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A new species of *Asterocheres* (Copepoda, Siphonostomatoida, Asterocheridae) associated to *Placospongia cristata* Boury-Esnault (Porifera) in Bahia State, Brazil

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Abstract

The siphonostomatoid fauna associated with the sponge, *Placospongia cristata* Boury-Esnault, is studied for the first time. *Asterocheres bimbarrensis* n. sp. is characterized by having two spines distally on the third endopod of P4 instead of a seta and a spine, is described and compared with its congeners. Another species of the genus, *A. neptunei* Johnsson, is also found associated with this sponge, however, *P. cristata* may not be its main host since it is scarce. *Asterocheres neptunei* has previously been recorded associated with an undetermined sponge in the southeast region of Brazil thus the present record extends its distribution to the northeast. This study is the first record of the sponge *P. cristata* in Bahia.

Key words: Asterocheridae, Siphonostomatoida, *Asterocheres*, new species, Copepoda, *Placospongia*, Porifera

Introduction

The siphonostomatoid fauna associated with invertebrates in Brazil is still poorly known. Many recent studies were carried out on the coral reefs of Abrolhos region, in the south of Bahia (Fig. 1) (Johnsson 1998a–b, 2000, 2002). These studies confirmed the existence of many new siphonostomatoid species associated with different invertebrate groups within that region. Despite these efforts, the remaining Bahia coast, stretching for almost a thousand kilometers, remains unexplored.

The sponges represent microhabitats of different shapes and these provide shelter to a diverse invertebrate fauna (Klitgaard 1995) including polychaetes (Martin & Britayev

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1998), molluscs (Klitgaard 1995), cnidarians (Uriz *et al.* 1992) and crustaceans (Klitgaard 1991). Specifically, sponges act as hosts to a wide variety of copepods, particularly siphonostomatoid families such as Asterocheridae, Dinophontiidae, Entomolepididae, Spongiocnizontidae and Sponginticolidae (Boxshall 2005). Although some studies indicate sponges are used as nourishment by the associated invertebrates (Martin & Britayev 1998), Mariani and Uriz (2001) have shown that copepods belonging to the genus *Asterocheres* feed on excreted or live cells of the sponges. Similar behaviour has been reported for some echinoderms (Röttger 1969).

The asterocherid genus *Asterocheres* is commonly found in association with sponges (Boxshall & Halsey 2004) but is has also been recorded in association with bryzoans (Ivanenko & Smurov 1997), cnidarians (Kim 2004a) and echinoderms (Kim 2004b). Kim (2004a) stated the genus comprised 58 nominal species, including many incompletely described ones, but since then two additional species of *Asterocheres* have been described; one from Madagascar (Kim 2004b) and another from Antarctica (Bandera *et al.* 2005). Despite the large number of *Asterocheres* species already recorded, it is probable that there are still many undescribed species in this genus. In studies carried out along the Brazilian coast only a few authors have identified the sponges to species or genus level (Johnsson 2000, 2002). Therefore, the knowledge of the true poriferan hosts for the Brazilian asterocherids is limited.

The present study describes the siphonostomatoid fauna found in association with *Placospongia cristata* Boury-Esnault 1973 (Porifera, Desmospongiae): a sponge only known from Brazil (Hooper & Van Soest 2002) and with a distribution previously restricted to Recife, Pernambuco State (Fig. 1), approximately 800 km from the site of study, Bimbarra Island.

Material and methods

This study was conducted in an estuarine region of Bimbarra Island (Fig. 1) located at the bottom of Todos os Santos Bay, which has an area of 1052 km^2. Bimbarra Island is located close to mangrove forests and rivers, which provide a constant influx of freshwater. This area is different from previous sampling sites in Bahia, which were reef formations located 70 km from the mainland.

A single specimen of the sponge *P. cristata* was collected from the intertidal zone at low tide (0.1 m). The sponge was attached to hard sediment protruding from the mud. The sample was isolated in a plastic bag with seawater, to which 95% ethanol was added to make a 5% solution (approximately). After soaking for 1–2 hours in this solution, the sponge was rinsed in water and this water was passed through a fine net. The copepods were then pick from the residuum following the methods of Humes (1996).

The new copepod species was cleared in lactic acid and body proportions were

measured. The holotype and one of the the paratypes (i.e. the allotype) were stained in Black Clorazol E, dissected, and mounted permanently, each one on a single slide with CMC-9 mounting media. All drawings were made with the aid of a drawing tube. The lengths of the antennule segments were measured along the posterior, non-setiferous margins. Romans numerals indicate the original segments followed by the number of setae in Arabic (Huys & Boxshall 1991). For the armature formula of legs 1–4, Roman numerals represent spines and Arabic numerals indicate setae. Abbreviations P1–P5 refer to legs 1–5.

The specimens studied here are deposited in the Museu de Zoologia / Universidade Federal da Bahia (UFBA).

Results

Asterocheres neptunei Johnsson, 2001

Material examined. 4 females (UFBA 0006 CRU) associated with *P. cristata* from Bimbarra Island, Madre de Deus, Bahia. Collected by R. Johnsson and R. Bispo, 01 August 2004.

Morphology. Asterocheres neptunei has a siphon reaching insertion of P1, each maxilulle lobe has 4 setae, the antennal exopod has 3 setae, the free segment of P5 is armed with 2 setae and the caudal rami are slightly longer than wide.

Remarks. This species has previously only been recorded from sponges collected at 3 m below low tide in Picinguaba (São Paulo), an inlet located at the southeast region of Brazil (Fig. 1) (Johnsson *et al.* 2001). Johnsson *et al*. (2001) did not determine *A. neptunei*'s host, so it is possible that the host (*Placospongia*) has not been recorded further south in Brazil or that *A. neptunei* recorded in Picinguaba was living associated with a different sponge. As Johnsson *et al.* (2001) found seventy-four specimens of *A. neptunei* in Picinguaba and only four were collected in association with *P. cristata* in Bahia, it may be possible that *P. cristata* is not be the principal host for *A. neptunei*. Consequently, although *A. neptunei* is not host restricted, it may have a host preference, however such questionings need further studies to be clarified. This is the first record of both, the host sponge *Placospongia cristata* and its symbiont, *A. neptunei* in Bahia, therefore the present record extends their distribution to the northeast of Brazil.

Asterocheres bimbarrensis sp. nov.

Figures 2–5

Material examined. Holotype: female (UFBA 0012 CRU), paratype (i.e. allotype): male (UFBA 0013 CRU), paratypes: 27 females (UFBA 0020 CRU) and 15 males (UFBA 0021

CRU) associated with *P. cristata* from Bimbarra Island, Madre de Deus, Bahia. Collected by R. Johnsson and R. Bispo, 01 August 2004.

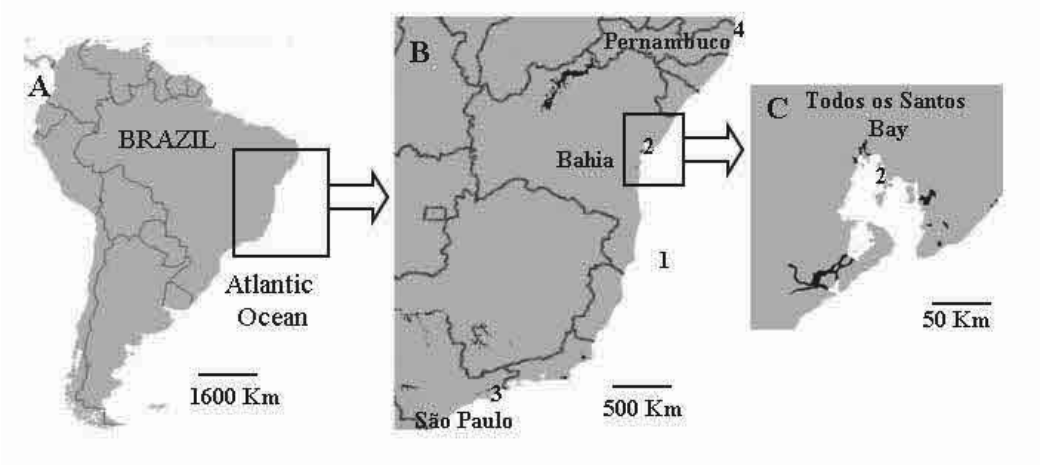

FIGURE 1. Location of collection sites in Brazil. (A) Brazilian coast; (B) eastern and northeastern coast, (Abrolhos region, 1; Bimbarra Island, 2; Picinguaba, 3; Recife, 4); (C) Todos os Santos Bay.

Description of female. Body length (excluding caudal setae) 750 µm (650–840 µm), greatest body width 400 µm (340–460 µm), body length 1.65 times width (based on 28 specimens). Body shape cyclopiform (Fig. 2a), with prosome enlarged, dorsoventrally flattened and urosome cylindrical. Pedigerous somite 1 totally fused with cephalosome, with epimera moderately pointed. Pedigerous somites 2–4 with epimera slightly pointed. Pedigerous somite 4 partially covered by preceding somite. Prosome length:width ratio, 1.2:1. Ratio of prosome length to urosome, 2.3:1.

Urosome 4-segmented (Fig. 2b). Genital double-somite 113 µm long, length:width ratio 1:1, rounded anterolaterally and with setae located close to genital area uncommonly long, compared to other *Asterocheres* species. Two postgenital somites, with posterior corners pointed and both wider than long (39 x 70 µm, 44 x 65 µm), length:width ratios, 0.56:1 and 0.68:1, respectively. Caudal rami subrectangular (35 x 29 µm), length 1.2 times width, armed with 6 setae. Length of setae II to VII: 52, 157, 324, 289, 142, and 106 µm, respectively; all setae plumose.

Antennule (Fig. 2c) slender, 332 µm long (not including setae) and consisting of 20 segments. Length of segments measured along their posterior margins: 13, 12, 10, 9, 9, 10, 10, 11, 10, 6, 10, 18, 24, 24, 22, 27, 29, 35, 12, and 31 µm, respectively. Segmental homologies and setation as follows: I-1; II-1; III-1; IV-1; V-1; VI-1; VII-2; VIII-2; IX-XII-4; XIII-1; XIV-1+spine; XV-2; XVI-2; XVII-2; XVIII-1; XIX-2; XX-1; XXI-1+ae; XXII-XXIII-2; XXIV-XXVIII-7. Aesthetasc on segment XXI, 137 µm long. Setation of III–VI based on insertions.

Antenna (Fig. 2d) 225 µm long (including distal claw), basis 70 µm long. Exopod 1-

segmented, 10 µm long, with 2 setae located distally and subdistally. Endopod 3-segmented; first segment 61 µm long, unarmed; second segment 12 µm long, with apical setae; third segment 22 µm long, with short lateral seta and terminal claw slightly curved and 60 µm long with seta close to it. Oral cone (Fig. 2e) 84 µm, reaching between maxilliped and leg 1. Mandible stylet-form (Fig. 2e–f) 70 µm long, slender; 2-segmented palp (Fig. 3a): first segment 40 µm long, ornamented with lateral setules; second segment 19 µm long, armed with 2 apical, smooth setae.

Maxillule (Fig. 3b) bilobed; inner lobe 68 µm, with 4 distal setae and ornamented with patches of setules: 1 basal, 1subapical. Outer lobe 27 µm long, with 3 setae. Maxilla (Fig. 3c) with syncoxa 104 µm long and claw, 166 µm long, distally curved and with patch of subapical setules.

Maxilliped (Fig. 3d) 194 µm long, 5-segmented; syncoxa 42 µm long, with small seta on inner margin; basis 85 µm long, with apical tooth; endopod 3-segmented, segments 19, 14, and 34 µm long, respectively. First and second endopodal segments unarmed. Third segment with 2 setae medially on inner margin, indicating a possible fusion between 2 endopodal segments, and apical seta close to claw-like element 83 µm long, slightly curved distally.

P1-P4 (Figs 3e–f, 4a–b) biramous, all rami 3-segmented. P2 and P3 endopod-3 with seta and spine distally, P4 endopod-3 with 2 serrate spines. Armature formula for P1-P4 in Table 1.

TABLE 1. P1–P4 armature formula for *Asterocheres bimbarrensis* male and females.

	Coxa	Basis	Exopod	Endopod
P1	0–1	1–I	I–1; I–1; III–2–2	0–1; 0–2; 1–2–3
P2	0–0	1–0	I–1; I–1; III–I–4	0–1; 0–2; 1–1+I–3
P3	0–0	1–0	I–1; I–1; III–I–4	0–1; 0–2; 1–1+I–3
P4	0–1	1–0	I–1; I–1; III–I–4	0–1; 0–2; 1–II–2

P5 (Fig. 2b) 62 µm long, exopod with 3 distal setae, inner and outer margins covered with setules. Somite 5 bearing seta near insertion of exopod.

Description of male. Body similar to female but smaller (Fig. 5a). Length (excluding caudal setae) 650 µm, greatest body width 332 µm, body length 1.96 times width. Cephalosome and pedigerous somite 2 with epimera slightly pointed. Pedigerous somite 3 slightly rounded and partially covering pedigerous somite 4. Prosome length:width ratio 1.3:1. Ratio of length of prosome to urosome 2:1.

Urosome (Fig. 5b) 5-segmented. Genital somite 124 x 95 µm, pointed post-laterally with 1 distal and 1 terminal seta on each side. Three abdominal somites, all wider than long (22 x 65, 23 x 55, 33 x 52 µm); length:width ratios 0.34:1, 0.42:1 and 0.63:1, respectively. Caudal rami 28 x 22 µm, length 1.26 times width, with 6 plumose setae.

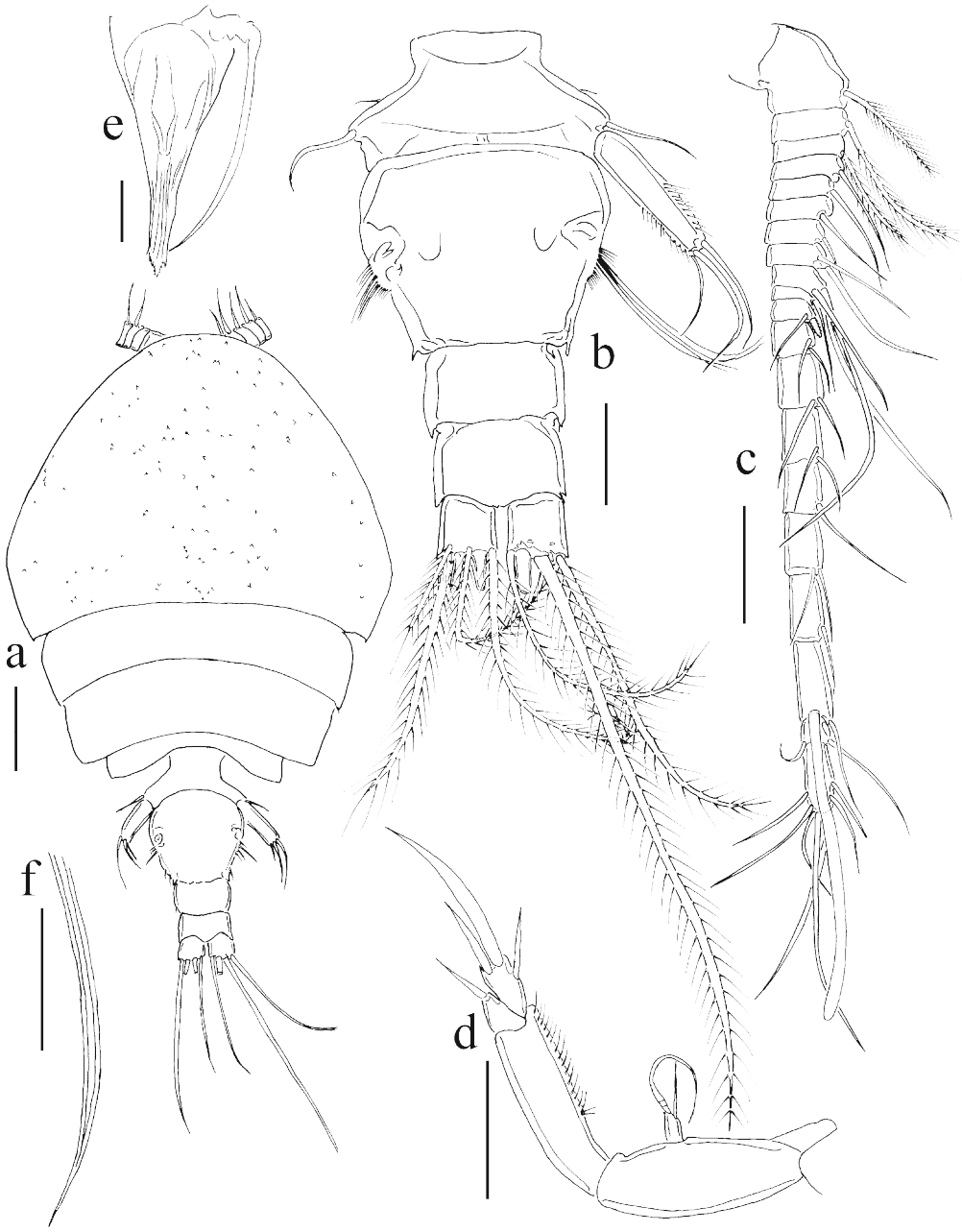

FIGURE 2. *Asterocheres bimbarrensis* sp. nov. female (holotype: UFBA 0012 CRU). *a,* habitus, dorsal view; *b*, urosome (left long setae of the genital somite were omitted) ; c, antennule*; d,* antenna; *e,* oral cone; *f,* distal end of mandibular stylet. Scale bars: a=100 μm; b–d=50 μm; e–f=20 μm.

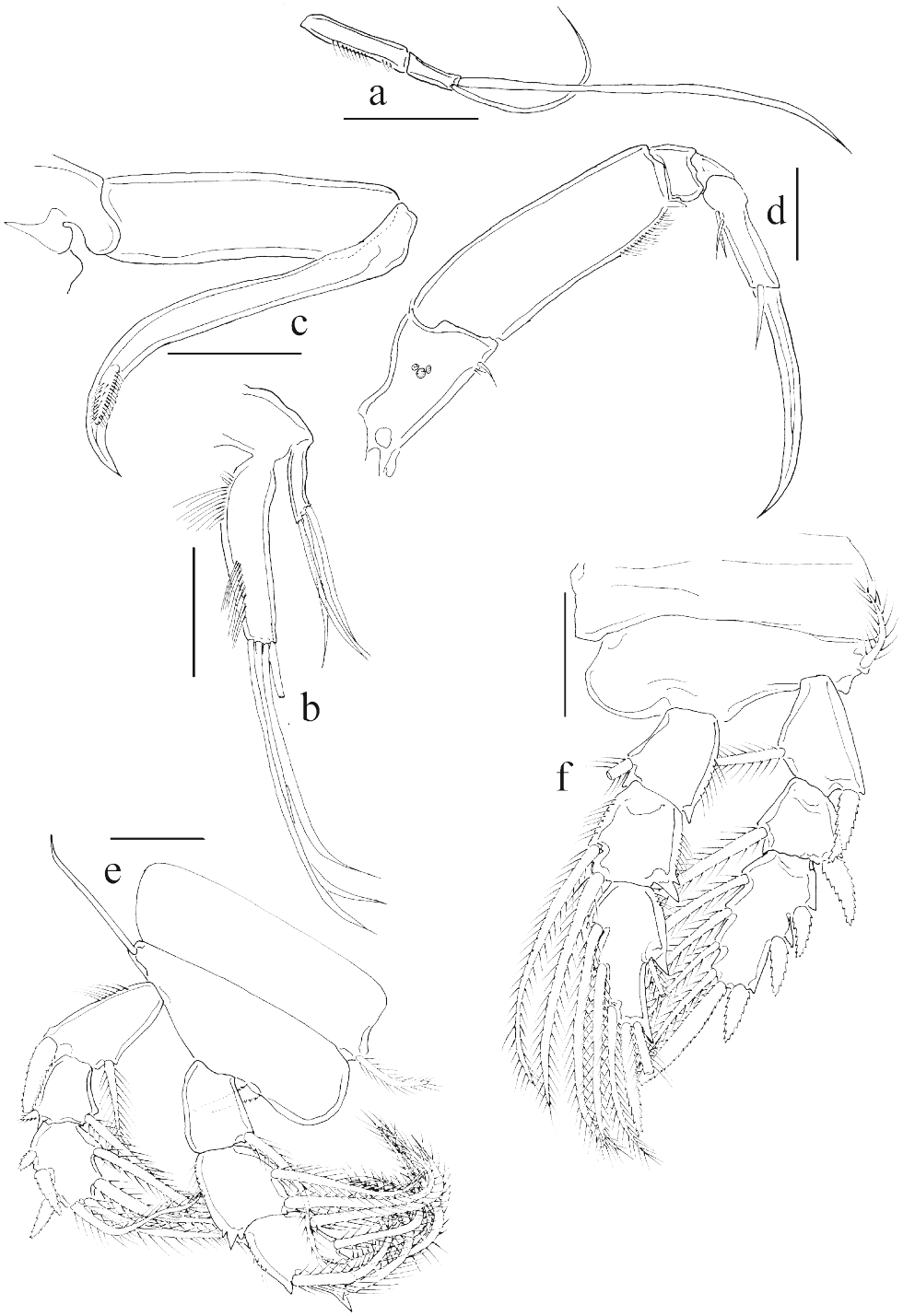

FIGURE 3. *Asterocheres bimbarrensis* sp. nov. female (holotype: UFBA 0012 CRU). *a,* mandibular palp; *b,* maxillule; *c,* maxilla; *d,* maxilliped; *e*, P1; *f,* P2. Scale bars: a–c, e–f=50 µm; d=30 µm.

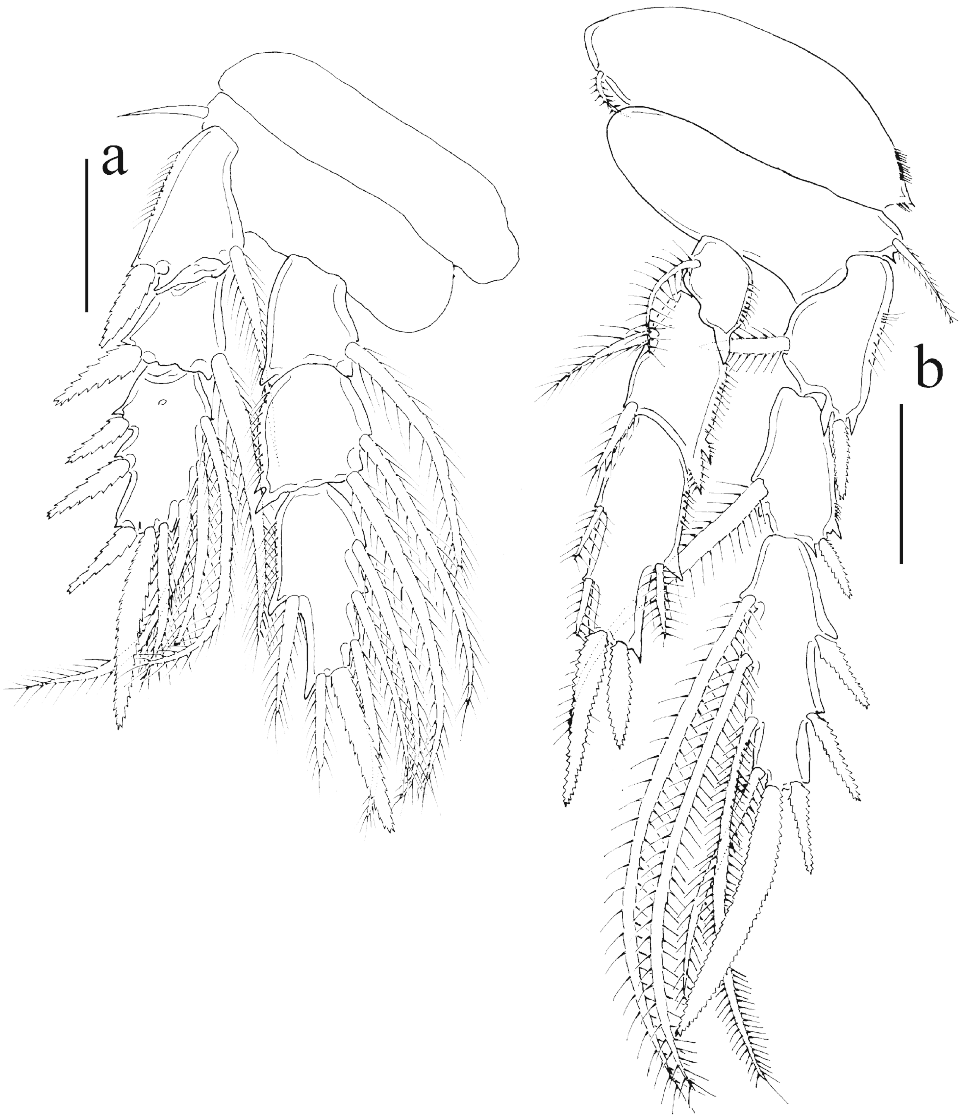

FIGURE 4. *Asterocheres bimbarrensis* sp. nov. female (holotype: UFBA 0012 CRU). *a*, P3; *b*, P4. Scale bars: 50 μm.

Antennule (Fig. 5c) 249 μm long (not including setae) and consisting of 18 segments. Length of segments measured along their posterior margins: 20, 11, 8, 9, 9, 8, 8, 9, 8, 11, 9, 6, 5, 17, 24, 22, 12, 38, and 26 μm, respectively. Segmental homologies and setation as follows: I-2; II-2; III-2; IV-2; V-1; VI-2; VII-2; VIII-2; XI-XII-5; XIII-1; XIV-1; XV-2; XVI-2; XVII-2; XVIII-2; XIX-XXI-3+ae; XXII-XXIII-2; XXIV-XXVII-7. All setae smooth. Aesthetasc on segment XXI 121 μm long.

All other appendages as for female.

Etymology. The specific name refers to the type locality of the specimen.

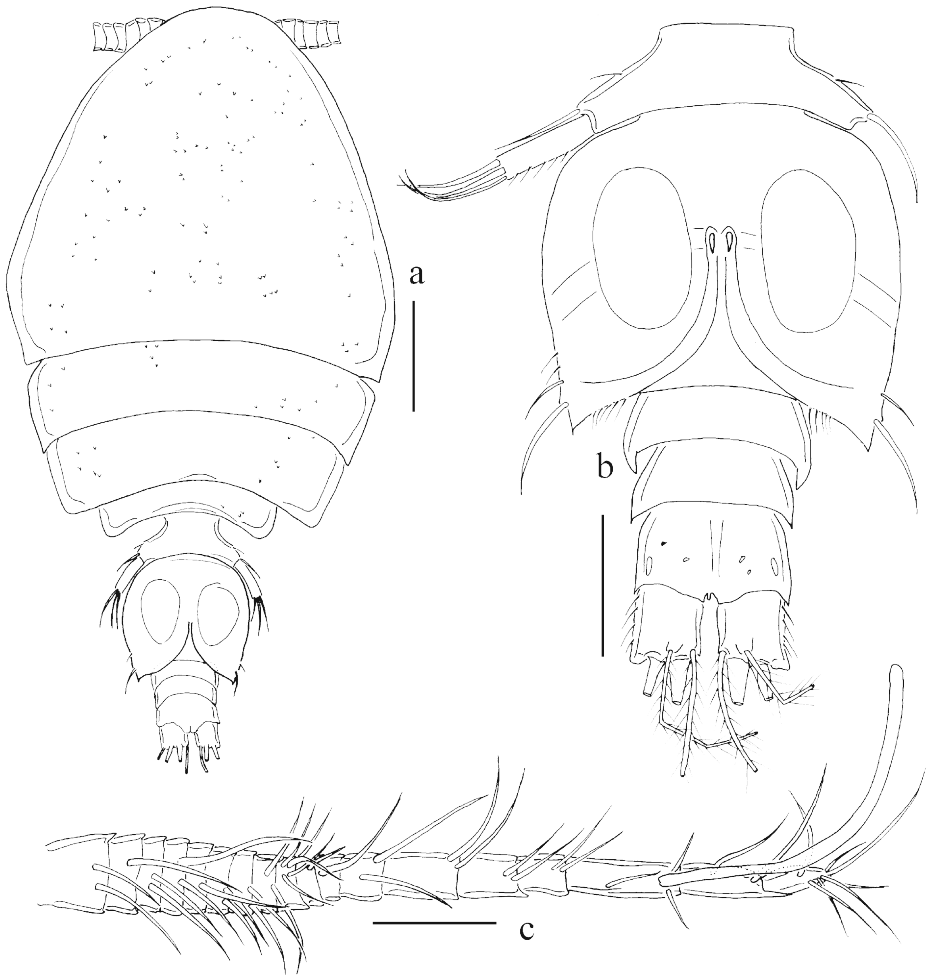

FIGURE 5. *Asterocheres bimbarrensis* sp. nov. male (paratype: UFBA 0020 CRU). *a,* dorsal view; *b*, urosome; *c*, antennule. Scale bars: a=100 µm; b–c=50 µm.

Remarks. Although A. bimbarrensis has been found on the same host species as *A. neptunei* both species have some marked differences. *Asterocheres neptunei* has a siphon, which reaches between the insertions of P1 and P2, the P5 exopod has two setae and the antennal exopod has three setae (Johnsson et al. 2001). The siphon of *A. bimbarrensis* is only slightly longer than the maxilliped insertion while the P5 exopod has three setae and the antennal exopod has only two setae.

In addition, the following characteristics of *A. bimbarrensis* further distinguish it from *A. neptunei*: outer lobe of the maxillule with three setae, P4 endopod-3 with two spines distally, instead of a seta and a spine, the caudal rami longer than wide, the postgenital somite of the female only slightly longer than anal somite and the maxilliped at least twice as long as the preceding segment. These last three characteristics are also shared with the following species of *Asterocheres*: *A. lunatus* Johnsson, 1998; *A. bacescui* Marcus, 1965;

A. maxillatus Stock, 1987; *A. minutus* (Claus, 1889); *A. suberites* Giesbrecht, 1897 and *A. echinicola* (Norman, 1868).

Asterocheres bimbarrensis and *A. echinicola* have another apparent similarity: the 20-segmented antennule (Sars 1918). However, the position of the aesthetasc on the antennule differs with *A. echinicola* having three segments posterior to the aesthetasc while *A. bimbarrensis* only has two. Such difference is due to different segmental fusions in both species. These species have the caudal rami longer than wide, however, in *A. echinicola* it is almost three times longer than wide (Sars 1918) and in the new species it is only slightly longer than wide. Besides these differences, *A. bimbarrensis* also has a patch of setules distally on the maxilla claw and the siphon slightly longer than in *A. echinicola*.

In *A. lunatus* and *A. bacescui* the antennal exopod is armed with a single seta (Johnsson 1998a; Marcus 1965), in *A. suberites* there are three setae (Giesbrecht 1899), while in *A. bimbarrensis* there are two setae on the exopod. The genital somite of *A. bacescui* is wider than long, while in the new species it is as long as wide. The length of the caudal rami of *A. bacescui* is 1.7 times the width but in *A. bimbarrensis* it is slightly wider than long. Endopod segments 2 and 3 of the antenna of *A. bacescui* are fused, which is not the case in the new species. Finally, the mandibular palp of *A. bacescui* has a single segment (Marcus 1965), a condition also present in *A. minutus* and *A. suberites* (cf. Giesbrecht 1899; Bocquet et al. 1963), in contrast to the 2-segmented palp of *A. bimbarrensis*.

Asterocheres minutus has both maxillule lobes almost identical in length (Bocquet *et al.* 1963) and the maxilla claw without a distal patch of setules as observed in the new species. In *A. bimbarrensis* the maxillule inner lobe is more than twice the length of the outer lobe.

Asterocheres suberites and *A. lunatus* have a 21-segmented antennule with three segments distal to the aesthetasc and the maxilliped endopod is 4-segmented (Johnsson 1998a; Giesbrecht 1899) while *A. bimbarrensis* has 20 segments on the antennule, maxilliped endopod is 3-segmented.

Among all these closely related species, *A. lunatus* is the only one found along the Brazilian coast, with its range from southern Bahia to Pernambuco. It is always found in association with sponges. However, the cephalosome and second pedigerous somite have pointed epimera and the third pedigerous somite covers not only entirely the fourth somite but also partially the fifth (Johnsson 1998a). In *A. maxillatus*, pedigerous somite 3 entirely covers pedigerous somites 4 and 5 and partially covers the genital double-somite (Stock 1987). The epimera of *A. bimbarrensis* are not projected and the third somite does not cover the posterior pedigerous somites.

Among the asterocherids mentioned above *A. bimbarrensis* is the only species with three setae on the outer lobe of the maxillule and two spines distally on the P4 endopod-3 instead of a seta and a spine.

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