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Three new species of *Remaneicaris* Jakobi, 1972 (Copepoda, Harpacticoida, Parastenocarididae) from the Ribeirão do Ouro River, Minas Gerais, Brazil, with some remarks on the groundpattern of the Parastenocarididae

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Abstract

Three new species of the parastenocaridid genus *Remaneicaris* Jakobi, 1972 were discovered in interstitial near-shore waters of the small river Ribeião do Ouro (a tributary of the Paraopeba river, in the São Francisco hydrographic basin). *Remaneicaris tridactyla* **n. sp.**, *R. paratridactyla* **n. sp.** and *R. juliae* **n. sp.** are described in detail. The presence of a 1-segmented endopod on the male leg 3, previously reported for some *Remaneicaris* species, is confirmed here, and the phylogenetic relevance of this structure is discussed. These new species differ from each other by the shape of the leg 3 exopod and endopod, shape of leg 4 endopod, ornamentation of the telson and previous urosomites, and by the number of sensilla and dorsal pores. Some remarks on the groundpattern of the Parastenocarididae are given.

Key words: hyporheos, Neotropis, groundpattern

Introduction

The family Parastenocarididae Chappuis, 1940 is a monophyletic group within Harpacticoida, being characterised and easily distinguished by the sexual dimorphism present in the third pair of legs. As an apomorphy, the males have these legs modified into a grasping organ (Martínez Arbizu & Moura 1994) that allows them to grasp the female during copulation (Glatzel 1991, 1996). In addition to the dimorphic third leg, the males present other modifications, mainly in the endopod of the fourth leg and, sometimes, in the first, second, fifth legs and the furca (Schminke 1991). These modifications constitute important characters used to distinguish species and supra-specific taxa.

The family currently contains 241 species and subspecies, but our knowledge of the phylogenetic relationships within the family is fragmentary. The monophyly of many genera proposed by Jakobi (1972) is still to be assessed. In South America, parastenocaridids encompass 66 known species, 33 of them reported from Brazil. These species belong to nine valid (see ICZN 1999 article 13) genera, viz. *Parastenocaris* Kessler, 1913; *Remaneicaris* Jakobi, 1972; *Brasilibathynellocaris* Jakobi, 1972; *Forficatocaris* Jakobi, 1969; *Pararemaneicaris* Jakobi, 1972; *Siolicaris* Jakobi, 1972; *Paraforficatocaris* Jakobi, 1972; *Potamocaris* Dussart, 1979 and *Murunducaris* Reid, 1994. The genus *Remaneicaris* was proposed by Jakobi (1972) to accommodate the species included in the "*remanei*-group" (Noodt 1963) together with some other neotropical species described subsequently. The genus was revisited by Corgosinho & Martínez Arbizu (2005), who profoundly modified Jakobi's concept in excluding some species from the genus, including some new and formerly known parastenocaridids, and by identifying some apomorphies which reveal its monophyletic status. *Remaneicaris* was considered valid by the former authors because it is based on a valid type species, viz. *Remaneicaris remanei* (Noodt, 1963), and therefore article 13 of ICZN (1999) applies.

In this study we describe three additional, new species of *Remaneicaris* collected from the hyporheic zone of a small river in the São Francisco River basin, Minas Gerais, Brazil. The phylogenetic positions of the new species within the genus are discussed and some remarks on the groundpattern of Parastenocarididae are provided.

Material and methods

The samples were taken on September 15 2000 next to the river bank of the Ribeirão do Ouro river, using the Karaman-Chappuis method (Chappuis 1942), washed through a 100 μ m mesh, stained with rose bengal, and fixed with formalin at a final concentration of 4%. Animals were dissected in lactic acid and mounted on slides in glycerin. Drawings were made using a drawing tube (with a 2x lens) on a Leica DMR microscope, equipped with Normarski interference contrast, at 400 and 1000 magnification.

Abbreviations used are: A1 = antennule, A2 = antenna, Ae = aesthetasc, Md = mandible, Mx1 = maxillula, Mx2 = maxilla, Mxp = maxilliped, enp = endopod, exp = exopod, ARS = anterior row of spinules, PRS = posterior row of spinules, PES = pre-endopodal spinules, PEHZ = pre-endopodal hyaline zone, IBRS = inner basal row of spinules, RVS = row of "V" spinules, DESnl = distal exopodal spinule.

The term groundpattern is used in the same sense of the concept of Ax (1984) of Grundmuster.

The type material is deposited in the invertebrate collection of the Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Brazil.

Descriptions

Family Parastenocarididae

Genus Remaneicaris

Remaneicaris tridactyla n. sp.

Type material: Holotype, one dissected male on 7 slides (INPA 1339a).

Paratypes: One dissected female on 7 slides (INPA 1339c); 2 undissected males mounted on different slides (INPA 1339b and INPA 1339d), 1 dissected male mounted on 7 slides (INPA 1339e), 1 undissected female mounted on one slide (INPA 1339f).

Etymology: The species name refers to the trifid structure of the modified thumb of the male leg 3.

Type Location: Ribeirão do Ouro river, Sítio do Corgosinho, Florestal, state of Minas Gerais, Brazil. Coordinates: 19°48'19"S, 44°27'45"W.

Male (Fig. 1 A–B). Length 404 μ m (measured from the tip of rostrum to the posterior rim of anal operculum). Rostrum not fused to cephalothorax, with a wide base and two sensilla on the tip. Cephalothorax and second urosomite with 1 dorsal integumental window. Urosomite 5 with a pair of lateral integumental windows. Dorsal pores on cephalothorax, thoracic somites 1 and 3 and second urosomite. Telson with 1 pair of lateral pores. For sensilla on tergites see Fig. 1 A–B. Telson with 1 dorsal row of 10 spinules located on the

anterior third (ARS), 2 rows of 5 large spinules on the posterior half (PRS), anterior to the sensilla, not reaching the operculum and 2 ventral rows of large spinules on the posterior half, near the insertion of the furca (Fig. 2 A–B). Anal operculum smooth and quadrate. Furca (Figs. 1 A–B and 2 A–B) about 6 times as long as wide, with 7 setae. All setae located on the posterior third. A1 (Fig. 3A) 9-segmented and prehensile; armature beginning with proximal segment: $\frac{0}{5}\frac{4}{2}$ + Ae/ $\frac{1}{4}\frac{2}{9}$ + Ae, 1 modified seta on the last segment (indicated by an arrow) and 1 hyaline spinule on the seventh and eighth segments. A2 (Fig. 3 B) with allobasis; 1segmented exp with 1 seta, and 1-segmented enp bearing an anterior hyaline frill and 7 setae. Md, Mx1, and Mxp armature as P. hispanica Martínez Arbizu 1997; Mx2 with 2 slender setae on the proximal endite and 3 on the distal endite, as in R. analuizae Corgosinho & Martínez Arbizu 2005. Leg 1 (Fig. 4 A) coxa without setae or spines, with 2 rows of spinules on the posterior side; basis with outer seta and 1 pore on the anterior side, 3 spinules on the outer margin, and 3 distal spinules anterior to the insertion of the enp; enp and exp of the same size; enp 2-segmented, segment 1 with 1 row of 5 long spinules along the inner margin, 1 row of 4 spinules on the outer margin and a posterior hyaline frill; segment 2 with a posterior hyaline frill and 2 distal setae, 1 of them geniculated; first enp segment of the same size of the first two exopodites; exp 3-segmented, segment 1 with 1 outer spine, segment 2 without setae or spines, segment 3 with 2 outer spines, 2 geniculated setae and a posterior pore. Leg 2 (Fig. 4 B) coxa without setae or spines, with 1 row of small spinules and 3 outer spinules on the posterior side; basis without outer seta and ornamented with 1 row of spinules on the outer margin, 1 row of small spinules at the level of the enp insertion and 1 pore near the outer margin; exp 3segmented, the first segment approximately the same length as the remaining exopodites, with a proximal row of spinules on the outer margin, distributed in a "V" shape, a row of spinules anterior to the insertion of the outer spine and an inner hyaline frill, segment 2 without armature, with 2 spinules located medially on the outer margin and with a row of distal spinules, segment 3 with 3 setae, a distal hyaline frill on the inner corner and 2 spinules located medially on the outer margin; enp 1-segmented with 1 distal seta, 2 distal spinules, and 3 spinules along the outer margin. Leg 3 (Fig. 4 C–D) coxa without setae or spines; basis with an outer seta; enp 1-segmented with 3 subdistal spinules; exp 1-segmented, elongated, bearing 2 rows of spinules along the outer margin and with 1 very modified seta ("thumb") in a subdistal position. Leg 4 (Fig. 4 E) coxa without setae or spines, with 3 small spinules on the posterior side; basis with outer seta, 1 pore near the outer margin, a row of spinules on the inner margin (IBRS) and 1 row of larger spinules near the insertion of the enp (PERS), in a hyaline area of the basis (PEHZ); exp 3-segmented, segment 1 almost same length as remaining segments, with an outer spine, a proximal row of spinules distributed in a "V" shape (RVS) on the outer margin, a row of spinules anterior to the insertion of the outer spine and an inner hyaline frill on the distal corner, segment 2 without setae, with a row of spinules on the distal portion, a row of small spinules along the inner margin, conferring on it a serrated shape, and with 2 long spinules located medially on the outer margin, segment 3 with 1 apical and 1 subdistal outer seta, a distal hyaline frill on the inner corner and 3 spinules located medially on the outer margin; enp 1-segmented, leaf-shaped, covered with numerous long spinules (hirsute) along the inner and outer margin and with a distal spine. Leg 5 (Fig. 2 C) triangular, ending in a spiniform process and with all setae arranged on the outer margin.

Female: Sexually dimorphic in number of body segments, A1, leg 3, leg 4 and genital field.

Habitus (Fig. 5 A–B). Length 413 μ m (measured from the tip of rostrum to the posterior rim of anal operculum). Rostrum as in male. Cephalothorax and genital double-somite with 1 dorsal integumental window. Urosomite 4 with 1 pair of lateral integumental windows. Dorsal pores as in male and 1 pair of lateral pores on the telson. For sensilla on tergites see Fig. 5 A-B. Telson with 2 dorsal rows of 4 spinules on the anterior third (ARS), 2 rows of 4 larger spinules on the posterior half, not reaching the operculum (PRS) and 2 ventral rows of large spinules on the posterior half, near the insertion of the furca (Fig. 5 A–B and 6 A–B). Anal operculum smooth and convex (Fig. 6 B). Furca (Fig. 6 A–B) about 5 times as long as wide, with 7 setae. All setae located on the distal third, as in males. A1 (Fig. 7A) 7-segmented, not prehensile; number of setae beginning with proximal segment:



FIGURE 1. *Remaneicaris tridactyla* **n. sp.**, male. A, habitus, lateral view; B, habitus, dorsal view. h = dorsal sensilla on the second male's urosomite.

B



FIGURE 2. *Remaneicaris tridactyla* **n. sp.**, male. A, telson, dorsal view; B, telson, lateral view; C, ventral view of the first urosomite with P5 and second urosomite with genital aperture. ARS = anterior row of spinules; PRS = posterior row of spinules.



FIGURE 3. *Remaneicaris tridactyla* **n. sp.**, male. A, antennule; B, antenna. Arrow indicating a modified seta on the last antennular segment.



FIGURE 4. *Remaneicaris tridactyla* **n. sp.**, male. A, leg 1; B, leg 2; C, leg 3, lateral; D, leg 3, frontal; E, leg 4. PES = pre-endopodal spinules; PEHZ = pre-endopodal hyaline zone; IBRS= inner basal row of spinules; RVS = row of "V" spinules.



FIGURE 5. Remaneicaris tridactyla n. sp., female. A, habitus dorsal; B, habitus lateral.



FIGURE 6. *Remaneicaris tridactyla* **n. sp.**, female. A, telson, ventral view; B, telson, dorsal view; C, first urosomite with P5 and genital field, ventral view.



FIGURE 7. Remaneicaris tridactyla n. sp., female. A, antennule; B, antenna; C, leg 1; D, leg 2; E, leg 3; F, leg 4.

0/4/5/2+Ae/1/2/9+Ae. A2 (Fig. 7B) with allobasis, 1-segmented exp with 1 seta, 1-segmented enp bearing 7 setae and a posterior hyaline frill. Buccal parts as in male. Leg 1 (Fig. 7 C) coxa without setae or spines and with 1 posterior row of spinules; basis with outer seta, 3 outer accessory spinules and 3 distal spinules near the insertion of enp; enp and exp as in males. Leg 2 (Fig. 7D) as in males. Leg 3 (Fig. 7E) coxa without setae or spines, with 2 rows of spinules on the posterior side; basis with 1 outer seta, and ornamented with 1 row of spinules near the insertion of the enp; exp 2-segmented, segment 1 with an outer spine, a proximal row of spinules and a row of spinules next to the outer spine, segment 2 with 1 spine, 1 seta and 2 long spinules on the outer margin; enp 1-segmented and spiniform, with 2 spinules on the outer margin and 1 spinule on the inner margin. Leg 4 (Fig. 7F) as in males, except for the presence of a spiniform enp ornamented with 1 row of 4 spinules on the outer margin and a row of small spinules on the basis, near the insertion of the enp. Leg 5 (Fig. 6C) as in male. Genital field as illustrated in Fig. 6C, with a single, medially located copulatory pore. Gonopore is a transverse slit.

Remaneicaris paratridactyla n. sp.

Type material. Holotype, 1 male, dissected and mounted on 7 slides (INPA 1391a-g).

Paratypes: 1 dissected female mounted on 7 slides (INPA 1392a–g), 1 male mounted on 9 slides (INPA 1393a–i), 1 undissected male (INPA 1394a) and 1 female (INPA 1394b) mounted on one slide each other.

Etymology: The species name refers to the complex structure of the modified thumb of leg 3, somewhat similar to the homologous structure found in *R. tridactyla* **n. sp.**

Locus typicus: Ribeirão do Ouro river, Sítio do Corgosinho; Florestal, state of Minas Gerais, Brazil. Coordinates: 19°48'19"S, 44°27'45"W.

Male (Fig 8 A–B). Length 413 µm (measured from the tip of rostrum to the posterior rim of anal operculum). Rostrum with wide base and 2 sensilla on tip. Cephalothorax and second urosomite each with 1 dorsal integumental window. Urosomite 5 with lateral integumental window. Dorsal pores on cephalothorax, thoracic somites 1 and 3 and second urosomite. One pair of lateral pores on telson. Arrangement of sensilla on tergites illustrated in Figs. 8 (A–B). Telson (Fig. 9 A–B) with a dorsal row of 8 spinules on the anterior half (ARS) and 2 rows of 3 spinules on the posterior half (PRS), near the operculum; ventrally, with a row of 4 spinules near the insertion of the furca. Anal operculum quadrate, without spinules. Furca 3.5 times longer than wide, with 7 setae, all located on distal third. A1 (Figs. 10A) 9-segmented and prehensile; armature beginning with proximal segment: 0/5/4/2/5+Ae/1/4/2/9+Ae, last segment with 1 modified seta as in *R. tridactyla* **n. sp.** A2 (Fig. 10B) with allobasis; 1-segmented exp with 1 seta, and 1-segmented enp with 7 setae. Mouthparts armature as *R. tridactyla* **n. sp.**; leg 1, leg 2 and leg 4 (Fig. 11A, B and E) similar to the respective appendices of *R. tridactyla* **n. sp.** male. Leg 3 (Fig. 11 C and D) coxa without setae or spines, with 2 rows of spinules on the posterior side; basis with outer seta; enp 1-segmented with 1 terminal seta; exp 1-segmented, elongate, bearing 2 rows of spinules along outer margin; subdistally, with 1 very modified seta (thumb). Leg 5 (Fig. 10 C) triangular, ending in a spinulous process and with all setae located on the outer margin.

Female: Sexually dimorphic in number of body segments, A1, leg 3, leg 4 and genital field.

Habitus (Fig. 12 A–B). Length 456 μ m (measured from the tip of rostrum to the posterior rim of anal operculum). For pores and sensilla see Fig. 12 A and B. Telson (Fig. 12 A–B) with a dorsal row of 9 spinules on the anterior half (ARS) and 2 rows of 3–4 spinules on the posterior half (PRS) near the operculum; ventrally, with a row of 4 spinules near the insertion of the furca. Operculum quadrate, without spinules. Furca 4 times longer than wide, with 7 setae, all located on distal third. A1 and A2 (Fig. 13 A–B), mouthparts, leg 1, leg 2, leg 3, leg 4 and genital field (Fig. 14 A–E) are similar to the respective structures of females of *R. tri-dactyla* **n. sp.**, but with some differences in the ornamentation of the basis of legs 1 to leg 4.



FIGURE 8. Remaneicaris paratridactyla n. sp., male. A, habitus lateral; B, habitus dorsal.



FIGURE 9. Remaneicaris paratridactyla n. sp., male. A, telson, lateral view; B, telson, dorsal view.

Remaneicaris juliae n. sp.

Type material. Holotype, 1 male, dissected and mounted on 5 slides (INPA 1340a–e). The slide with the A1, A2 and mouthparts was lost.

Paratypes: 1 dissected female mounted on 7 slides (INPA 1341a–g), 1 partially dissected male mounted on 1 slide (INPA 1342a) and 1 undissected female mounted on 1 slide (INPA 1342b).

Etymology: The species name honors a friend, Julia Funk, of Freiburg, Germany.



FIGURE 10. *Remaneicaris paratridactyla* **n. sp.**, male. A, antennule; B, antenna; C, ventral view of first urosomite with P5.



FIGURE 11. Remaneicaris paratridactyla n. sp., male. A, leg 1; B, leg 2; C and D, leg 3; E, leg 4.



FIGURE 12. Remaneicaris paratridactyla n. sp., female. A, habitus lateral; B, habitus dorsal.



FIGURE 13. Remaneicaris paratridactyla n. sp., female. A, antenna; B, antennule.



FIGURE 14. Remaneicaris paratridactyla n. sp., female. A, leg 1; B, leg 2; C, leg 3; D, leg 4; E, leg 5.



FIGURE 15. Remaneicaris juliae n. sp., male. A, habitus lateral; B, habitus dorsal.



FIGURE 16. *Remaneicaris juliae* **n. sp.**, male. A, ventral view of the first urosomite with P5 and second urosomite with genital aperture; B, dorsal view of the telson and the two previous urosomites; C, telson in a lateral view.



FIGURE 17. Remaneicaris juliae n. sp., male. A, antennule; B, leg 1; C, leg 2; D, leg 3; E, leg 4.



FIGURE 18. Remaneicaris argentina, male, leg 3. DESnl = distal exopodal spinule.

Type location: Ribeirão do Ouro river, Sítio do Corgosinho; Florestal, state of Minas Gerais, Brazil. Coordinates: 19°48'19"S, 44°27'45"W.

Male (Fig 15 A–B). Length 441 µm (measured from the tip of rostrum to the posterior rim of anal operculum). Rostrum with wide base and 2 sensilla on tip. Cephalothorax and second urosomite each with 1 dorsal integumental window. Urosomite 5 with 1 pair of lateral integumental windows. Dorsal pores on cephalothorax, thoracic somites 1 and 3 and second urosomite. One pair of lateral pores on telson. Arrangement of sensilla on tergites illustrated in Figs. 15 (A–B). Urosomites 4 and 5 with a posterior row of large spinules (Fig. 16B). Telson (Fig. 16 B–C) with a dorsal row of 8 spinules on the anterior half (ARS) and 2 rows of 3 spinules on the posterior half (PRS) near the operculum; ventrally, with a row of 4 spinules near the insertion of the furca. Operculum quadrate, without spinules. Furca 3.5 times longer than wide, with 7 setae, all of them located on distal third. A1 (Figs. 17 A) 9-segmented and prehensile; armature beginning with proximal segment: 0/5/4/2/5 + Ae/1/4/2/9 + Ae, as in the former species, with a modified seta on the last segment. A2 as in the previously described species, with allobasis; 1-segmented exp with 1 seta, and 1-segmented enp with 7 setae; Mouthparts armature as in R. tridactyla n. sp. Leg 1, leg 2 and leg 4 (Fig. 17 B, C and E) similar to the respective appendices found in males of R. tridactyla n. sp. and R. paratridactyla n. sp., with the exception of the enp of leg 4, somewhat more blunt and with a blade-shaped distal spine. Leg 3 (Fig. 17 D) coxa without setae or spines; basis with outer seta, 2 outer spinules and 1 proximal row of spinules; enp 1-segmented, without any armature or ornamentation; exp 1-segmented, elongated, bearing 1 row of spinules along outer margin; subdistally, with 2 strong spinules and a strong and curved spine thumb. Leg 5 (Fig. 16A) triangular, ending in a spinulous process and with all setae located on the outer margin.

Female. No striking differences in armature and ornamentation between appendices of the female of *R*. *juliae* **n**. **sp**. and the previously described species. Sensilla and pore patterns just as in males, with the exception of the genital double-somite which carries 4 setae. Telson and previous 2 urosomites as in males.

Discussion

The three species described here share the subdistal position of the outer spine on the third exopodal segment of leg 4, a character that has been considered as the most important synapomorphy of *Remaneicaris* (Corgos-inho & Martínez Arbizu, 2005).

Remaneicaris tridactyla **n. sp.**, *R. paratridactyla* **n. sp.** and *R. juliae* **n. sp.** share the presence of a posterior row of spinules (PRS, indicated in Fig. 2A) on the dorsal margin of the telson, located directly anterior to the sensilla; as well as a second row of spinules located anteriorly on the dorsal margin of the telson (ARS, indicated in Fig. 2A). These species also share the presence of a row of up to 5 strong spinules located ventrally near the insertion of the furca. These characters are present also in R. remanei (Noodt, 1963) and R. paraguayensis (Noodt, 1963), and can be used to define a monophyletic group within the genus. Remaneicaris paraensis (Noodt, 1963) and R. hexacantha (Kiefer, 1936) display the PRS and the ventral row of spinules, but lack the ARS. Other species such as R. persephone (Noodt, 1965) and R. sierrae (Noodt, 1965) display the PRS, but other characters indicate that these species belong to another monophyletic subgroup within *Rema*neicaris. For instance R. persephone and R. sierrae belong to a larger group that shares the presence of a leg 6 with 2 setae in females. No seta on leg 6 is present in the monophyletic group formed by R. tridactyla n. sp. and the other species around it. Although the presence of armature elements on leg 6 may be considered a plesiomorphic condition compared to the lack of them, we believe that the most parsimonious assumption is to consider the appearance of these elements as a synapomorphy for a more derived group within *Remaneicaris*, since the alternative, considering it as a plesiomorphy, would imply the loss of this character at least four times within the genus. Remarkably no armature elements on leg 6 are known for any other species within Parastenocarididae. Within this group, R. persephone is more closely related to R. hecate (Noodt, 1965), with which it shares the elongation of enp of leg 4 in the females, passing the distal rim of first exp segment, as a synapomorphic character. Remaneicaris sierrae is most closely related to R. cordobaensis (Noodt, 1965) and R. ciliata (Noodt, 1965), sharing the loss of a row of large spinules (PERS) near the insertion of leg 4 enp in males as a synapomorphy. The phylogenetic position of *R. hexacantha* is difficult to assess because males are unknown; but it seems that this species is closely related to the species around R. tridactyla n. sp., R. paratridactyla and R. juliae n. sp. A ARS is present in R. analuizae Corgosinho & Martínez Arbizu 2005 and R. euniceae Corgosinho & Martínez Arbizu 2005. but these species belong to a different monophyletic subgroup within *Remaneicaris*, sharing the development of a hyaline structure on the distal rim of the last antennular segment in males.

R. tridactyla **n. sp.** differs from all other species of the genus by the complex structure of the "thumb", which is divided into three processes (Fig. 4 C and D). Within *Remaneicaris*, this condition is only present in *R. paratridactyla* **n. sp.**, although this structure is not so strongly developed in the latter species (Fig. 11 C and D). To our knowledge, no other species of Parastenocarididae display this structure. The illustrations by Noodt (Noodt 1962, 1963, 1965) and Kiefer (Kiefer 1967) of the leg 3 of the males of *R. palaciosi* (Noodt, 1962), *R. clandestina* (Noodt, 1963), *R. argentina* (Noodt, 1965), *R. jujuyensis* (Noodt, 1962) and *R. drepanephora* (Kiefer, 1967) suggest a similar condition in these species. However, study of the type material revealed that they are not homologous to the condition present in *R. tridactyla* **n. sp.** but is formed by the transformation of the distal spinule (DESnl) on the outer margin of the exp, together with the elongation of the

outer setae (thumb) (indicated in Fig. 18). *Remaneicaris juliae* **n. sp.** has to be considered more primitive, because it does not have the trifid thumb (Fig. 17 D). It differs from the other species by the presence of a row of strong spinules on the fourth and fifth urosomites (Fig. 15 A and B, Fig. 16 B).

The three species described above have a lateral integumental window on the fifth urosomite of the male (fourth urosomite in the female). This character is present in almost all *Remaneicaris* species. Other, alternative patterns can be seen within the genus. For example, *Remaneicaris analuizae* Corgosinho & Martínez Arbizu, 2005 has a second lateral window on the fourth urosomite in the male (third urosomite in the female). *Remaneicaris palaciosi* and *R. meyerabichi* (Noodt, 1962) have a window on the last urosomite, which extends from the dorsal to the lateral margin (Noodt 1962). Other, undescribed species have come to our knowledge that have on the fifth male urosomite and fourth female urosomite, two windows on each side laterally, which seems to be the result of a split of the previously single lateral window. Finally, observations of Noodt's type material revealed that in *R. hecate*, *R. pluto* (Noodt, 1965) and *R. persephone* and in females of *R. oncophora* (Noodt, 1965), the integumental window of the second urosomite is divided into two, laterodorsal windows. It seems that *Remaneicaris ignotus* (Dussart, 1983) is the most basal species within the genus (Corgosinho & Martínez Arbizu in press; Corgosinho 2007) and it does not have lateral windows, but rather one dorsal window on each of urosomites 2–5.

Remarks on the groundpattern of Parastenocarididae

Species of the genus *Remaneicaris* have many plesiomorphic characters, which allow us to make some remarks on the reconstruction of the groundpattern of the family.

Integumental windows. Besides *Remaneicaris*, only some African Parastenocarididae, viz. *P. caffer* Chappuis, 1936; *P. madagascarensis*, Chappuis, 1952; *P. forficulata* Chappuis, 1952; *P. arenosus* Fryer, 1956 and *P. aethiopica* Cottarelli & Bruno, 1995 display lateral or ventro-lateral windows on the fourth urosomite of females and fifth urosomites of males (Chappuis 1936, 1952; Fryer 1956; Cottarelli & Bruno 1995). We do not share the idea that this can be used as a synapomorphy to unify all these species together in a monophyletic, suprageneric group (Corgosinho & Martínez Arbizu 2005). Since *Remaneicaris* does not have the lateral position of integumental windows in its groundpattern (see *R. ignotus*), the appearance of lateral windows on the African species should be interpreted as a homoplasy. The exclusion of *R. palaciosi* and *R. meyerabichi* from the *remanei-group* (*Remaneicaris*) based on the presence of dorsal integumental windows (Reid 1994), is not accepted here because the displacement of the integumental windows to a lateral position occurs within *Remaneicaris* and is therefore not a diagnostic synapomorphy for the genus.

Cuticular pores and sensilla. Males and females of *R. tridactyla* **n. sp.** and *R. juliae* **n. sp.**, and males of *R. paratridactyla* **n. sp.** share a pattern of cuticular pores. They have 1 dorsal pore on the cephalothorax, 1 dorsal pore on the first and third thoracic somites and 1 dorsal pore on the second urosomite (genital double-somite in females) (Fig. 5). The telson has one lateral pore on each side. Females of *R. paratridactyla* **n. sp.** have one additional dorsal pore on the last urosomite (Fig. 12). Illustrations by Ahnert (1994) of species of *Potamocaris* and *Forficatocaris* give the position of dorsal pores on the thorax and urosomites, and Martínez Arbizu (1997) showed the position of these pores in *P. hispanica*. The comparison of these drawings with our observations and considering three other undescribed species of *Remaneicaris* allows us to say that the groundpattern for the family is, probably, the presence of one dorsal pore on each somite and one lateral pore on each side of the telson.

The study of the sensilla patterns within the Parastenocarididae has been neglected by previous authors working with these animals, probably because the number and position of these structures is difficult to discern accurately. Almost nothing is known about the sensilla patterns even within the Harpacticoida, but it seems that the number and position of these structures can provide interesting phylogenetic information. The maximum number of sensilla described until now for a species of Parastenocarididae in males is 17/6/6/5/5/4/

4/5/0/1 (Ahnert 1994), counted from cephalothorax to telson, considering only one of the lateral sides of the animal. It is very difficult at present to say anything about the groundpattern of this character, and more accurate observations of other Parastenocarididae are needed. The pattern of sensilla in males of *R. tridactyla* **n. sp.** is 14/5/4/4/4/1/3/3/0/1, for *R. paratridactyla* **n. sp.** is 14/5/5/4/3/2/3/3/0/1 and for *R. juliae* **n. sp.** is 14/4/4/4/3/2/3/3/0/1. The pattern in *Remaneicaris* females is the same, with the exception of the double-somite which carries 4 sensilla. One of them, near the dorsal integumental window, probably is homologous to the dorsal sensilla present on the second urosomite of males (indicated as "h" in Fig. 1).

Interestingly, it seems that no members of Harpacticoida (perhaps even no copepod) have sensilla on the somite anterior to the telson.

Mouthparts. The mouthparts seem to be very conservative within the family, although some important differences can be seen in some groups. The Md, Mx1 and Mxp are quite similar and small differences do not involve changes in number of setae and spines. The groundpattern of the family as present in *Remaneicaris* is as follows: Mandible with a coxal gnathobasis bearing 1 seta and a palp with 2 setae; Mx1 with precoxal arthrite with 5 elements (1 dorsal surface seta, 3 claw-like pinnate spines and 1 slender seta), coxa with 1 seta and basis with 3 setae, and Mxp 3-segmented, distal segment with 1 claw-like seta. The Mx1 condition described for *P. ahaggarica* Bozic 1978 having a precoxal arthrite with more than 3 spines, coxa with 2 setae, enp with 2 setae and exp represented by 1 seta deserves re-examination, because it represents a dramatic deviation from the pattern observed in all other species of the family. Reid (1995), while redescribing P. brevipes Kessler, 1913 stated that the Mx1 of this species is "like that of *P. ahaggarica*". Our own examination of *P. brevipes* from Germany showed that the segmentation and setation of Mx1 is the same as in other Parastenocarididae and not like *P. ahaggarica* as depicted by Bozic (1978). The presence of 8 setae on the precoxal arthrite of Simplicaris lethae Galassi & De Laurentiis, 2004 and 7 on Potamocaris bidens Noodt, 1955 and Forficato*caris* spp. (Ahnert 1994), deserves re-confirmation because we have never observed this number of elements in other parastenocaridids, or even in species belonging to the Potamocaris-Forficatocaris complex collected by us in Brazil.

Another, peculiar symplesiomorphy of *Remaneicaris* is the presence of 2 setae on the proximal syncoxal endite of Mx2 (all other parastenocaridids have only 1 seta) and 3 bare setae on the distal endite (one of them pinnated in all parastenocaridids but *Remaneicaris*). Two setae on the proximal syncoxal endite have been described for *Murunducaris*, *P. brevipes* and *P. ahaggarica*. Re-examination of the type species of *Murunducaris* as well as of *P. brevipes* from Germany revealed that only 1 seta instead of 2 is present on this endite in these species also. The pattern in *P. ahaggarica* requires re-confirmation (see above).

Antennule. Remaneicaris species have a 9-segmented A1 in the male. The same number of segments occurs also in other parastenocaridids such as Potamocaris (Martínez Arbizu in prep). The groundpattern of A1 in Parastenocarididae can be reconstructed as a 9-segmented antennule, with the following armature: 0/5/4/2/5+Ae/1/3?/2/9+Ae. Probably representing the following ancestral segments (sensu Huys & Boxshall 2001): I; II-VIII; IX-XII; XIII; XIV-XVI; XVII-XVIII; XIX-XX; XXI-XXII; XXIII-XXVIII. The 8-segmented condition in some genera and species such as Murunducaris (personal observations), Brasilibathynellocaris (personal observations), P. trichelata Reid, 1994, P. hispanica and Simplicaris Galassi & De Laurentiis, 2004 should be interpreted as a derived condition, being the result of the non-formation of segment 6. All Forficatocaris species studied by Ahnert (1994) display an 8-segmented antennule also. However, in his drawings, the third and fourth segments of the groundpattern of Parastenocarididae are represented by a single segment carrying 6 setae. After re-examination of Noodt's type specimens, we concluded that segments 3 and 4 are separated in these species also. Groundpattern segment 4 is very small and difficult to discern without good optics, which may be the reason that this segment has been rarely illustrated by parastenocaridid researchers in the past. The 10-segmented condition described for the male of Potamocaris estevesi Reid, 1991 (Rocha et al. 1998) is probably wrong. The female antennule is 7-segmented in the groundpattern of the family; ornamentation 0/4/5/2+Ae/1/1/9+Ae.

Leg 1. None of the species described above has an inner seta on the basis of leg 1. Meanwhile it was reported for some species and was observed by the authors on the type material of *Remaneicaris ignotus*. This should be seen, together with the presence of a row of spinules on the inner margin of leg 1 enp 1, as a plesio-morphic condition and composes the groundpattern of Parastenocarididae.

Male leg 3. A striking character observed for the three species described here is the presence of a 1-segmented enp on the inner margin of leg 3 basis in the male. Within *Remaneicaris* only *R. rhizophora* (Noodt, 1965) seems to lack the whole enp. Other species show a reduction of the enp. For example, *R. oncophora*, *R. analuizae* and *R. euniceae* display only 1 seta (no segment) at this position, a condition present in most parastenocaridids. Loss of the entire segment and even the seta is not unusual within the family. The presence of an enp segment, should be interpreted as a plesiomorphic character within Parastenocarididae. This, among other plesiomorphies, would suggest a basal position of the genus within the family, if we consider that all other Parastenocarididae share, as a synapomorphy, the loss of the enp in the male leg 3 and the setation of Mx2.

Male leg 4. *Remaneicaris tridactyla* **n. sp.**, *R. paratridactyla* **n. sp.** and *R. juliae* **n. sp.** share with other members of *Remaneicaris* (viz. *R. remanei*, *R. hecate*, *R. sanctiludovicci* (Noodt, 1965), *R. icoaraci* (Noodt, 1963), *R. persephone*, *R. pluto*, *R. oncophora*, *R. rhizophora*, *R. paraguayensis*, *R. sierrae*, *R. cordobaensis*, *R. euniceae*, *R. analuizae*, *R. tageae* (Noodt, 1972) and *R. divae* (Noodt, 1972)), the similar leaf-shaped appearance of the leg 4 enp. With the exception of *R. euniceae*, *R. analuizae*, *R. tageae* and *R. divae*, the species mentioned above have a row of spinules near the insertion of the male leg 4 enp (PERS) and a row of spinules on the inner margin of the male leg 4 basis (IBRS) (both labeled in Fig. 4). These two characters can also be observed in *R. membranacea* (Noodt, 1965) and perhaps in *R. paraensis. Remaneicaris cordobaensis* and *R. ciliata*, as *R. membranacea* and *R. paraensis*, do not have the "typical" leaf-shaped leg 4 enp and can be characterized by the loss of the PERS. However, we believe that they belong to a large monophyletic group around *R. remanei*, all of them sharing the transformation of a seta on the male A1. The sexual dimorphism of the leg 4 enp is a synapomorphy of the family (Martínez Arbizu & Moura 1994), but it is difficult to reconstruct the condition in the groundpattern because of the extreme plasticity of this enp in regard to shape and size. In the groundpattern a terminal seta is still present on the leg 4 enp in the male.

Leg 5 of *R. tridactyla* **n. sp.**, *R. paratridactyla* **n. sp.** and *R. juliae* **n. sp.** consists of a triangular plate in both sexes, with all the armature elements located on the outer side, due to the presence of a well-developed inner process on each limb. In *R. ignotus*, there is no inner cuticular process and the three elements are located in a distal position, conferring a square configuration on this limb. An incipient inner cuticular process on leg 5 is observed in *R. argentina*, *R. jujuyensis*, *R. drepanephora*, *R. palaciosi*, *R. clandestina* and probably *R. hurdi* (Jakobi & Silva, 1962). We believe that the evolutionary steps involved here are: Absence of an inner process, passing through an incipient inner process and finishing in a well-developed inner process on the leg 5. The absence of the intercoxal sclerite on leg 5 is a character present in the groundpattern of *Remaneicaris* and probably constitutes a synapomorphy for the genus. Associated with the lack of the intercoxal sclerite, there normally occurs a migration of both appendices to a ventro-lateral position. In *R. ignotus* both legs 5 are located more ventrally, a character that we consider plesiomorphic within the genus. No sexual dimorphism should be expected in the groundpattern of *Remaneicaris*. Until now we can only say that the groundpattern for the family probably is composed by the leg 5 plates joined by a small intercoxal sclerite, as in *P. hispanica*, and without any sexual dimorphism.

Leg 6. In some members of *Remaneicaris* (viz. *R. sanctiludovici, R. sierrae, R. cordobaensis, R. ciliata, R. hecate, R. pluto, R. persephone, R. oncophora*), the leg 6 is a small flap armed with 2 setae covering the gonopore. As mentioned before, the presence of armature elements on P6 cannot be considered a plesiomorphy for Parastenocarididae, but as a synapomorphy for a group within *Remaneicaris*. Therefore, it does not compose the groundpattern for the family or even for the genus *Remaneicaris*.

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