

**A new species of *Parastenocaris* from Mindoro Island, Philippines:
Parastenocaris distincta sp. nov. (Crustacea: Copepoda:
Harpacticoida: Parastenocarididae)**

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Abstract

A new species of harpacticoid, *Parastenocaris distincta* sp. nov., is described and discussed. The new species was collected in a freshwater interstitial habitat near the mouth of a river in Western Mindoro Province, the Philippines. This is the second species of *Parastenocaris* described from this country. The medial ornamentation of P1 basis, the morphology of male P3 and the number and distribution of the integumental pores in the new species differ from those previously reported in other species of *Parastenocaris*. We review and discuss the more common arrangements of these features in recently described species, emphasizing the taxonomic discriminative value of their variations.

Key words: *Parastenocaris*, Philippines, interstitial habitat, Harpacticoida, groundwater

Introduction

The harpacticoid family Parastenocarididae Chappuis is composed of seven genera: *Parastenocaris* Kessler, *Forficatocaris* Jakobi, *Paraforficatocaris* Jakobi, *Remaneicaris* Jakobi, *Potamocaris* Dussart, *Murunducaris* Reid, *Simplicaris* Galassi and De Laurentiis. All of them are exclusive to freshwater subterranean waters, *Paraforficatocaris*, *Forficatocaris*, *Potamocaris*, and *Murunducaris* are neotropical with a more or less limited distribution, *Remaneicaris* is neotropical with a wide distribution (Corgosinho & Martínez Arbizou 2005), *Simplicaris* has very restricted distribution being known only for Central Italy (Galassi & De Laurentiis 2004; Ruffo and Stoch 2005). Only *Parastenocaris* has a wide distribution (Galassi & De Laurentiis 2004).

The genus *Parastenocaris* is the most species rich in the Parastenocarididae, with representatives on all continents except Antarctica (Karanovic 2004). The possible

polyphyly of this genus is presently under intense discussion (Schminke 1993; Reid 1995; Martínez Arbizou 1997; Galassi & De Laurentiis 2004; Cottarelli *et al.* in press).

The new species of *Parastenocaris* is the second species of the genus reported from the Philippines, the only other known species is *P. mangyans* Bruno and Cottarelli, collected in the Oriental Province of Mindoro Island. However, two more species, yet to be described, are reported from “the Mountain Province of Luzon Island near Bontoc Town” (Bruno & Cottarelli 1999), and from Sibuyan Island, Romblon Province (Cottarelli unpubl.).

Materials and methods

Specimens were collected using the Karaman-Chappuis method (Delamare Deboutteville 1960) in freshwater about 300 m from the mouth of a river located 600 m from the village of Wawa, Western Mindoro Province, the Philippines (13°27'56.46"N, 120°45'46.26"E).

Specimens were fixed in 5% buffered formalin, sorted and mounted on permanent slides in Faure's medium. They were drawn at 1,250X, with an oil immersion lens, using a drawing tube mounted on a Zeiss Axioskop® phase-contrast microscope.

The following abbreviations are used, when required, throughout the text and figures: enp = endopod; exp = exopod; P1–P5 = legs 1–5. The nomenclature and descriptive terminology follow Huys and Boxshall (1991).

The holotype and one female paratype are deposited at the Museo Civico di Storia Naturale di Genova (MCSNG); the remaining material is located at the senior author's collection Environmental Sciences Department, della Tuscia University, Viterbo (DSAUT).

Family Parastenocarididae Chappuis

Genus *Parastenocaris* Kessler

Parastenocaris distincta sp. nov.

Material examined—Holotype: male, dissected and mounted on slide labelled: *Parastenocaris distincta* holotype male (MCSNG 53622a). Paratype (i.e. allotype): female, dissected and mounted on slide labelled: *Parastenocaris distincta* allotype female (MCSNG 53622b). Paratypes: two male, each dissected and mounted on slide labelled: *Parastenocaris distincta* paratype male no. 1, 2 respectively (DSAUT); two males, each mounted on slide, labelled: *Parastenocaris distincta* paratype male no. 3, 4 respectively (DSAUT). One female, mounted on slide labelled: *Parastenocaris distincta* paratype female no. 1 (DSAUT); 2 female, dissected and mounted on slide labeled: *Parastenocaris*

distincta paratype female no. 2, 3 respectively (DSAUT). Two female copepodites, stage V, each mounted on slide labeled: *Parastenocaris distincta*, copepodite female no. 1, 2, respectively (DSAUT). All material collected by V. Cottarelli on 02-08-05 (adults) and 02-23-04 (copepodites).

Description of male—Body vermiform, slender, unpigmented, eyeless. Length, measured from rostrum to apex of caudal rami: 0.389 mm. Hyaline frills of somites smooth. Genital somite and first 3 abdominal somites with oval dorsal integumental windows, the one on the first abdominal somite smallest (Fig. 1A). Anal somite (Fig. 1B–C) with paired sensilla on dorsal side, and 2 medial rows of small longitudinal spinules near the anus. Anal operculum (Fig. 1B–C) with slightly concave, smooth distal margin, a row of thin distal spinules visible under transparent operculum. Caudal rami (Figs 1B–1C) shorter than last abdominal somite, length to width ratio 2.5; anterolateral accessory seta (I) and seta II short, subequal; seta III slightly longer; outer terminal seta (IV) long (length seta/length caudal ramus: 1.7), pinnate; inner terminal seta (V) without breaking plane; terminal accessory seta (VI) smooth, short (length seta/length caudal ramus: 0.6); dorsal seta (VII) articulate (length seta/length caudal ramus: 1.2). All caudal setae inserted on the distal third of the caudal ramus. Spermatophore as in Fig. 1G.

Rostrum (Fig. 1D) small, reaching half of first segment of antennule; with 2 apical sensilla.

Antennule (Fig. 1D–E) geniculate, 8-segmented; first segment bare with transverse row of distal spinules; second segment with 6 setae, 1 one-side plumose; segment 3 with 4 distal setae; segment 4 represented by U-shaped, bare sclerite. Segment 5 enlarged (Fig. 1D–E), on the ventral side a distal tubercle carrying 2 setae of different lengths and 1 long apical aesthetasc, which reaches past end of antennule; 1 subapical, short seta at the base of the tubercle. The medial side of the segment has a proximal expansion curved inwards, with 1 small seta and 1 small pointed tip, and a distal hyaline membrane. Segment 6 bare, partially fused to segment 5. Segment 7 short, slightly curved inwards, with medial hyaline membrane, slender seta on the medial distal corner, and medio-distal process with a single pointed tip. Segment 8 with 6 setae and apical trithek consisting of 2 subequal setae and 1 slender, short aesthetasc.

Antenna (Fig. 1F), coxa unarmed; allobasis with 1 transversal row of spinules on medial margin; exopod 1-segmented, not-defined at base, with 1 short, pinnate apical spine; endopod bearing 2 geniculate and 1 transformed setae and 2 spines (Fig. 1F), 2 spinules along medio-distal margin, 2 spines and some spinules along lateral margin.

Mandible (Fig. 1H), cutting edge of coxal gnathobase with 2 strong teeth and 1 row of smaller teeth; palp 1-segmented, with 2 distal setae.

Maxillule (Fig. 1I), praecoxal arthrite with 4 claw-like spines and 1 subapical, curved seta; coxa with pinnate distal seta; basis with 2 apical setae.

Maxilla (Fig. 1J), syncoxa with 2 endites, proximal one with 1 seta, distal one with 2 setae, 1 pinnate; allobasis with apical pinnate claw; endopod with 2 setae.

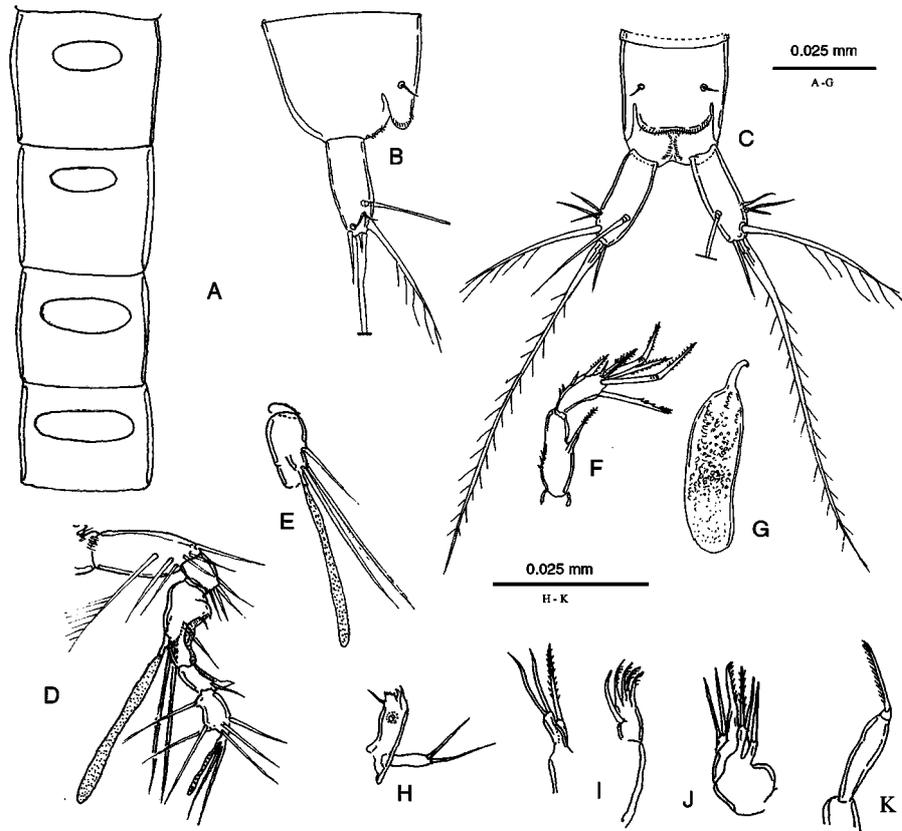


FIGURE 1. *Parastenocaris distincta* sp. nov. A, C, D–J: holotype (MCSNG 53622a). B: paratype male. A: dorsal integumental windows on genital somite and abdominal somites 1–3, dorsal view. B: anal somite, anal operculum, caudal rami, lateral view. C: anal somite, anal operculum, caudal rami, dorsal view. D: rostrum and antennule, dorsal view. E: fourth and fifth antennular segment, ventral view. F: antenna. G: spermatophore. H: mandible. I: maxillule. J: maxilla. K: maxilliped.

Maxilliped (Fig. 1K), prehensile; syncoxa small, unarmed; basis slim, elongate, unarmed; endopod represented by distally unipinnate claw.

P1 (Fig. 2A), basis with thin lateral seta, rows of transverse spinules and 1 enlarged, chitinous protrusion, with rounded bifid tip near endopod insertion; exopod 3-segmented, shorter than endopod; third segment with 1 pinnate and 2 geniculate apical setae, and 1 subapical pinnate seta. Endopod 2-segmented; enp-2 with a long, geniculate, pinnate seta and 1 short, pinnate seta on apex.

P2 (Fig. 2B), basis with 1 pore and 1 row of spinules, without lateral seta; exopod 3-segmented, with fringed extension on medial distal corner of segment 1, armature shown in figure; endopod very small, reaching 1/4 of exp-1, represented by a small, outwardly curved cylindrical segment, with 1 apical short seta.

P3 (Fig. 2C), elongated, basis with long, lateral seta, a pore and 1 transverse row of spinules; endopod represented by a thin, pointed segment, on the medial margin proximal to the endopod one strong, triangular laminar process; longitudinal row of long spinules

(Fig. 2C) and row of thin setae posterior to the endopod and process. Exp-1 fused with exp-2, slender, smooth, with spine inserted at about 1/5 of the lateral margin. Exp-2 ending in a long, inwardly curved apophysis with blunt tip. Outer spine of Exp-1 represented by a leaf-like, pointed thumb, shorter than apophysis, with proximal pore, and 3 short spinules at its insertion.

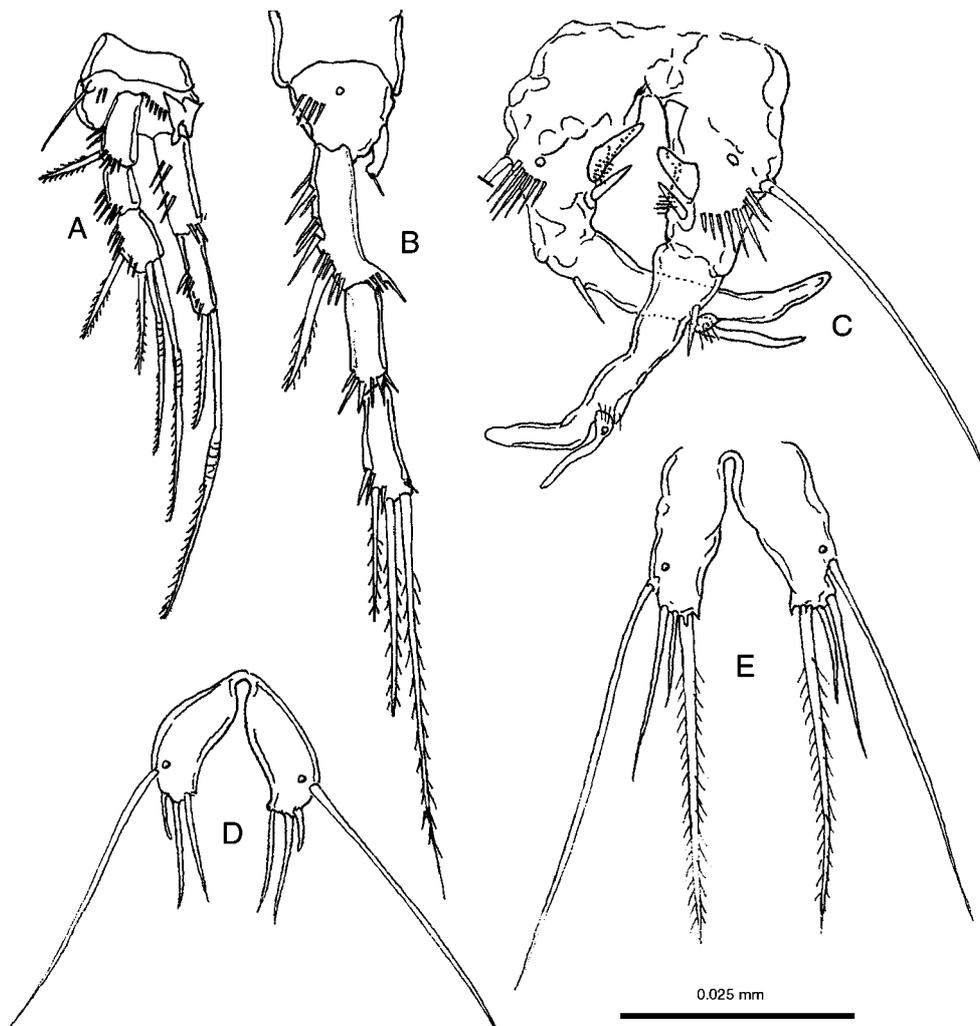


FIGURE 2. *Parastenocaris distincta* sp. nov. A, B, C, E: holotype (MCSNG 53622a). D: paratype (i.e. allotype, MCSNG 53622b). A: P1. B: P2. C: P3. D: P5. E: P5.

P4 (Fig. 3A), basis with long, lateral seta; exopod long, 3-segmented, chaetotaxy shown in figure. Exp-1 and exp-3 with fringed extensions on medial distal corner. Endopod represented by a cylindrical segment with a round protrusion at midlength, followed by bifid blunt tip, reaching to 1/2 length of exp-1; 2 long spines, 1 hooked, near the endopod insertion.

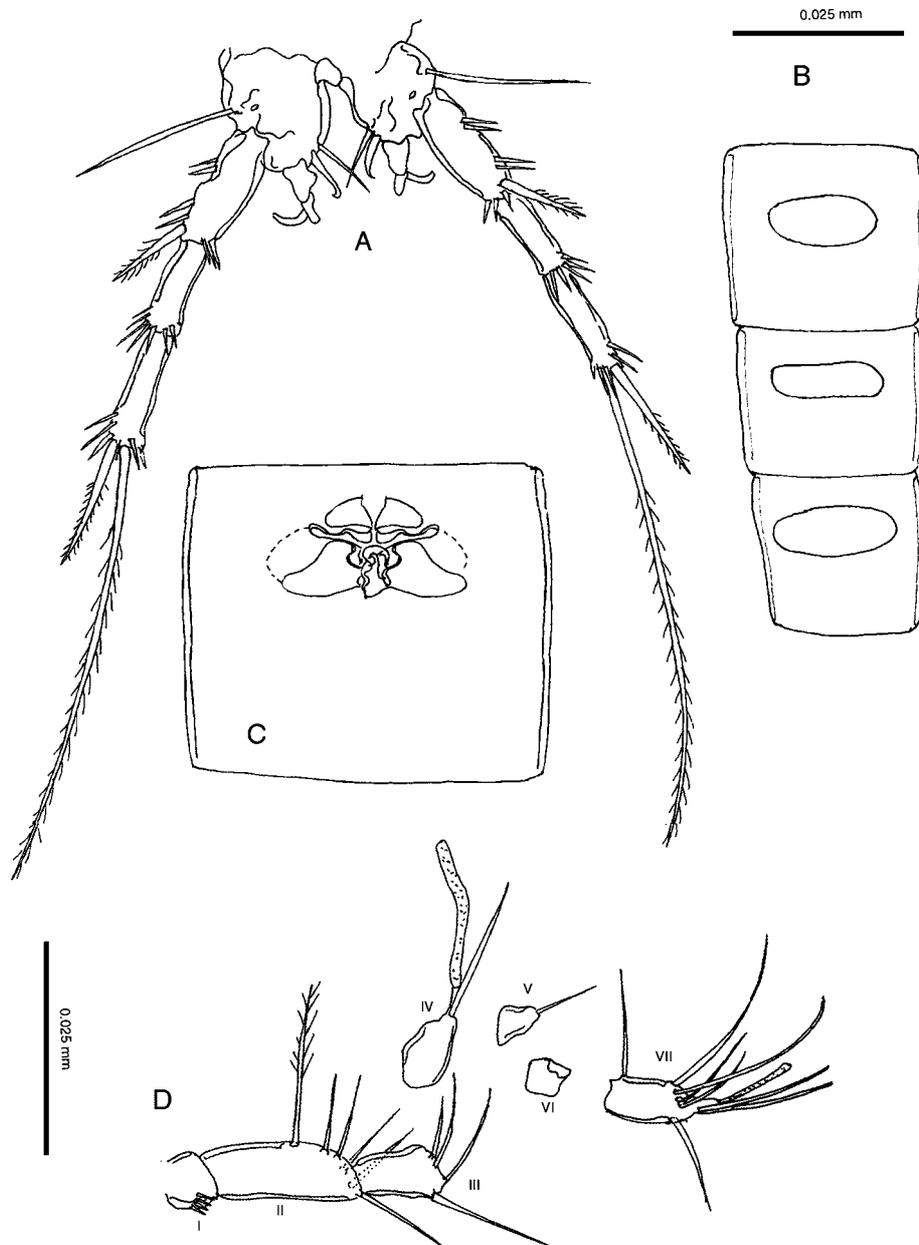


FIGURE 3. *Parastenocaris distincta* sp. nov. A: holotype (MCSNG 53622a). B: paratype female. C, D: paratype (i.e. allotype, MCSNG 53622b). A: P4. B: dorsal integumental windows on genital double-somite, abdominal somites 2-3, dorsal view. C: genital double-somite and genital field, ventral view. D: antennule, partly disarticulated, segments marked by roman numbers.

P5 (Fig. 2E), without intercoxal plate, represented by 2 almost rectangular, elongated plates fused at the base. A medial subapical tooth-like, small curved expansion; 3 apical setae, medial one longest, pinnate, the middle one is shortest; 1 very long, lateral, subapical seta with a pore near its insertion.

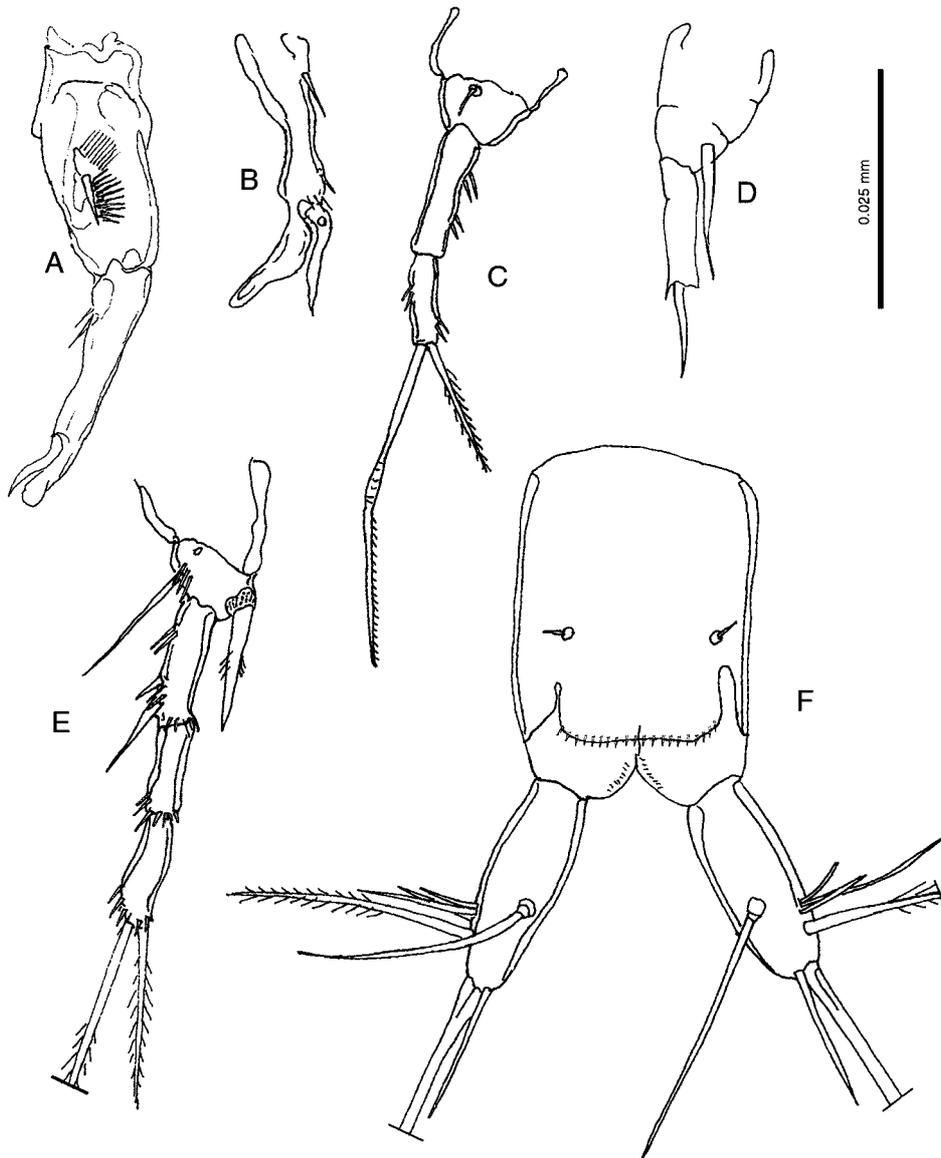


FIGURE 4. *Parastenocaris distincta* sp. nov. A, B: paratype male. C, D, E, F: paratype (i.e. allotype, MCSNG 53622b). A: P3, lateral view (variability). B: P3 exopod (variability). C: P1 basis and endopod, medial view. D: P3 endopod and exp-1, medial view. E: P4. F: anal somite, anal operculum, caudal rami, dorsal view.

Description of female—Length, measured from rostrum to apex of caudal rami: 0.410 mm. Genital somite, and abdominal somites 2–3 with oval dorsal integumental windows larger than in male (Fig. 3B). Genital somite and first abdominal somite fused, forming genital double-somite (Fig. 3C). Genital field located in the proximal 1/2 of the genital double-somite (Fig. 3C). Anal somite, anal operculum, rostrum, antenna, oral appendages, maxilliped, P1 and P2, as in the male. Caudal rami (Fig. 4F) similar to those of the male, outer terminal seta relatively shorter than in male.

Antennule (Fig. 3D), 7-segmented, with aesthetasc on segment 4 reaching past end of segment 7. Segment 1 with row of short spinules. Setal formula (from proximal segment): 0, 6, 4, 1 + aesthetasc, 1, 0, 6 + trithek. Apical trithek represented by 2 setae of same lengths and 1 slender, short aesthetasc.

P1 basis (Fig. 4C), lateral ornamentation as in the male, the medial margin with 1 slender, short seta.

P3, exopod 2-segmented as normal in the genus; endopod (Fig. 4D) represented by a thin, pointed segment, reaching past the end of exp-1.

P4 (Fig. 4E), basis with lateral seta, a row of spinules and 1 pore; exopod similar to that of male, with fringed extension on medial distal corner of each segment; endopod inserted on a small chitinous plate, represented by a small cylindrical, pointed segment as long as exp-1, with few longitudinal spinules.

P5 (Fig. 2D), without intercoxal plate, fused at the base. P5 similar to that of the male, but less elongate, lacking medial subapical tooth-like expansion; all setae are relatively shorter than in male, the lateralmost apical seta shortest.

Variability—All morphological characters described above appear to be constant, except the P3 of one male paratype which has two spinules on the exp-1 lateral margin at about 1/5 of the length (Fig. 4A); the P3 of another male paratype has one spinule on the exp-1 lateral margin at about 1/5 of the length, and a second spinule on the lateral margin at about 3/5 of the length (Fig. 4B).

Etymology—The specific name from the Latin adjective “*distinctus*” meaning “different”, it refers to the peculiar shape of the male P1 basis and P3. The epitheton is an adjective in feminine singular.

Discussion

The new species could be assigned to the *minuta*-species group of Lang (1948) due to the morphology of the male P4 endopod and P3. However, according to Berera and Cottarelli (2003) and Galassi and De Laurentiis (2004), this species group is polyphyletic, and its use has no phylogenetic value in assessing affinities of *P. distincta*. Instead, this species is characterized by some features, which have not been previously reported in any other species of *Parastenocaris*, although they do exist in other species of *Parastenocaris* (pers. obs.) and appear to be important in defining this possibly polyphyletic genus (Schminke 1993; Reid 1995; Martínez Arbizou 1997; Galassi & De Laurentiis 2004; Cottarelli *et al.* in press). These features are:

Dorsal integumental windows on the cephalic shield and on genital and abdominal somites: these structures are widespread in recently described species, whereas they apparently lack in several species described less recently. We checked our collection for

the 13 species of *Parastenocaris* we described in the last 20 years (*P. lorenzae* Pesce, Galassi & Cottarelli; *P. oligoalina* Cottarelli, Bruno & Venanzetti; *P. etrusca* Cottarelli, Bruno & Venanzetti; *P. aethiopica* Cottarelli & Bruno; *P. quollensis* Cottarelli & Bruno; *P. impervia* Cottarelli & Bruno; *P. aesculapii* Cottarelli & Bruno; *P. aphroditis* Cottarelli & Bruno; *P. amalasuntae* Bruno & Cottarelli; *P. mangyans*; *P. corsica* Cottarelli, Bruno & Berera; *P. silvana* Cottarelli, Bruno & Berera; *P. sibiritica* Berera & Cottarelli) and the integumental windows on the somites are indeed always present even if they differ among taxa in number, size and position. The dorsal integumental window on the cephalic shield on the other hand is not always present; but this structure may not be recognizable in over-cleared specimens. In the new species, for instance, both sexes have dorsal integumental windows of the most common number and position (as described by Kessler, 1913 in *P. brevipes*). In several species with the common number and position of somite windows, the anteriormost window is approximately rectangular, and the following windows become more oval in shape; this is the plesiomorphic condition according to Reid (1994). In *P. distincta* all the integumental windows are markedly oval, and sexually dimorphic, being larger in females. The only other species known for the Philippines, *P. mangyans*, differs from *P. distincta* and from all other *Parastenocaris* species because the male has the usual set of oval windows but the female has the dorsal set and a large additional ventral window on the genital somite.

Integumental pore numbers and distribution. Several species of *Parastenocaris* have integumental pores in various positions on the exoskeleton; pores are present in other genera of Parastenocarididae (i.e. *Forficatocaris*, *Remaneicaris*, *Potamocaris*, and *Simplicaris*). The most common arrangement for *Parastenocaris* is to have a pore on the lateral side of the P1–P4 basis, and those pores are present in *P. distincta* and in those species discussed in the previous paragraph; however, some species, have additional pores on the P5 and caudal rami, and on the last abdominal somite (Bruno & Cottarelli 1998, 1999; Karanovic 2004; Cottarelli *et al.* in press), and *Parastenocaris amalasuntae* has a lateral pore on each side of the rostrum (Bruno & Cottarelli 1998). *Parastenocaris distincta* has an additional pore on P5. A distal pore on the P3 exp-1 of male is recorded only for *P. silvana*, a species from Corsica (Cottarelli *et al.* 2000); the pore on the thumb of male P3 of *P. distincta* had not been recorded before. Thus, the pore patterns of *Parastenocaris* could be an informative character to define the taxonomy of this genus; however, difficulties could arise due to the need to use SEM to observe these microstructures, and this is not always possible if there are few types available.

Male antennule. The segment 7 of the antennule of the male has a pointed medial protrusion, which together with the medial expansion of segment 5 improves the prehensile function of the antennule (e.g. *P. gayatri* in Ranga Reddy 2001, *P. aesculapii* Cottarelli and Bruno, and *P. corsica*). In other *Parastenocaris*, such as *P. sibiritica* Berera and Cottarelli, segment 7 has a pointed protrusion but segment 5 is not transformed (a similar condition is present in *Simplicaris*). Thus, in *Parastenocaris* there are three possible specialization of the male A1 for holding to the female: no modification of

segments 5 and 7 as in *P. mangyans*; only segment 7 transformed; both segments 5 and 7 transformed. The last combination would represent the most apomorphic status. A new arrangement is present in *P. distincta* where segment 7 has a seta as well as the above-discussed tip; this segment is bare in all the *Parastenocaris* mentioned above. Only Reid (1995) describes (but does not discuss) a small seta on segment 7 in *P. trichelata* Reid.

Medial ornamentation of P1 basis. Recently, we discussed (Cottarelli *et al.* in press) the peculiar sexual dimorphism of the P1 basis in *Parastenocaris* and the various setal arrangements are listed in Table 1. The feature recorded for *P. distincta* appears unique. Thus, the medial ornamentation of P1 basis varies among several species of *Parastenocaris*, and the characters recorded are probably not homologous: this could be another indication of the possible polyphyly in the genus (Schminke, 1993; Martínez Arbizu 1997; Galassi & De Laurentiis, 2004).

TABLE 1. The different conditions of the P1 basis medial ornamentation recorded for some species of *Parastenocaris*.

Species	P1 basis medial ornamentation
<i>P. amalasuntae</i>	lacking in both males and females
<i>P. proserpina</i> Chappuis	lacking in both males and females
<i>P. admete</i> Cottarelli	lacking in both males and females
<i>P. mangyans</i>	one seta in males, bare in females
<i>P. corsica</i>	males and females with one seta in the same position but the female's is shorter and thinner
<i>P. silvana</i>	males and females with a seta in the same position but the female's is shorter and thinner
<i>P. cf. glacialis</i> Cottarelli <i>et al.</i>	males with two setae and females with one
<i>P. pasquinii</i> Cottarelli	males with one curved hook and one small seta and females with one seta
<i>P. crenobia</i> Galassi	males with one hook, the female is unknown
<i>P. distincta</i>	an enlarged, chitinous protrusions, with rounded bifid tip in the males, and a simple small seta in the females

The characters listed above vary among species of *Parastenocaris*, however, we presented only few examples because a discussion of phylogenetically informative characters for the genus is not within the scope of this paper. Several more examples for other species are available in literature.

Parastenocaris distincta is characterized by some peculiar autoapomorphies related to the P3 of the male. These legs are used by the male to grasp the female's genital somite during coupling (Glatzel & Schminke 1996) and are shaped like pincers but variation from this basic plan occurs in different species. In the new species, the medial margin of the P3 basis of the male, has a peculiar triangular laminar process, which is inserted near the

endopod, and is relatively strong. The function of this laminar process is unknown; it might represent a structure, which improves the hold of P3 on the female. Examination of the literature has revealed only three species of *Parastenocaris* with similar structures: *P. kimi* Dumont where the inner side of the basal segment is lined with particularly strong spines (Dumont 1981); *P. gayatri* Ranga Reddy which has the inner margin of P3 exp-1 with one large triangular hyaline at midlength, one large dentate process close to it and one small chitinous knob proximally (Ranga Reddy 2001); and Gorgosinho and Martínez Arbizou (2005) describe “a foliaceous hyaline structure proximal to enp on inner margin” for the male P3 of *Remaneicaris analuizae* Gorgosinho and Martínez Arbizou.

In addition, *Parastenocaris distincta* is characterized by longitudinal rows of long spinules and thin setae on the medial margin of the male P3 exopod, which are longer and stronger than in other species. It is likely that these structures help to improve the grasping efficiency of the male P3 in a way, until now, never recorded in *Parastenocaris*.

Parastenocaris distincta was collected at the mouth of a river a short distance from the sea, in an area with medium-fine, non-organic sand, with little organic matter and clear water (24.3°C, pH: 7.31). The only other harpacticoids collected at this site were few specimens of *Psammopsyllus brevipes* Cottarelli, Puccetti & Saporito, an interstitial Leptopontiidae from the subfamily Psammopsyllinae, which was described from Sulawesi, Indonesia and recently collected in the Philippines [Cottarelli, Bruno & Berera, submitted to *Hydrobiologia: What and where is Psammopsyllus operculatus* Nicholls, 1945? Notes on the distribution of the operculatus species-group and description of *Psammopsyllus paraoperculatus* sp. nov. (Copepoda, Harpacticoida)]. This is the first record of the association of *Parastenocaris* and *Psammopsyllus* in tropical waters; this association is common in temperate waters (Berera & Cottarelli 2003).

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