cocoensis*, is known from the Pacific Ocean only (Giesbrecht 1893, Wilson 1942, 1950, Fagetti 1962, Heinrich 1968, Álvarez-Silva et al. 2003). It is regarded as a frequent and widely distributed species in oceanic waters of the central and south Pacific Ocean (Grice 1962, Sherman 1964) but it was also recorded from embayments (Alvarez-Silva et al. 2003). It is likely that some of these records could be assignable to *P. cocoense* and thus should be revised. The new species *P. cocoensis* was recorded from coastal waters of Isla del Coco at a salinity of 32 psu, which is remarkably lower than the salinity range of previous reports of *P. tenuiremis* in the Eastern Tropical Pacific (36.1 psu) (Alvarez-Silva et al. 2003) and the Central South Pacific (34–35 psu)

Table 1.—Comparison of the new species *P. cocoensis* from Isla del Coco, Costa Rica, with other members of the *Pontella fera* species group. GS = genital double-somite, 5PS = fifth pedigerous somite, EXP = exopod.

	P. tenuiremis (Giesbrecht 1893)	*P. tenuiremis* (Grice 1962)	*P. fera* Type I (Jeong et al. 2008a)	*P. fera* Type II (Jeong et al. 2008a)	*P. chierchiae* (Tanaka 1936, Jeong et al. 2008a)	*P. cocoensis*
Female						
Modified setae on antennules	absent	no data	absent	absent	absent	present, arrow-shaped
Posterior corners of 5PS	short, symmetrical	no data	Wing-like, symmetrical	weak, asymmetrical	bifurcate, symmetrical	moderately developed, slightly asymmetrical
Margins of genital somite	swollen on right side & proximally on left side	no data	swollen on left side	swollen on both sides	weakly swollen on left side	swollen on left side only
Processes on GS lateral margins	rounded on middle left margin; short thumb-like on right margin	no data	absent	absent	postero-medial subtriangular process	digitiform process on right margin
Anal somite	0.35 as long as GS	no data	0.35 as long as GS	0.35 as long as GS	0.45 as long as GS	0.2 as long as GS, telescoped
Male						
Medial processes on EXP1 of right fifth leg	one small, subtriangular, one rounded	one thumb-like, one rounded	one long, digitiform, one low, rounded	two rounded, subequal processes	one process with apical spine	one thumb-like, one rounded

(Sherman 1963, 1964). This is the third record of a species of *Pontella* in marine waters of Costa Rica; only *P. mimocerami* and *P. agassizi* have been previously reported in the country (Morales-Ramírez 2001, Morales-Ramírez & Suárez-Morales 2009).

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Literature Cited

Alameda-De la Mora, G. 1980. Sistemática y distribución de los copépodos (Crustacea) del Golfo de Tehuantepec (México). B. Sc. Thesis, Faculty of Sciences, Universidad Nacional Autónoma de México, Mexico City.

Álvarez-Cadena, J. N. 1985. Composición y abundancia de los copépodos planctónicos de la Bahía de Mazatlán. Anales del Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México 12:1–14.

Álvarez-Silva, C., M. G. Miranda-Arce, & G. De Lara-Isassi. 2003. Familia Pontellidae (Crustacea: Copepoda) en la Bahía La Ventosa, Oaxaca, México: Sistemática y ecología. Revista de Biología Tropical 51:737–742.

Boxshall, G. A., & S. H. Halsey. 2004. *An Introduction to Copepod Diversity*. The Ray Society, London. 996 pp.

El-Sherbiny, M., & H. Ueda. 2008. Redescription of the poorly known calanoid copepod *Pontella karachiensis* Fazal-Ur-Rehman, 1973 from the Red Sea with notes on its feeding habits. Plankton & Benthos Research 3:19–27.

Fagetti, E. 1962. Catálogo de los copépodos planctónicos chilenos. Gayana (Zoología) 4:3–59.

Fernández-Álamo, M. A., L. Sanvicente-Añorve, & G. Alameda-De la Mora. 2000. Copepod assemblages in the Gulf of Tehuantepec, Mexico. Crustaceana 73:1139–1153.

Fleminger, A. 1956. Taxonomic and distributional studies on the epiplanktonic calanoid copepods (Crustacea) of the Gulf of Mexico. Ph.D. Dissertation. Harvard University Library, Cambridge, Mass.

Fleminger, A. 1967. Distributional atlas of calanoid copepods in the California Current region, Part II. CalCOFI Atlas 7:1–213.

Fleminger, A. 1986. The Pleistocene equatorial barrier between the Indian and Pacific Oceans and a likely cause for Wallace's Line. UNESCO Technical Papers on Marine Science 49:84–97.

Fleminger, A., & K. Hulsemann. 1974. Systematics and distribution of the four sibling species comprising the genus *Pontellina* Dana (Copepoda, Calanoida). Fishery Bulletin 72:63–120.

Fleminger, A., B. H. R. Othman, & J. G. Greenwood. 1982. The *Labidocera pectinata* group: an Indo-West Pacific lineage of planktonic copepods with descriptions of two new species. Journal of Plankton Research 4:245–270.

Giesbrecht, W. 1889. Elenco dei Copepodi pelagici raccolti dal tenente di vascello G. Chierchia durante il Viaggio della R. Corvetta: Vettor Pisani" negli anni 1882–1885 e dal tenente di vascello F. Orsini nel Mar Rosso, nel 1884. Atti dell' Accademia Nazionale dei Lincei, Rendiconti della Classe di Scienze Fisiche, Matematiche e Naturali 4:24–29.

Giesbrecht, W. 1893. Systematik und Faunistik der pelagischen Copepoden des Golfes von Neapel und der angrenzenden Meeres-Abschnitte. Fauna und Flora des Golfes von Neapel und der Angrezenden Meeres-Abschnitte 19:1–831.

Grice, G. D. 1962. Calanoid copepods from equatorial waters of the Pacific Ocean. Fishery Bulletin 186:171–246.

Heinrich, A. K. 1969. The ranges of neuston copepods in the Pacific Ocean. Zoologicheskii Zhurnal 48(10):1456–1467. (In Russian).

Hernández-Trujillo, S. 1989. Copépodos de la familia Pontellidae en Baja California Sur (1982–1984). Investigaciones Marinas CICIMAR 4:225–232.

Hernández-Trujillo, S. 1994. Pontellidae copepods in the Pacific off Baja California, México, July 1988. Investigaciones Marinas CICIMAR 9:55–58.

Hernández-Trujillo, S., R. Palomares-García, G. López-Ibarra, G. Esqueda-Escárcega, & R. Pacheco. 2004. Riqueza específica de copépodos en Bahía Magdalena, Baja California Sur, México. Anales del Instituto de Biología, Universidad Nacional Autónoma de México, Serie Zoología 75:253–270.

Jeong, H. G., H.-L. Suh, Y. H. Yoon, & H. Y. Soh. 2008a. Redescription of *Pontella* species (Calanoida, Pontellidae) from Korean waters, with notes on their spatio-temporal distribution. Ocean Science Journal 43:209–222.

Jeong, H. G., H.-L. Suh, Y. H. Yoon, I. H. Choi, & H. Y. Soh. 2008b. The first records of two neustonic calanoid copepods, *Pontella securifer* and *P. sinica* (Calanoida, Pontellidae) in the South Sea, Korea. Ocean Science Journal 43:91–100.

Jeong, H. G., H.Y. Soh, & H. L. Suh. 2014. Morphological and genetic differentiation of heteromorphy in *Labidocera rotunda* (Copepoda, Calanoida, Pontellidae). Zootaxa 3764:181–191.

Lillelund, K., & R. Lasker. 1971. Laboratory studies of predation by marine copepods on fish larvae. Fishery Bulletin 69:655–667.

Matsuo, Y., & R. Marumo. 1982. Diurnal vertical migration of pontellid copepods in the Kuroshio. Bulletin of the Plankton Society of Japan 29:89–98.

Morales-Ramírez, A. 2001. Biodiversidad marina de Costa Rica, los microcrustáceos: Subclase Copepoda (Crustacea: Maxillopoda). Revista de Biología Tropical 49, Supl. 2:115–133.

Morales-Ramírez, A., & E. Suárez-Morales. 2009. Copepoda. Pp. 291–305 *in* I. S. Wehrtmann & J. Cortés, eds., Marine Biodiversity of Costa Rica. Monographiae Biologicae 86. Springer Science, The Netherlands.

Mulyadi, M. 1997. Three new species of Pontellidae (Copepoda, Calanoida) from coastal waters of Java, Indonesia. Crustaceana 70:653–675.

Mulyadi, M. 2000. New records and taxonomy of the genus *Pontella* (Crustacea: Copepoda: Calanoida), with notes on its distribution in Indonesian waters. Raffles Bulletin of Zoology 48:181–200.

Mulyadi, M. 2002. The calanoid copepods family Pontellidae from Indonesian waters, with notes on its species-groups. Treubia 32:1–167.

Mulyadi, M. 2003. Three new species of *Pontella* (Copepoda, Calanoida) from Indonesian waters, with notes on their species-groups. Crustaceana 76:385–402.

Ohtsuka, S. 1985. A note on the feeding habit of a calanoid copepod, *Pontellopsis yamadae* Mori. Publications of the Seto Marine Biological Laboratories 30:145–149.

Ohtsuka, S., & T. Onbé. 1991. Relationship between mouthpart structures and in situ feeding habits of species of the family Pontellidae (Copepoda: Calanoida). Marine Biology 111:213–225.

Othman, B. H. R., & T. Toda. 2006. Pontellid copepods from Singapore. Coastal Marine Science 30:305–319.

Palomares-García, R., E. Suárez-Morales, & S. Hernández-Trujillo. 1998. Catálogo de los copépodos (Crustacea) pelágicos del Pacífico Mexicano. CICIMAR-IPN/ECOSUR, Mexico City. 352 pp.

Pillai, P. P. 1975. On the species of *Pontella* Dana and *Pontellopsis* Brady of the International Indian Ocean Expedition collections (1960–1965). Journal of the Marine Biological Association of India 17:129–146.

Razouls, C., F. de Bovée, J. Kouwenberg, & N. Desreumaux. 2014. Diversity and geographic distribution of marine planktonic copepods. Available at http://copepodes.obs-banyuls.fr/en

Sherman, K. 1963. Pontellid copepod distribution in relation to surface water types in the central North Pacific. Limnology and Oceanography 8:214–227.

Sherman, K..1964. Pontellid copepod occurrence in the central South Pacific. Limnology and Oceanography 9:476–484.

Silas, E. G., & P. P. Pillai. 1973. The calanoid copepod family Pontellidae from the Indian Ocean. Journal of the Marine Biology Association of India 15:771–858.

Suárez-Morales, E., C. Franco-Gordo, & M. Saucedo. 2000. On the pelagic copepod (Crustacea: Copepoda) community of the central Mexican tropical Pacific (autumn, 1990). Crustaceana 73:751–761.

Suárez-Morales, E., & R. Gasca. 1989. Copépodos calanoides epipelágicos del Domo de Costa Rica (Junio-Agosto, 1982). Ciencias Marinas 15:89–102.

Suárez-Morales, E., & R. Gasca. 1998. Updated checklist of the marine Copepoda (Crustacea) of Mexico. Anales del Instituto de Biología, Universidad Nacional Autónoma de México, Serie Zoología 69:105–119.

Tanaka, O. 1936. On some new species of Copepoda from Sagami Bay. Japanese Journal of Zoology 7:31–36.

Walter, T. C., & G. A. Boxshall. 2014. *Pontella* Dana, 1853. *In* Walter, T. C. & G. A. Boxshall. 2014. World Copepoda database. Accessed through: World Register of Marine

Species, http://www.marinespecies.org/aphia.php?p=taxdetails&id=104211

Wilson, C. B. 1942. The copepods of the plankton gathered during the last cruise of the Carnegie. Carnegie Institution of Washington, Publication 536:1–237.

Wilson, C. B. 1950. Copepods gathered by the United States Fisheries Steamer "Albatross" from 1887 to 1909, chiefly in the Pacific Ocean. Bulletin of the United States National Museum 100:141–441.

Zheng, Z., S. Li, S.J. Li, & B. Chen. 1982. Marine planktonic copepods in Chinese waters. Shanghai Scientific and Technological Press, Shanghai. 162 pp. (in Chinese).

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