



A new *Setacheres* (Copepoda, Siphonostomatoida, Asterocheridae) associated with *Ircinia felix* (Duchassaing & Michelotti) (Porifera) from Brazil

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Abstract

Recent surveys of the copepod fauna associated with the sponge *Ircinia felix* (Porifera, Dictyoceratida) in Brazil resulted in the discovery of a new siphonostomatoid species belonging to a recently erected genus of Asterocheridae. *Setacheres portobarrensis* **sp. nov.** possesses a 21-segmented antennule, with 3 free distal segments, after the aesthetasc. The third exopodal segment of leg 3 shows a distal seta instead of a spine as in some other congeners. The new species shows several unique features on the third endopodal segment of the antenna, the mandibular stylet, the inner lobe of the maxillule, and setules and spinules located in specific regions of legs 1 to 4. *Setacheres portobarrensis* **sp. nov.** follows the same distributional pattern as its congeners, and this is the first record of a siphonostomatoid copepod associated with *Ircinia felix*.

Key words: copepod symbiosis, associated fauna, symbiotic fauna, sponge

Introduction

Almost all members of Siphonostomatoida live in association with other marine animals. These copepods form a group of diverse organisms ranging from cyclopiform animals to highly transformed siphonostomatoids (Boxshall & Halsey 2004). Among the groups of this order that are symbiotic with invertebrate hosts, the Asterocheridae Giesbrecht, 1899 is the largest family, comprising 56 genera (Ahyong *et al.* 2011). This family and especially members of its type genus *Asterocheres* Boeck, 1860 can be found associated with many phyla, including sponges, cnidarians, and echinoderms (Johnsson & Neves 2012; Johnsson 2002; Johnsson *et al.* 2001; Kim 2010). A recent revision by Kim (2010) restricted the diagnosis of *Asterocheres* based on a strict leg armature setation, the antennule bearing an aesthetasc on the 18th segment and the distal antennular section showing 1–3 segments resulting from distal fusions in a total of 19–21 segments. In consequence, many species must now be considered *species inquirendae*. Subsequently, Johnsson *et al.* (2016) reported a new asterocherid species that did not conform to Kim's leg armature definition because the third endopodal segment of leg 3 showed a 1,2,3 setation pattern. The genus *Setacheres* Johnsson, Bahia & Neves, 2016 was recently erected to accommodate this new species and another eight species that were originally assigned to *Asterocheres* but have been considered as *species inquirendae* since the revision proposed by Kim (2010).

Sponges act as hosts for a wide spectrum of associated organisms, mainly copepods, amphipods and polychaetes, which can be found either in their interior channels or on their surface. Studies dealing with siphonostomatoids in symbiosis with invertebrate hosts have led to the description of new species since the end of the 1990s (*see* Johnsson & Neves 2012). Recent surveys have focused on specific hosts, identifying them individually and providing more accurate data (Bahia *et al.* 2012; Bispo *et al.* 2006; Canario *et al.* 2012). The dictyoceratid sponge *Ircinia felix* (Duchassaing & Michelotti, 1864) is distributed along the northwestern Atlantic coast from the Gulf of Mexico and the Caribbean Sea to Brazil, where it has been recorded in the states of Ceará, Rio Grande do Norte and Bahia (Hadju *et al.* 2011). The present contribution provides new data on the

siphonostomatoid copepod fauna associated with sponges with the description of a new species of *Setacheres* associated with *I. felix* in Salvador northeastern Brazil, together with a key to the known species of the genus.

Material and methods

Specimens of *Ircinia felix* were hand-collected during low tide, with depths ranging from 2 to 4 m, on Porto da Barra Beach (13°0'14.01"S, 38°32'3.14"W), in the city of Salvador, Bahia State, Brazil (Fig. 1). The hosts were collected and immediately placed in individual plastic bags with sea water. Ethanol was added to the sea water until a final concentration of 5% was reached. After approximately 2 hours the sponges were rinsed and the debris filtered through a 100 µm mesh screen and then fixed in 70% ethanol for subsequent analysis. The new species of *Setacheres* was cleared in lactic acid, measured, stained in Chlorazol black E, dissected, and permanently mounted in CMC-9 (Huys & Boxshall 1991). All drawings were made with the aid of a drawing tube fitted on an Olympus CH30. All structures were also observed and checked with the aid of a Nikon Eclipse Ci microscope equipped with a digital camera. Roman numerals in the armature formula of legs 1–4 indicate spines and Arabic numerals indicate setae. Antennular segments are denoted by Roman numerals indicating ancestral segments following Huys & Boxshall (1991). Type specimens were deposited in the Museu de Zoologia of the Universidade Federal da Bahia (UFBA) in Brazil.

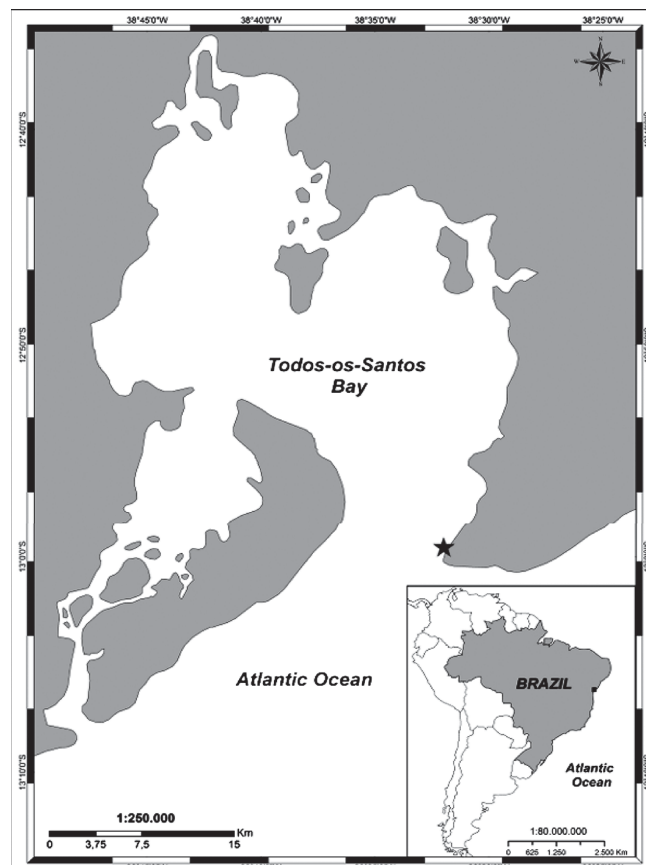


FIGURE 1. Sampling site in Porto da Barra Beach, Todos-os-Santos Bay, Salvador City, Bahia, Brazil.

Taxonomy

Order SIPHONOSTOMATOIDA Thorell, 1859

Family ASTEROCHERIDAE Giesbrecht, 1899

Genus *Setacheres* Johnsson, Bahia & Neves, 2016

***Setacheres portobarrensis* sp. nov.**

(Figs. 2–4)

Material examined. Holotype adult female (UFBA 3182) and paratype adult female (UFBA 3183), Porto da Barra Beach (13°00'14.01"S, 038°32'3.14"W), Salvador city, Bahia State, Brazil, collected by C. Bahia and V. Queiroz on 4 August 2011. Both specimens found associated with *Ircinia felix*. Paratype (UFBA 3183) dissected and mounted on slide. Holotype preserved in ethanol.

Description of female. Mean body length (excluding caudal setae) 687 µm (686–688 µm) and mean body width 393 µm (390–395 µm) ($n = 2$). Body (Fig. 2a) cycloform, dorsoventrally flattened, prosome longer than wide, urosome cylindrical. Pedigerous somite 1 completely fused with cephalothorax to form cephalosome. Pedigerous somites 2–4 with posterolateral margins not projected posteriorly and slightly rounded. Pedigerous somite 3 longer than pedigerous somite 2. Pedigerous somite 4 smaller than third somite and larger than fifth somite.

Prosome 470 µm long and 386 µm wide. Length: width ratio = 1.2:1. Urosome (Fig. 2b) 4-segmented. Fifth pedigerous somite 32 µm long and 116 µm wide. Genital somite 79 µm long and maximum width 104 µm, length: width ratio = 0.7:1, vestigial leg 6 located midlaterally with thin seta, close to genital openings; setules located posteriorly to leg 6. Two postgenital somites, both wider than long (36 × 56, 38 × 55 µm, respectively), epimera directed posterolaterally; first postgenital somite armed with 2 spinules on outer margin, anal somite with 4 spinules along lateral margin. Prosome: urosome ratio = 2.2:1. Caudal rami (Fig. 2b) longer than wide, 25 × 22 µm. Length: width ratio 1.1:1 µm, armed with 6 setae. All setae on specimens broken.

Rostrum (Fig. 2c) wider than long (72 × 224 µm), triangular with rounded apex. Antennule (Fig. 2d) 295 µm long (not including setae), 21-segmented. Lengths of segments in proximal to distal order: 35, 9, 9, 8, 9, 7, 9, 14, 10, 5, 8, 17, 20, 19, 13, 20, 23, 26, 9, 10 and 7 µm. Segmental homologies as follows: 1(I)-2; 2(II)-2; 3(III)-2; 4(IV)-2; 5(V)-2; 6(VI)-2; 7(VII)-2; 8(VIII)-2; 9(IX–XII)-6; 10(XIII)-2; 11(XIV)-I+2, 12(XV)-2; 13(XVI)-2; 14(XVII)-2; 15(XVIII)-2; 16(XIX)-2; 17(XX)-2; 18 (XXI)-2+ Aesthetasc; 19(XXII–XXIII)-3; 20(XXIV–XXV)-1; 21(XXVI–XXVIII)-5. Aesthetasc 72 µm long. Both setae from segments 1–3 and one seta from segment 8 with sparse setules distally.

Antenna (Fig. 3a) 192 µm long (including distal claw); coxa 14 µm long; basis 62 µm long with spinules along inner margin. Exopod 1-segmented, 8 µm long, with 2 apical setae and small subdistal seta; all setae naked. Endopod 3-segmented; first segment 56 µm long, unarmed, inner margin ornamented medially with row of spinules and armed distally with 3 large spinules; second segment 6 µm long, armed with single robust seta covered with setules; third segment 10 µm long, armed with 2 subdistal spiniform setae and distal claw (36 µm).

Oral cone (Fig. 2a) 172 × 94 µm (length × width), reaching to insertion of maxilliped bases. Mandible (Fig. 3b) with 2-segmented palp, both segments slender and naked, measuring 26 and 25 µm long, respectively; second segment with 2 naked distal setae, longer seta twice as long as shorter seta. Mandibular stylet 128 µm long, distally acuminate, posteriorly to a subterminal serrated portion with 7 teeth and triangular distal end. Maxillule (Fig. 3c) bilobed, both lobes laterally naked; inner lobe 50 µm long, with 5 naked distal setae, one seta much smaller than others. Outer lobe 18 µm long, armed with 4 naked distal setae, one more robust than the others. Maxilla (Fig. 3d) 230 µm long, syncoxa 95 µm long, with small tooth-like projection on outer margin plus tubular extension of maxillary gland opening and strongly curved distally claw.

Maxilliped (Fig. 3e) 6-segmented, 246 µm long; syncoxa 51 µm long with naked seta on inner margin and minute tooth-like projection on outer margin; basis 90 µm long, with subdistal row of setules and 2 small rows of spinules on inner and outer margins, respectively. Endopod 4-segmented, segments measuring 22, 9, 12 and 25 µm long, respectively; first and second segments naked, third segment with naked seta; fourth segment with spiniform serrate seta, close to distal curved claw-like element 46 µm long, with spinules on inner margin approximately reaching midlength.

Legs 1–4 (Figs. 4a–d) biramous, with 3-segmented rami. Armature formula as follows:

	coxa	basis	exopod	endopod
leg 1	0–1	1–1	I–1; I–1; III,4	0–1; 0–2; 1,2,3
leg 2	0–1	1–0	I–1; I–1; III,I,4	0–1; 0–2; 1,2,3
leg 3	0–1	1–0	I–1; I–1; III,1,4	0–1; 0–2; 1,2,3
leg 4	0–1	1–0	I–1; I–1; III,I,4	0–1; 0–2; 1,1+1,2

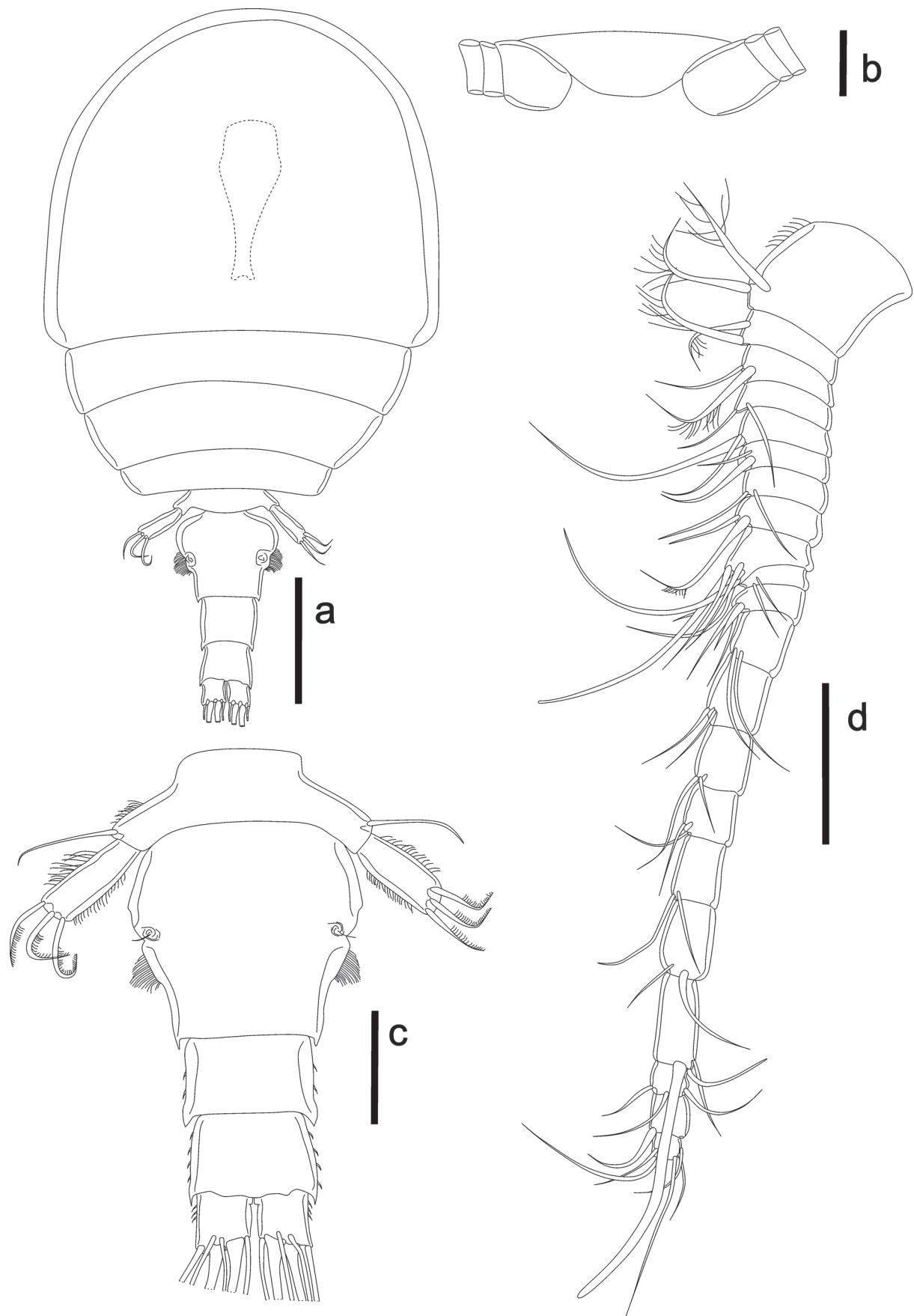


FIGURE 2. *Setacheres portobarrensis* sp. nov. female (paratype: UFBA 3183). a, body, dorsal view; b, rostrum; c, urosome; d, antennule. Scale bars: a = 125 μ m; b = 50 μ m; c = 70 μ m; d = 50 μ m.

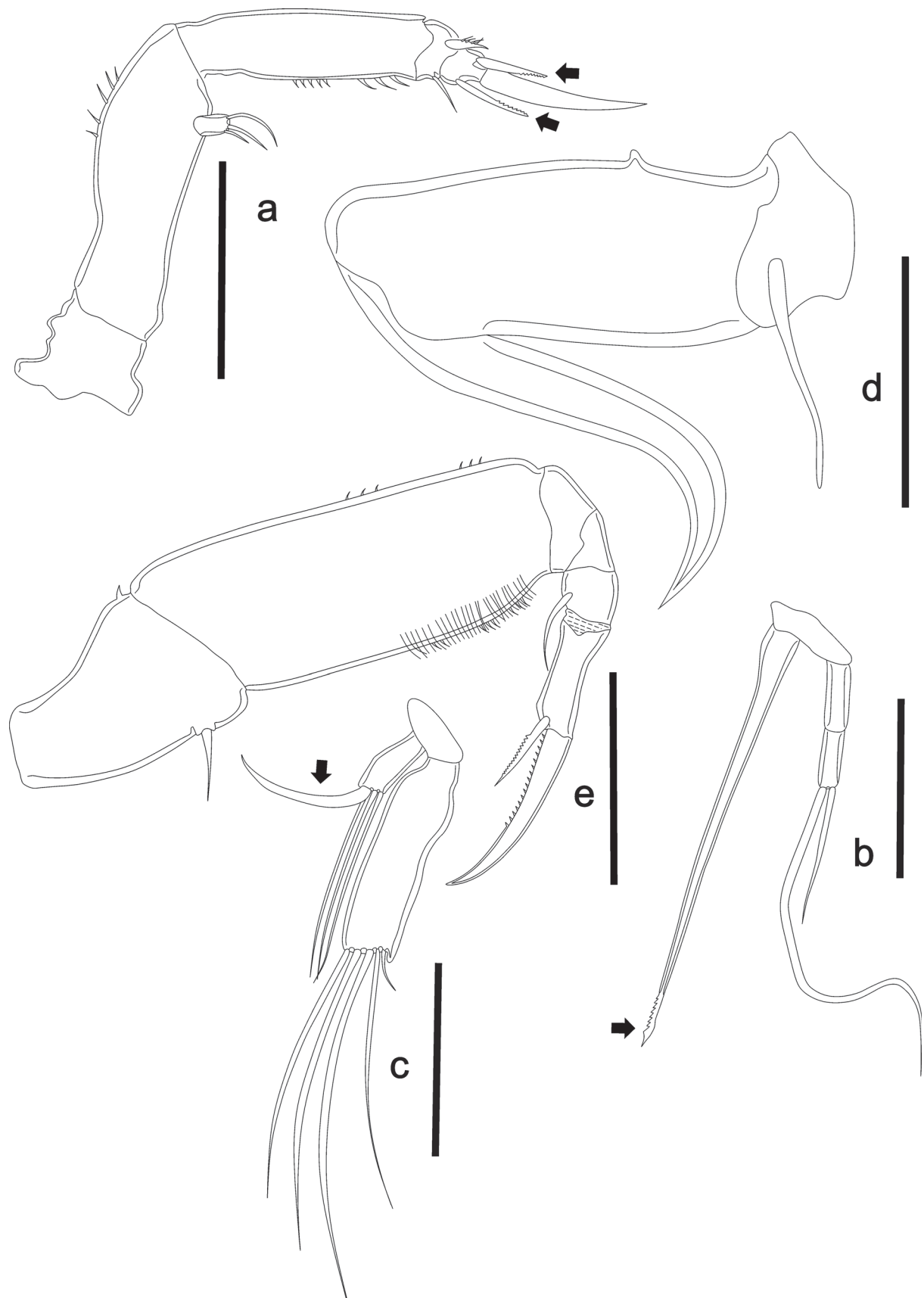


FIGURE 3. *Setacheres portobarrensis* sp. nov. female (paratype: UFBA 3183). a, antenna, arrows indicating spine-like setae close to distal claw on third endopodal segment; b, mandible, arrow indicating mandibular stylet with subterminal serrated portion and triangular distal end; c, maxillule, arrow indicating very thick, claw-like bristle on outer lobe; d, maxilla; e, maxilliped. Scale bars: a–e = 50 μ m.

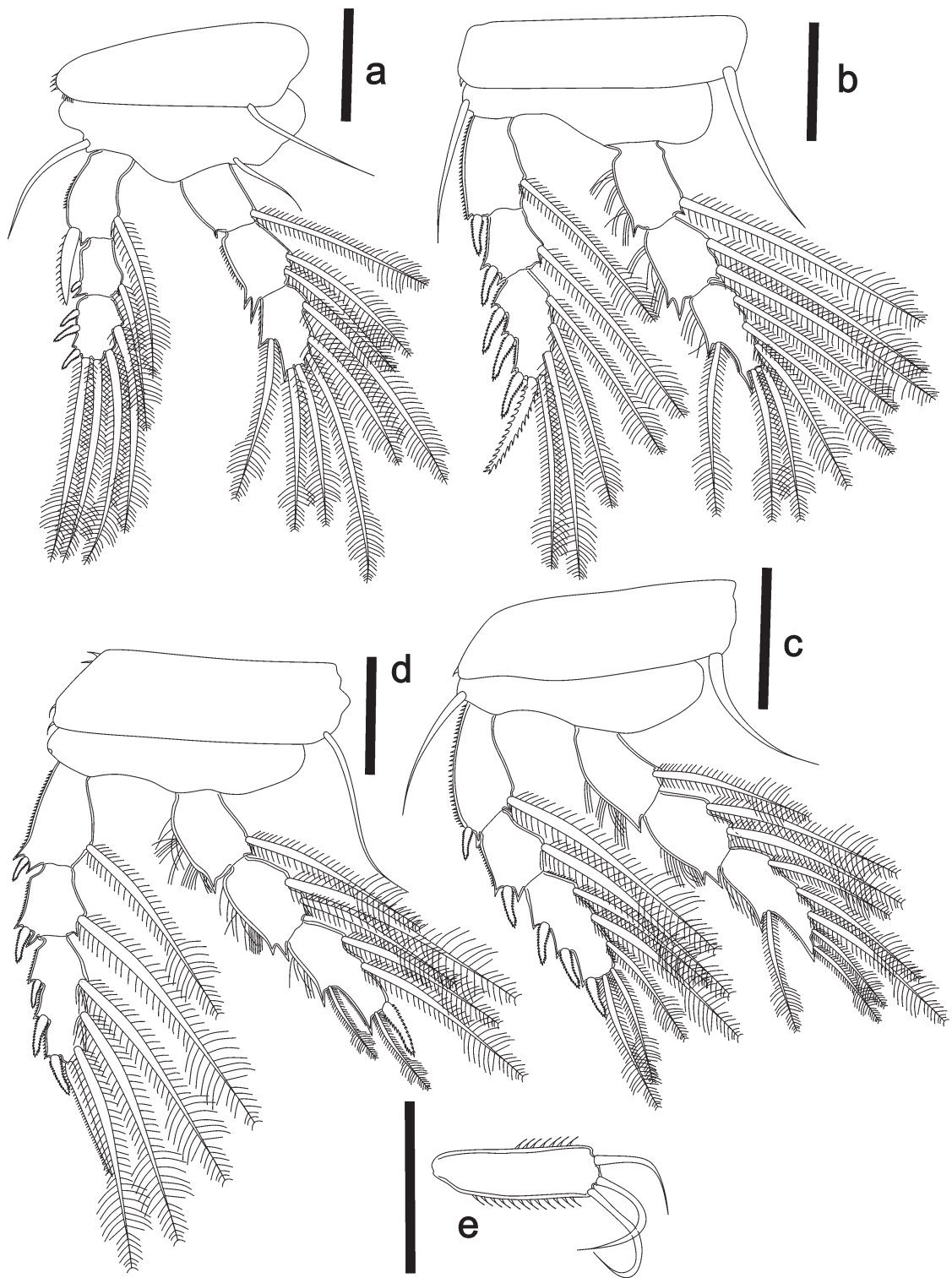


FIGURE 4. *Setacheres portobarrensis* sp. nov. female (paratype: UFBA 3183). a, leg 1; b, leg 2; c, leg 3; d, leg 4; e, leg 5. Scale bars: a–d = 50 μ m; e = 40 μ m.

All legs with small spinules on outer margin of coxa, legs 2 and 3 each with a single spinule, leg 4 with 4 spinules and leg 1 with 2 rows of spinules. Legs 2 - 4 each with long setules along outer margin of endopod. Outer margins of most exopodal segments covered with small spinules. First exopodal segment of leg 1 bearing large spine reaching insertion of proximalmost spine of third exopodal segment. Second segment with tiny spine, smaller than adjacent tooth-like projection (Fig. 4a). Leg 3 with distal seta on third exopodal segment, instead of spine (Fig. 4c). Leg 4 with distal spine on third endopodal segment (Fig. 4d). Leg 5 (Fig. 4e) with longer spinules on both margins, with 3 naked distal setae.

Male. Unknown.

Type locality. Porto da Barra Beach (13°0'14.01"S, 38°32'3.14"W), Salvador city, Bahia State, Brazil.

Etymology. The name “*portobarrensis*” refers to the type locality of the new species, Porto da Barra Beach, in Salvador city, Bahia State, Brazil.

Remarks. In a recent study, Johnsson *et al.* (2016) erected the new genus, *Setacheres* in order to accommodate some *Asterocheres* that were previously considered as *species inquirendae* (Kim, 2010). The main character shared by the species included in the new genus is the presence of 2 distal setae on the third endopodal segment of leg 3, instead of a seta and a spine. Considering the new species described here, the genus *Setacheres* now contains 10 species; they can be separated into three different groups based on the number of free segments posterior to the ancestral antennular segment XXI, which can range from 1 to 3. *Setacheres portobarrensis* **sp. nov.** possesses a 21-segmented antennule, with 3 free segments distally, after the aesthetasc. An identical condition is observed in *S. eudistomus* Johnsson, Bahia & Neves, 2016 and *S. lunatus* Johnsson, 1998, while *S. paraboecki* Johnsson, 1998, despite showing 3 free distal segments, has a 20-segmented antennule, resulting from a fusion of segments in the mid-region of the antennule (Johnsson 1998; Johnsson *et al.* 2016). *Setacheres portobarrensis* **sp. nov.** also differs from these two Brazilian species in the third exopodal segment of leg 3, which has a distal seta (III,I,4) instead of a spine (III,I,4) (Johnsson 1998; Johnsson *et al.* 2016). Some other species of the genus with the same distal pattern are *S. spinopaulus* Johnsson, 1998, *S. unicus* Johnsson, 2001, *S. abrolhensis* Johnsson, 1998, and *S. paraboecki* Johnsson, 1998 but none of them has a 21-segmented antennule (Johnsson 1998; Johnsson *et al.* 2001). In addition, *S. portobarrensis* **sp. nov.** shows many unique features such as: 1) spine-like setae close to the distal claw on the third endopodal segment of the antenna (arrows in Fig. 3a); 2) mandibular stylet with subterminal serrated portion and triangular distal end (arrow in Fig. 3b); 3) outer lobe of the maxillule with a very thick, claw-like bristle (arrow in Fig. 3c).

Distribution. *Setacheres portobarrensis*, like the other known members of the genus (Johnsson *et al.* 2016), occurs in the Tropical Southwestern Atlantic Province (TSA) (Spalding *et al.* 2007), as observed for *S. abrolhensis*, *S. lunatus*, *S. aplysinus*, and *S. spinopaulus* (Johnsson & Neves 2012). Further studies may provide additional information about the range of the new species.

Key to the species of *Setacheres*

1	Basis of leg 1 armed with 1,0	2
-	Basis of leg 1 armed with 1,I	3
2	Second endopodal segment of leg 4 armed with 0,1	<i>S. ventricosus</i> (Brian, 1928)
-	Second endopodal segment of leg 4 armed with 0,2	<i>S. lunatus</i> (Johnsson, 1998)
3	Female antennule 18-segmented	<i>S. unicus</i> (Johnsson, 2001)
-	Female antennule at least 19-segmented	4
4	Female antennule 19-segmented	5
-	Female antennule at least 20-segmented	8
5	Mandibular palp 1-segmented	<i>S. aplysinus</i> (Johnsson, 2002)
-	Mandibular palp 2-segmented	6
6	Maxilliped endopod 4-segmented	<i>S. spinopaulus</i> (Johnsson, 1998)
-	Maxilliped endopod at least 5-segmented	7
7	Maxillule with 3 setae on each lobe	<i>S. picinguabensis</i> (Johnsson, 2001)
-	Maxillule with 4 setae on each lobe	<i>S. abrolhensis</i> (Johnsson, 1998)
8	Free segment of leg 5 armed with 2 setae	<i>S. paraboecki</i> (Johnsson, 1998)
-	Free segment of leg 5 armed with 3 setae	9
9	Maxilliped endopod 5-segmented	<i>S. eudistomus</i> Johnsson, Bahia & Neves, 2016
-	Maxilliped endopod 6-segmented	<i>S. portobarrensis</i> sp. nov.

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