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ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.4981.2.5
http://zoobank.org/urn:lsid:zoobank.org:pub:org:pub:B63A108A-42F9-4A39-8E68-960BA35D30BC

A new Entomolepididae genus and a new species of *Spongiopsyllus* Johnsson, 2000 (Copepoda, Siphonostomatoida) and their association with *Aplysina* Nardo, 1834 (Porifera, Demospongiae) in Todos-os-Santos Bay, Bahia, Brazil

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Abstract

The Entomolepididae family is a small taxon with a very characteristic body morphology and is represented, in the Atlantic Ocean, by three genera and five species. A recent study in Todos-os-Santos Bay, in Bahia State, has revealed a new species of *Spongiopsyllus* and a new species and genus belonging to the Entomolepididae. The new species of *Spongiopsyllus* is found in association with the sponge *Aplysina cauliformis* (Carter, 1882) sampled at the Porto da Barra beach. It is distinguished from its congeners mainly by differences in the segmentation pattern of the antennule, endopod of antenna, and the setation of the maxillule, maxilla and maxilliped. The new genus and species from Parmulodinae Eiselt, 1959 is found in association with the sponge *Aplysina solangeae* Pinheiro, Hajdu & Custódio, 2007, sampled at the Yacht Club Beach. The genus differs from others Parmulodinae mainly due to segmentation pattern of the antennule, endopod of antenna, maxilliped and swimming legs.

Key words: Porifera, symbiotic fauna, taxonomy

Introduction

Among the siphonostomatoid families that live in association with invertebrates, the Entomolepididae, Brady 1899 is a small taxon with very characteristic body morphology. The flattened oval aspect and the body shield covering almost the entire body distinguishes the group from all other families and suggests a life mode attached to its host. The Entomolepididae comprises 17 species classified in seven different genera (Ahyong *et al.* 2011; Canário *et al.* 2012; Lee & Kim 2017; Uyeno & Jonhsson 2018; Canário *et al.* 2019) being recorded in all oceans of the world.

According to Boxshall & Halsey (2004), the main host group for the Entomolepididae is Porifera. Considering the 11 species with identified hosts, nine of them are found in association with sponges: *Paralepeopsyllus mannarensis* Ummerkutty, 1960; *Paralepeopsyllus dambayensis* Lee & Kim, 2017; *Paralepeopsyllus leei* Lee & Kim, 2017 (all these three species in unidentified sponges); *Parmulella emarginata* Stock, 1992 and *Parmulodes verrucosus* Wilson, 1944 both associated with *Chondrilla nucula* Schimidt, 1862; *Entomopsyllus adriae* (Eiselt, 1959) associated with *Verongia aerophroa* as *Aplysina aerophroa* (Nardo, 1833) and *Verongia cavernicola as Aplysina cavernicola* (Vacelet, 1959); *Entomopsyllus brevicaudatus* Lee & Kim, 2017 (unidentified sponge); *Spongiopsyllus adventicius* Johnsson, 2000 found associated with *Aplysina* sp. and unidentified sponges, besides further records with *Aplysina lacunosa* (Lamarck, 1814), *Dysidea janiae* (Duchassaing & Michelotti, 1864) and *Monanchora* sp. (Carter, 1883); *Spongiopsyllus atypicus* Canário *et al.* 2019 recorded in *Aplysina insularis* (Duchassaing & Michelotti, 1864) (Wilson 1944; Eiselt 1959; Ummerkutty 1960; Boxshall & Halsey 2004; Johnsson & Neves 2012; Lee & Kim 2017; Canário *et al*. 2019).

However the family is also recorded in association with other hosts such as the stony coral *Mussismilia hispida* (Verrill, 1901) (*Spongiopsyllus redactus* Johnsson, 2000), the octocoral *Tubipora musica* Linnaeus, 1758 (*Entomopsyllus stocki* Kim, 2004) and sea anemones (*Entomolepis hamondi* McKinnon, 1988) – all of them

Accepted by E. Suárez-Morales: 13 May 2021; published: 4 Jun. 2021

cnidarian hosts – *Entomolepis ovalis* Brady, 1899 is recorded on the tunicate *Botrylloides leachi* (Savigny, 1816), and *Lepeopsyllus typicus* Thompson & Scott, 1903 was found in oyster washings (Mollusca) (Brady 1899, Thompson & Scott 1903, McKinnon 1988, Johnsson 2000, Kim 2004).

The present study provides new data about the family, with the record of two new species, from two different localities at Salvador city, Bahia State in the Northeastern region of Brazil: (1) A new *Spongiopsyllus* species is described associated with the sponge *Aplysina solangeae* Pinheiro, Hajdu & Custódio, 2007; (2) A new genus and species of Parmulodinae is described, associated with *Aplysina cauliformis* (Carter, 1882). Both new species have been recorded in association with species of *Aplysina*, in which there are no previous records of copepod associations.

Material and Methods

Samples of *Aplysina solangeae* and *A. cauliformis* were collected at depths of 3 m at Porto da Barra (13°00'14.4"S 38°32'01.5"W) and Yacht Club (12°59'58.5"S 38°31'50.8"W) beaches respectively. The sponges were wrapped in a plastic bags with seawater and then transported alive to the laboratory where they were rinsed and fixed in 70% ethanol. The samples were washed and filtered through a 100 μm mesh net and fixed in ethanol (70%). With a stereomicroscope the copepods were sorted out from the sediment (Johnsson & Neves 2012). The specimens were cleared in lactic acid, measured, and the habitus was drawn. Then the specimen was stained in Chlorazol Black E, dissected, and mounted permanently in CMC-9® (Masters Chemical Company, Inc.) mounting medium. All drawings were made with an Olympus CH30 compound microscope equipped with a drawing tube and examined with the aid of a Nikon Eclipse Ci with a digital camera. The lengths of the antennule segments were measured along the posterior, non-setiferous margin. For the antennule formula Roman numerals indicate the ancestral segments followed by the number of setae in Arabic numerals (Huys & Boxshall 1991). In the armature formula of legs 1–4, Roman numerals are spines and

Arabic numerals indicate setae. The species studied are deposited in the Museu de História Natural of the Universidade Federal da Bahia (UFBA).

Taxonomy

Order Siphonostomatoida Thorell 1859

Family Entomolepididae Brady, 1899

Subfamily Parmulodinae Eiselt 1959

Parmulopsyllus gen. nov.

Diagnosis

Body shield with only pedigerous somite 2 free. Urosome cylindrical and 3-segmented. Antennule of female 16-segmented with aesthetasc on 15th segment. Antenna with 1-segmented exopod and 3-segmented endopod. Oral cone elongated. Mandible consisting of stylet and 1-segmented palp bearing two distal setae. Maxilla without ornamentations. Maxillule bilobed. Maxilliped 4-segmented. Legs 1-3 biramous, both rami 3-segmented. Third endopodal segment of leg 2 with armature formula 1,2,2; third exopodal and endopodal segments of leg 3 with armature formula III,1+I,3 and 1,2,3 respectively. Leg 4 totally absent. Free segment of leg 5 with 3 setae.

Remarks: *Parmulopsyllus* **gen. nov.** shows the characteristics of the subfamily Parmulodinae. A single thoracic free somite between cephalothorax and abdominal pleural plate. Mandible not greatly lengthened and retaining a recognizable blade. Basal segment of maxillule small, with long inner lobe, and outer lobe about 1/3 total length of the inner one. Leg 4 absent; leg 5 present as in Entomolepinae, but considerably shorter (McKinnon 1988), or totally absent as *Paralepeopsyllus* Ummerkutty, 1961.

Considering the swimming legs of the genera included in Parmulodinae, *Parmulella* has leg 4 similar to a

knob or a monomerous rudiment and its leg 5 is leafshaped or clavate (Stock 1992). In *Parmulodes*, leg 4 is reduced to a minute distal seta and leg 5 is 1-segmented and slightly elongated (Wilson 1944, Canário et al. 2019). *Parmulopsyllus* **gen. nov.** has leg 4 totally absent and leg 5 slightly longer than in *Parmulodes* but not as long as in *Parmulella*.

Parmulopsyllus **gen. nov.** also differs from the other genera in its subfamily by having a 16-segmented antennule instead of a 17 or a 18-segmented antennule as in *Parmulodes* and *Parmulella*, respectively (Stock 1992, Wilson 1944); a 4-segmented maxilliped instead of a 5-segmented as both other genera, and a distinctive armature formulae on the third endopodal segment of leg 2 with formula 1,2,2 instead of 1,2,3 as *Parmulodes* and *Parmulella* (Stock 1992, Wilson 1944, Canário *et al.* 2019), on the third endopodal segment of leg 3 with formula 1,2,3 instead of 1,1,3 as in both other genera (Stock 1992, Canário *et al.* 2019).

Etymology: '*Parmula*' from the Latin little shield, added suffix *'odes'* (masculine) and *'psyllus'* from the greek meaning flea. Gender masculine.

Type species by original designation: *Parmulopsyllus iamarinoi* **sp. nov.**

Description

Parmulopsyllus iamarinoi sp. nov.

(Figs 1–3)

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Material examined. Holotype female (UFBA 3290) associated with *Aplysina cauliformis* at 3 m depth in Yacht Club Beach, Salvador, Bahia, Brazil, collected by C. Borges in 27th September 2012.

Description of female.

Body shield flattened (Fig. 1a), with radiating bands along outer margin. Mean body length (excluding caudal setae) 1110 µm and mean body width 930 µm. Pedigerous somite 1 fused with cephalosome. Pedigerous somite 2 narrower than the others. Pedigerous 3 and 4 fused, forming posterior shield covering urosome almost entirely, except for distal portion of anal somite and caudal rami. Urosome (Fig. 1b) 3-segmented. Genital double-somite fused with fifth pedigerous somite, 257 × 150 µm; length: width ratio 1.7:1. Both postgenital somites wider than long, 62 × 85, 65 × 80 µm, respectively. Caudal rami elongated, 27 µm long, armed with 6 plumose setae distally.

Antennule (Fig. 1c) slender, 325 µm long (not including setae), and 16-segmented. Length of segments in proximal to distal order: 111, 14, 9, 48, 15, 16, 5, 16, 18, 21, 23, 22, 25, 26, 28, and 29 µm, respectively. Segmental homologies and setation as follows: 1(I)–1; 2(II)–2; 3(III)–1; 4(IV-VII)–7; 5(VIII)–2; 6(IX–XII)–5; 7(XIII)–1; 8(XIV)– I+1; 9(XV)–2; 10(XVI)–2; 11(XVII)–1; 12(XVIII)–1; 13(XIX)–2; 14(XX)–1; 15(XXI)– 1+ae; 16(XXII–XXVIII)–9. Aesthetasc 94 µm long. Segment 8 bearing spine and seta. Antenna (Fig. 1d) 348 µm long (including distal claw); unarmed coxa with 53 µm long, basis 108 µm long. Exopod 1-segmented, 37 µm long armed with two very short, distal setae. Endopod 3-segmented; first segment unarmed, 91 µm long, ornamented with setules along outer margin, second segment 23 µm long and unarmed, third segment 24 µm long and armed with plumose, robust seta and terminal claw slightly curved with 36 µm long.

Oral cone (Fig. 2a) 264 µm long, reaching genital double somite, distal margin (Fig. 2b) ornamented with a dense bunch of setules on spatula-like tip. Mandible (Fig. 2c) comprising stylet and slender 1-segmented palp measuring 127 µm long, with 2 distal unequal setae, one partially plumose. Stylet slender (Fig. 2c) with 350 µm, with middle portion narrowing abruptly. Maxillule (Fig. 2d) bilobed. Inner lobe 98 µm long, armed with four naked setae, one much shorter than others. Outer lobe 30 µm long, armed with four distal setae. Maxilla (Fig. 2e) with syncoxa measuring 214 µm long and claw 156 µm long, very curved distally. Maxilliped (Fig. 2f) 4-segmented, 419 µm long (excluding claw); syncoxa and basis 113 and 167 µm long respectively, both unarmed. Endopod 2-segmented; first segment 46 µm long and armed with two setae; second segment 31 µm long, ornamented with setules on inner margin and armed with seta close to distal claw. Claw ornamented with setules and bearing slight indentation near tip.

Legs 1 to 3 (Figs. 3a–c) biramous, with 3-segmented rami. Leg 4 absent.

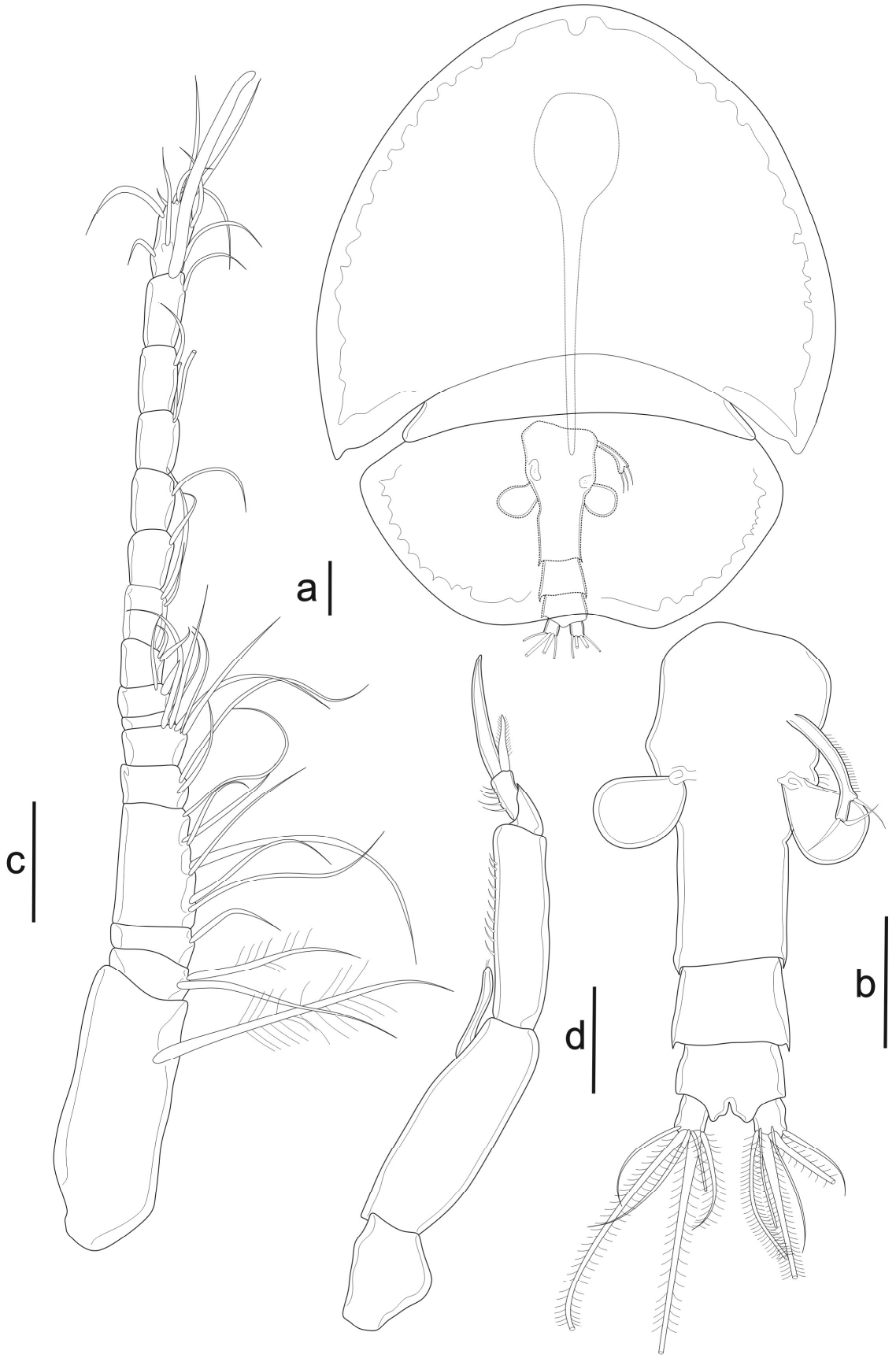

FIG. 1. *Parmulopsyllus iamarinoi* **gen. et sp, nov.,** female (UFBA 3290). a) Body in dorsal view; b) urosome; c) antennule; d) antenna. Scale bars: a = 200 µm; b = 100 µm; c–d = 50 µm.

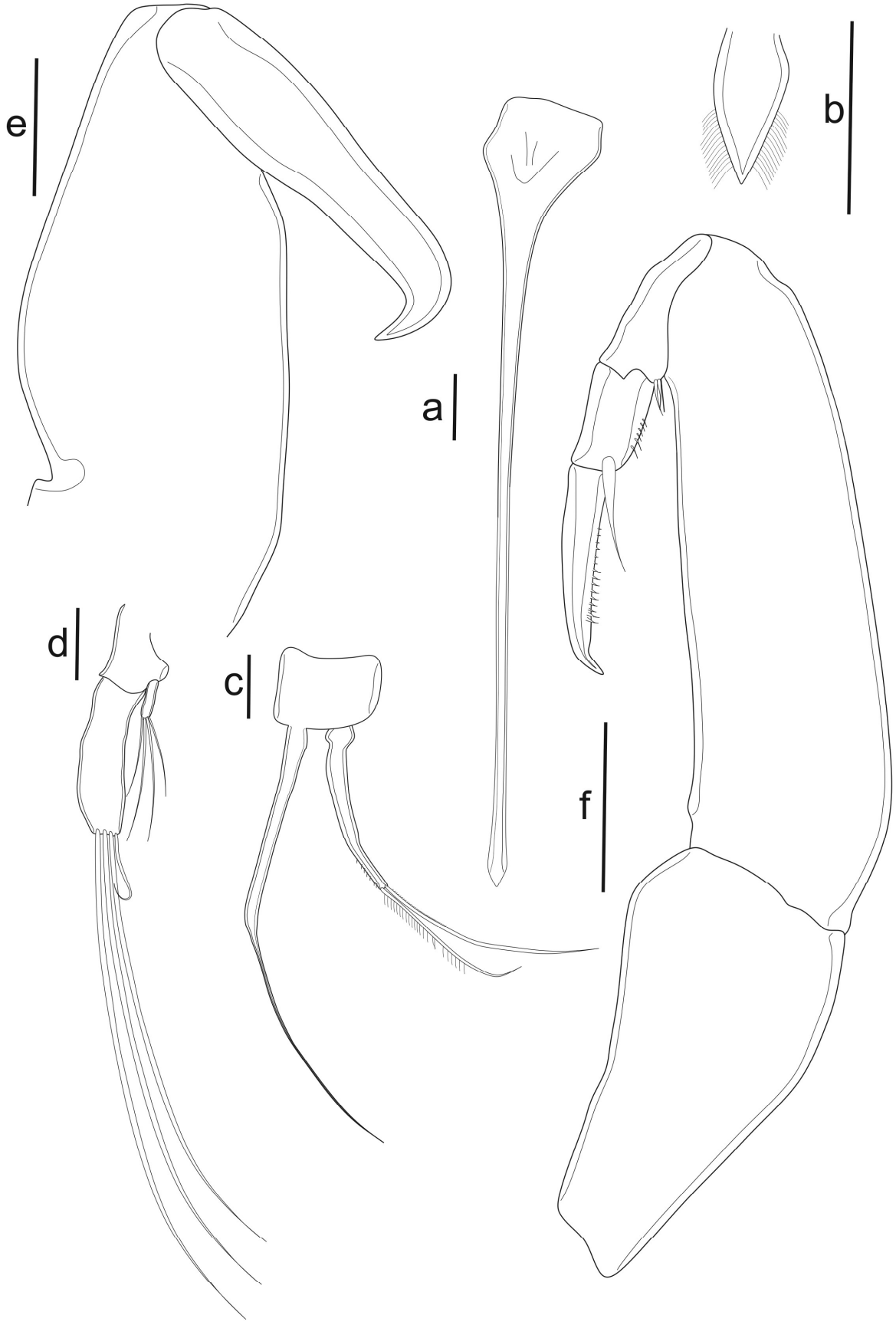

FIG. 2. *Parmulopsyllus iamarinoi* **gen. et sp. nov.**, female (UFBA 3290). a) Oral cone; b) Tip of oral cone, c) Mandible; d) maxillule; e) maxilla; f) maxilliped. Scale bars: a–f = 50 μm.

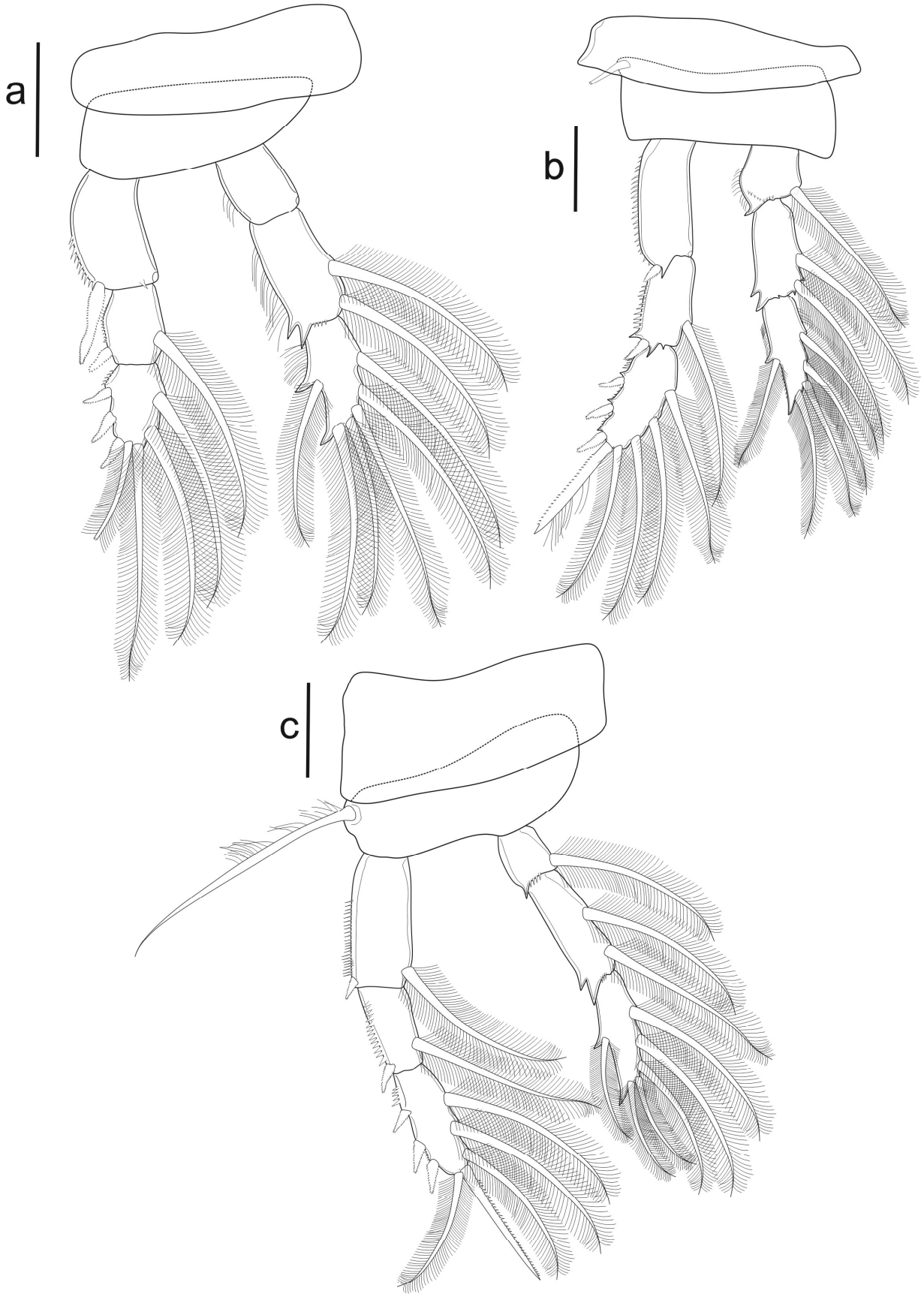

FIG. 3. *Parmulopsyllus iamarinoi* **gen. et sp. nov.**, female (UFBA 3290). a) P1; b) P2; c) P3. Scale bars: a–c = 50 µm.

Armature formula of legs 1 to 3 as follows, with missing seta indicated in parenthesis:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	0-0	I-(1); I-1; III,2,2	0-(1); 0-2; 1,2,3
Leg 2	0-0	1-0	I-(1); I-1; III,I,4	0-1; 0-2; 1,2,2
Leg 3	0-0	1-0	I-1; I-1; III,1+I,3	0-1; 0-2; 1,2,3

All exopodal segments of legs 1 to 3 (Figs. 3a, b and c) have spinules on outer margins. All endopodal segments of leg 1 have row of long setules on outer margin, similarly for first and third endopodal segments of leg 2. On leg 1, first exopodal segment with distal denticle and second endopodal segment showing four denticles. Leg 3 with first and second endopodal segments bearing four and three deticle, respectively. First endopodal segment of leg 2 showing row of spinules distally.

Free exopodal segment of P5 (Fig. 1b) elongated and curved, 207 µm long, reaching distal margin of genital double-somite, and armed with two distal setae and another one subdistally.

Male. Unknown.

Etymology. Species named in honor of Atila Iamarino, biologist, PhD in microbiology and scientific communicator for his notorious work informing, educating and raising awareness in combating misinformation about covid-19.

Spongiopsyllus intermedius sp. nov.

(Figs 4–6)

lsid:zoobank.org:act:5B344D20-F69F-4202-96B1-45B275CF5379

Material examined. Holotype female (UFBA 3185) and paratype female (UFBA 3186) associated with *Aplysina solangeae*, at 3 m depth at Porto da Barra Beach, Salvador, Bahia, Brazil, collected by C. Borges, R. Johnsson and E. G. Neves in 9th October, 2014.

Description of female.

Mean body length (excluding caudal setae) 1065 µm and mean body width 775 µm. Body shield flattened (Fig. 4a), with radiating bands along outer margin. Pedigerous somites 2–4 free. Urosome (Fig. 4b) four-segmented. Genital double-somite fused with fifth pedigerous somite, 237 × 147 µm; length: width ratio 1.6:1. Genital openings near insertion of leg 5. All three postgenital somites wider than long, 52 × 65, 23 × 58 and 42 × 54 µm, respectively. Length prosome: urosome ratio = 1.4:1. Caudal rami elongate, 115 µm long, armed with 6 plumose setae distally.

Antennule (Fig. 4c) slender, 257 µm long (not including setae), and 16-segmented. Length of segments: 58, 23, 27, 8, 11, 15, 12, 10, 10, 12, 10, 10, 12, 12, 10 and 17 µm, respectively. Segmental homologies and setation as follows: 1(I)–2; 2(II– III)–2; 3(IV–VI)–6; 4(VII)–2; 5(VIII)–2; 6(IX–XIII)–5; 7(XIV)–2; 8(XV)–2; 9(XVI)–2; 10(XVII)–2; 11(XVIII)–2; 12(XIX)–2; 13(XX)–2; 14(XXI)–2+ae; 15(XXII)–2; 16(XXIII–XXVIII)–6. Aesthetasc 107 µm long. Antenna (Fig. 4d) 187 µm long (including distal claw); basis 67 µm long. Exopod 1-segmented, 48 µm long, and with two unequal, sub-distal setae and five small setules along lateral margin. Endopod 2-segmented; first segment 52 µm long, with six setules on inner margin; second segment 20 µm long, ornamented with row of long setules along outer margin, and armed with 2 naked setae and terminal narrow claw, slightly curved distally.

Oral cone 956 µm long, reaching anal somite. Mandible (Fig. 5a) comprising stylet and slender 2-segmented palp measuring 48 and 57 µm long, respectively. Stylet slender, tapering distally. Palp with second segment ornamented with setules along outer margin and armed with two apical, unequal setae.

Maxillule (Fig. 5b) bilobed. Inner lobe 67 µm long, armed with two long apical setae. Outer lobe 46 µm long, ornamented with setules along outer margin and armed with three apical setae. Maxilla (Fig. 5c) with syncoxa measuring 174 µm long and curved claw with 137 µm long, armed with minute setule on mid-inner margin. Maxilliped (Fig. 5d) 5-segmented, 287 µm long (excluding claw); syncoxa and basis 94 and 110 µm long, respectively, both unarmed. Endopod 3-segmented, 34, 22, 27 µm long, respectively, and bearing single seta on each segment plus curved claw measuring 46 µm long. All setae naked.

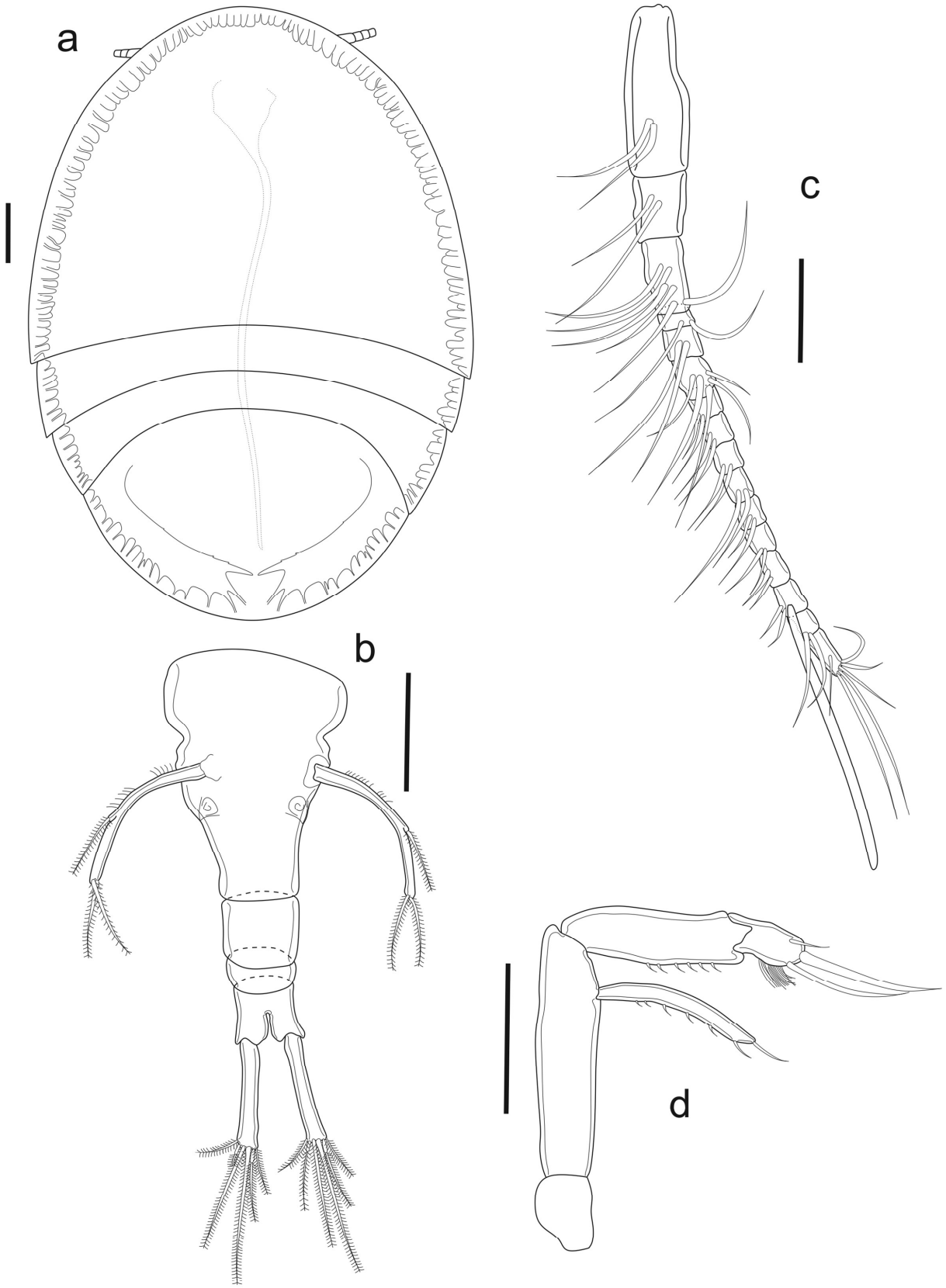

FIG. 4. *Spongiopsyllus intermedius* **sp. nov.**, female (UFBA 3144). a) Body in dorsal view; b) urosome; c) antennule; d) antenna. Scale bars: a = 200 µm; b = 100 µm; c–d = 50 µm.

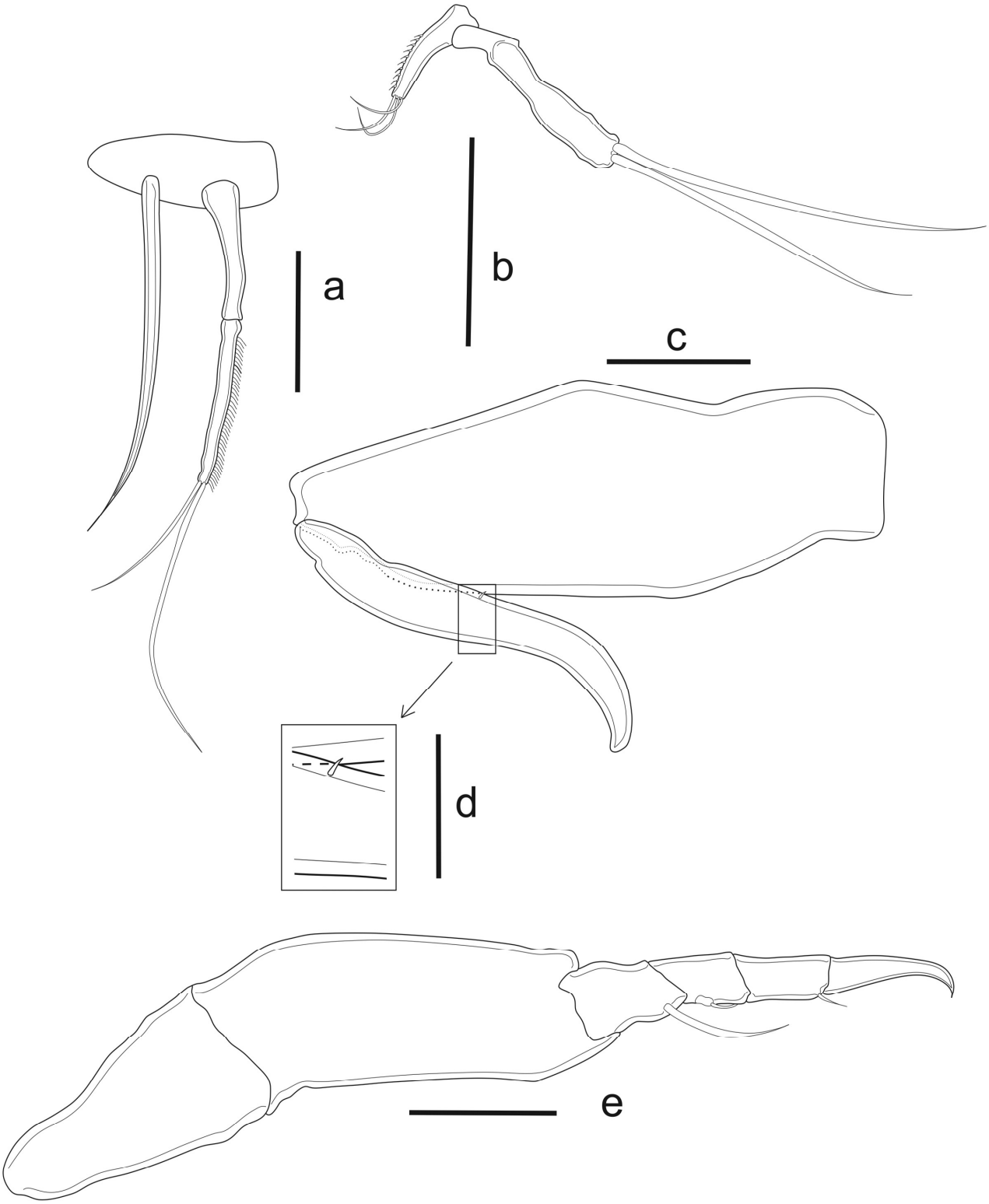

FIG. 5. *Spongiopsyllus intermedius* **sp. nov.**, female (UFBA 3144). a) Mandible; b) maxillule; c) maxilla; d) detail from the maxilla; e) maxilliped; Scale bars: a–e = 50 µm.

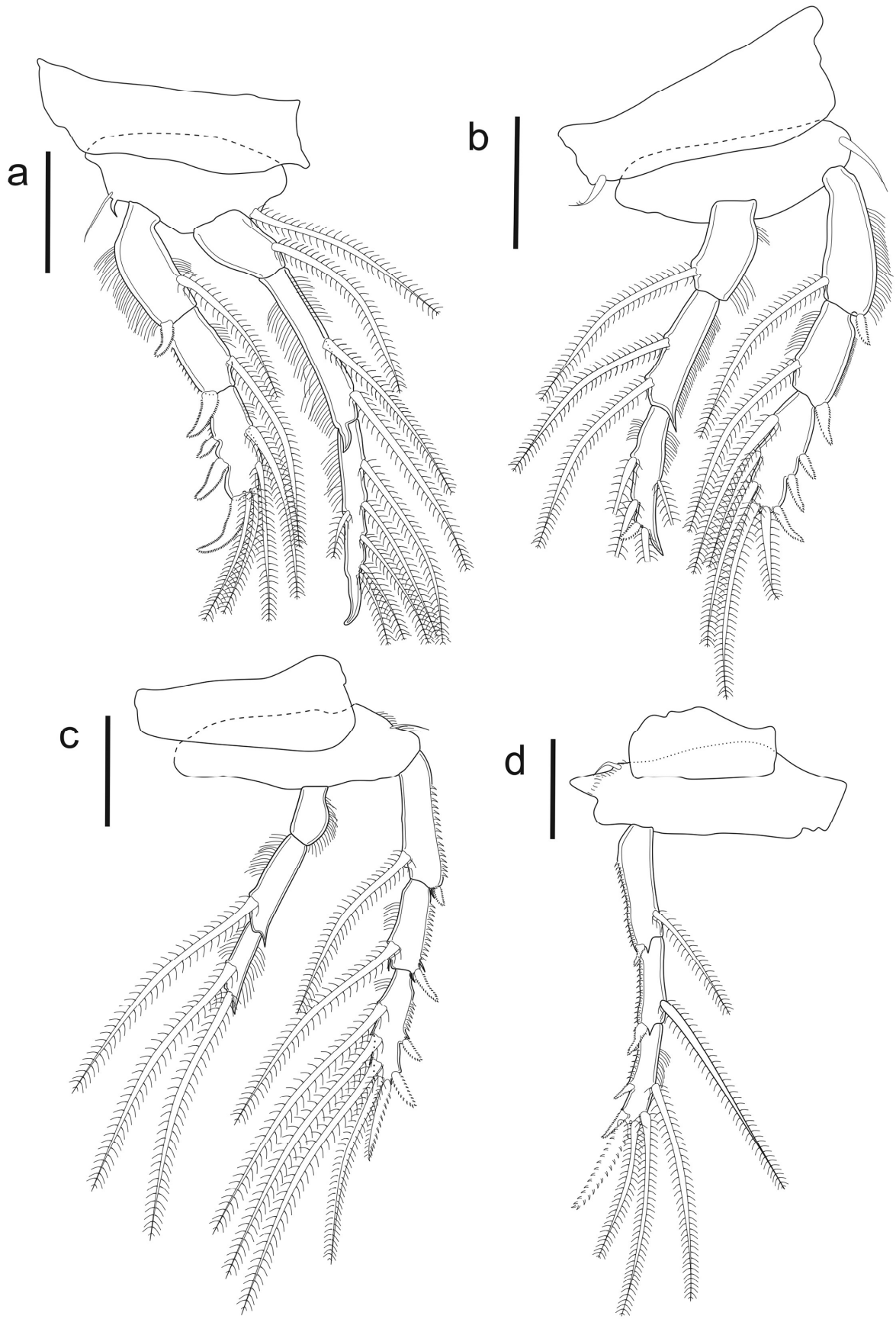

FIG. 6. *Spongiopsyllus intermedius* **sp. nov.**, female (UFBA 3144). a) P1; b) P2; c) P3; d) P4. Scale bars: a–d = 50 µm.

Legs 1 to 3 (Figs. 6a–c) biramous, with 3-segmented rami. Leg 4 (Fig. 6d) with exopod 3-segmented and endopod absent. Armature formula of legs 1 to 4 as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	1-1	I-1; I-1; II,I,4	0-1; 0-2; 1,5
Leg 2	0-1	1-0	I-1; I-1; III,1,4	0,1; 0,2; 1,1+I,2
Leg 3	0-0	1-0	I-1; I-1; II,I,4	0-0; 0-1; 0,1,1
Leg 4	0-0	1-0	I-1; I-1; II,I,3	Absent

Basis of leg 1 with tooth-like projection on outer margin close to outer seta. Second and third endopodal segments of leg 1 (Fig. 6a) prolonged distally into sharp tooth-like process, therefore distal setae of third segment located sub-distally on inner margin. Exopodal spines of leg 1 stout proximally. Second and third endopodal segments of legs 2 and 3 (Figs. 6b-c) showing similar prolonged process but reduced in size in comparison with leg 1 and not occupying distal position as in third segment of leg 1. Leg 3 with first endopodal segment with outer margin hump-shaped middistally; first and second exopodal segments showing small tooth-like projections close to elements. Basis of leg 4 with projection on outer lateral margin.

Free exopodal segment of leg 5 (Fig. 4b) elongated, medially curved, 170 µm long, reaching beyond distal margin of genital double-somite, and armed with 3 plumose setae, 2 distal ones and single seta medially on outer margin.

Male. Unknown.

Etymology. The specific name '*intermedius'* means intermediate in Latin, referring to the existence of 16 segments of antennule in the new species. This number of segments is intermediary when compared with the 17-segmented *S. adventicius* Johnsson, 2000 and the 15-segmented *S. redactus* Canário *et al.* 2012.

Remarks

Spongiopsyllus intermedius **sp. nov.** has all the characters of the genus *Spongiopsyllus* such as a body shield covering the urosome, except for the tip of the caudal rami, three postgenital somites, and reduction in the female leg setation (Johnsson 2000).

The new species has a 16-segmented antennule, differing from *S. adventicius*, *S. redactus* and *S. atypicus* which have 17, 15 and 14 segments, respectively (Canário *et al*. 2012, 2019, Johnsson 2000). Consequently, the segmental homologies are different in the three species:

Spongiopsyllus intermedius **sp. nov.** has the ancestral segments XXII free and, XXIII-XXVIII fused, *S. redactus* has XXII-XXVIII fused, *S. atypicus* has XXII-XXIII and XXIV-XXVIII fused, and *S. adventicius* has XXII and XXIII free, XXIV-XXVIII fused. Also, the new species shows the homologies of the basal segments of the antennule as II-III, IV-VI, VII, IX-XIII as in *S. redactus*, which is different from *S. adventicius* that has II, III-V, VI, VII-VIII, IX-XII and *S. atypicus* that has II, III-VIII, IX-XIII. (Canário *et al*. 2012, 2019, Johnsson 2000). Antennule segmentation patterns are built based on model proposed by Huys & Boxshall (1994). The number of setae and key segments such as the one with the aesthetasc provide the cues to trace the homologies and becomes strong characters used in diagnosis of genera and families, not only in Entomolepididae (Kim 2004, McKinnon 1988) but also in other families such as Asterocheridae (Conradi & Bandera 2011, Kim 2013) and Artotrogidae (Eiselt 1965, Kim 2016).

S. intermedius **sp. nov.** has the endopod of the antenna 2-segmented, as in *S. redactus* and *S. atypicus* however differing from *S. adventicius,* that is 3-segmented (Canário *et al*. 2012, 2019; Johnsson 2000). Nevertheless, in the new species the distal endopodal segment shows 2 setae and row of setules along the outer margin while *S. adventicius* and *S. redactus* have 3 setae and a naked outer margin, and *S atypicus* has 4 setae and a margin ornamented with long setules (Canário *et al*. 2012, 2019; Johnsson 2000). The exopod of the antenna has 2 unequal apical setae in *S. intermedius* **sp. nov.** as in *S. redactus*, unlike *S. adventicius* that has 2 equal apical setae and *S. atypicus* that has a smooth distal seta and seven setules laterally (Canário *et al*. 2012, 2019; Johnsson 2000).

The stylet in the new species tapers distally, similarly to *S. adventicius* but different from *S. redactus* that has subapical denticulated margin (Canário *et al.* 2012, Johnsson 2000). The inner lobe of the maxillule of *S. interme-*

dius **sp. nov.** is armed with 2 setae, instead of 3 as in *S. adventicius* and *S. redactus*, and 4 in *S. atypicus* (Canário *et al*. 2012, 2019; Johnsson 2000). The new species has the endopod of the maxilliped with armature formula 1,1,1, different from *S. adventicius, S. atypicus* and *S. redactus* that have 0,2,1; 2,0,1; and 2,1,1, respectively (Canário *et al.* 2012, 2019; Johnsson 2000).

Spongiopsyllus intermedius **sp. nov.** also shows differences in the armature formula of the swimming legs. Coxa of leg 1 has no seta as in *S. atypicus* and unlike its other congeners that have an inner seta (Canário *et al.* 2012, 2019; Johnsson 2000). Basis of legs 3 and 4 with 1-0, while its congeners have no seta, except *S. atypicus* that has 1-0 on the basis of leg 4 (Canário *et al*. 2012, 2019; Johnsson 2000). Third endopodal segment of leg 1 with 6 setae altogether as in *S. redactus*, unlike *S. adventicius* and *S. atypicus* that has 5 setae (Canário *et al*. 2012, 2019; Johnsson 2000).

The maxilla is armed with a small setule on inner margin of the claw, the third endopodal segment of leg 2 with seta and spine distally (1, 1+I, 2), the third exopodal segment of leg 3 with distal seta medially (III, 1, 4), and the small tooth-like projections close to the spines of the first and second exopodal segments of P3 are all characters not observed in any of its congeners (Canário *et al*. 2012, 2019; Johnsson 2000).

Ecological considerations

Sponges are known to be used as shelter, nurseries and food source for many marine invertebrates and the availability of internal spaces in the sponge's aquiferous system can influence these associates abundance and species richness (Chin et al. 2020). The Entomolepididae family is mostly found in association with sponges (Boxshall & Halsey 2004) in their majority belonging to the Demospongiae class (Boxshall & Halsey 2004, Johnsson & Neves 2012, Canário et al. 2019, van Soest et al. 2021).

Aplysina Nardo, 1834 (Demospongiae, Verongiida) is characterized by large sponges with many forms and live colours, composed by skeleton with only spongin fibers and alpha-chitin (Pinheiro et al. 2007, Ehrlich et al. 2007). The genus has a circumtropical distribution, and is highly conspicuous in the western Tropical Atlantic Ocean in comparison to the Indian and Pacific Oceans (van Soest 1994). *Aplysina* currently comprises 44 valid species (van Soest et al. 2021), of which 15 species occur to the Brazilian coast and 14 of them being described to the Northeastern region (Pinheiro et al. 2007). Four of these species have already been registered in association with specific species of Entomolepididae: *Aplysina lacunosa* (Lamarck, 1814), *Aplysina insularis* (Duchassaing & Michelotti, 1864), *Aplysina cauliformis* (Carter, 1882) and *Aplysina solangeae* Pinheiro, Hajdu & Custódio, 2007 (Johnsson & Neves 2012, Canário et al. 2012, 2019).

Aplysina cauliformis occurs from the Florida to Brazil (van Soest et al. 2021). The species is characterized by slender cylindrical branches, conulose surface with some spare smooth areas, hard consistence, irregular oscula often longitudinally aligned along the branches (diameter approximately 1-3mm), purple or light-yellow colored, becoming brownish purple in alcohol (Pinheiro et al. 2007). *Aplysina solangeae* is endemic to Brazil, occurring along the coasts of the states of Ceará and Bahia. In the latter it is found in Salvador city, being only recorded in shallow waters, up 5m deep (Hajdu et al. 2011). This species is short, stout with lamellar form, having digitiform projections in their apical region, irregular surface, ranging from smooth to finely rugose, very soft consistence, small oscula on top of volcaniform projections, and color in life is yellow, turning dark-brown after preserved (Pinheiro et al. 2007; Hajdu et al. 2011).

Molecular data have supported the monophyly of *Aplysina*, according to morphological characters, biogeographical analyses and biochemical characteristics (Shimitt 2005, Cruz-Barraza et al. 2012). The genus lacks a mineral skeleton, being difficult to establish its classification due to phenotypic plasticity. However, other characters such as external morphology and skeleton are relevant and species of Eastern Pacific and Caribbean are clearly distinct in morphology and distribution (Cruz-Barraza et al. 2012).

The present study registers *S. intermedius* **sp nov.** in association with *A. solangeae* which is endemic to Brazil and *P. iamarinoi* **gen. nov. sp nov.** in association with *A. cauliformis*. This sponge is originally described to Caribbean, and a recent study indicates that it is more closely related to the Eastern Pacific species (Cruz-Barraza et al. 2012). Other species of *Spongiopsyllus* has been recorded in *Aplysina*: *S. atypicus* in *A. insularis* (Canário et al. 2019); *S. adventicius* was originally reported in *Aplysina* sp. and *A. lacunosa*, but this species occur too in other species of sponges, as *Dysidea janiae* (Duchassaing & Michelotti, 1864) and *Monanchora* sp. Carter, 1883 (Johns-

son 2000, Johnsson & Neves 2012). *Spongiopsyllus redactus* is the only species of the genus recorded in a different host phylum, being found associated with the scleractinian coral *Mussismilia hispida* (Verrill, 1901) (Canário et al. 2012).

Entomolepididae have at least three pairs of swimming legs with some reductions in segmentation and number of elements of these appendages, such as in the fourth leg of *Lepeopsyllus* Thompson & Scott, 1903 which is reduced to a small segment, and absent in *Entomopsyllus* McKinnon, 1988 as well in *Entomolepis* Brady, 1899 (Brady 1899, Thompson & Scott 1903, McKinnon 1988). This pattern may indicate that, despite living in association, they are still able to move from host to host or crawl on the external body surface as observed with *Micropontius* Gooding, 1957, while its siphon, which has robust and powerful muscles, is used to draw food from the sponge tissue (Gooding 1957, Huys & Boxshall 1991, Mariani & Uriz 2001).

Although the reduced locomotion capacity due to the absence of the fourth leg, which is the major legs reduction pattern between the species associated with *Aplysina*, the association of *P. iamarinoi* **gen. et sp. nov.** in *A. cauliformes*, may be related to morphological features of the sponge surface, which is rough and conulose, providing an environment more stable in comparison to other *Aplysina* species. Among the other *Aplysina* species, so far used as host for the Entomolepididae copepods, *A. solangeae* and *A. insularis* have a smooth to finely rugose surface and in *A. lacunosa* the nsurface is totally marked by irregular shaped grooves. The oscules of all these species are in apical position and surface and oscules are considerable bigger than in *A. cauliformes* (Pinheiro *et al*. 2007). All three *Spongiopsyllus* associated with these species have less reductions on their leg pattern when compared to the *P. iamarinoi* **gen. et sp. nov.**, showing a biramous and 3-segmented third leg with fewer endopodal elemements, and a uniramous and 3-segmented fourth leg instead of totally absent leg 4 respectively.

Despite the tendency of *Parmulopsyllus iamarinoi* **gen. et sp. nov.** and most *Spongiopsyllus* species to live in association with *Aplysina* species, when other Entomolepididae species are considered, we observe that *Entomopsyllus adriae* (Eiselt, 1959) was recorded associated with *Verongia aerophoba* (Nardo, 1833) and *Verongia cavernicola* (Vacelet, 1959) (Boxshall & Halsey 2004), but Wiedenmayer (1977) stablished *Aplysina* as a senior name over *Verongia*. Thus, approximately 1/3 of the species of the family are found associated with sponges of the genus *Aplysina*, what may reflect host genus preference in the Entomolepididae X sponge relation.

Key to the species of the Entomolepididae (adapted from Farias *et al.* 2020)

1. Pedigerous somite 2 free in dorsal view . . . 2
– Pedigerous somites 2 and 3 free in dorsal view . . . 8
2. Most of urosome exposed . . . 3
– Most of urosome hidden under body shield . . . 4
3. Female antenna 3-segmented; antennule 18-segmented with aesthetasc on segment 15. . . *Parmulella emarginata* Stock, 1992
– Female antenna 4-segmented; antennule 17-segmented with aesthetasc on segment 16 . . . *Neoparmulella periperiensis* Farias et al. 2020
4. Leg 3 biramous . . . 5
– Leg 3 uniramous (*Paralepeopsyllys* Ummerkutty, 1960) . . . 6
5. Leg 4 reduced to a knob and antennule 17-segmented. . . . *Parmulodes verrucosa* Wilson, 1944
– Leg 4 absent and antennule 16-segmented . . . *Parmulopsyllus iamarinoi* **gen. nov. sp nov.**
6. Antennule 15-segmented . . . *Paralepeopsyllys leei* Lee & Kim, 2017
– Antennule 14-segmented . . . 7
7. Third exopodal segment of leg 3 with three setae . . . *Paralepeopsyllus mannarensis* Ummerkutty, 1960
– Third exopodal segment of leg 3 with four spines and three setae . . . *Paralepeopsyllus dambayensis* Lee & Kim, 2017
8. Leg 4 absent (*Entomolepis* Brady 1899) . . . 9
– Leg 4 present . . . 10
9. Caudal ramus 5-6 times longer than wide . . . *E. ovalis* Brady, 1899
– Caudal ramus at least 10 times longer than wide . . . *E. hamondi* McKinnon, 1899
10. Leg 4 endopod absent . . . 11
– Leg 4 endopod reduced to small segment (*Lepeopsyllus* Thompson & Scott, 1903) . . . 12
11. Three postgenital somites in female and four in male (*Spongiopsyllus* Johnsson, 2000) . . . 13
– Two postgenital somites in female and three in male (*Entomopsyllus* McKinnon, 1988) . . . 16
12. Female antennule 15-segmented . . . *L. typicus* Thompson & Scott, 1903
– Female antennule 13-segmented . . . *L. ovalis* Thompson & Scott, 1903
13. Female antennule 14-segmented . . . *Spongiopsyllus atypicus* Canário et al., 2019
– Female antennule with 15 or more segments . . . 14

14. Female antennule 15-segmented . . . . . *Spongiopsyllus redactus* Canário et al., 2012
– Female antennule with 16 or more segments 15
15. Female antennule 16-segmented . . . . . *Spongiopsyllus intermedius* ***sp. nov.***
– Female antennule 17-segmented . . . . . *Spongiopsyllus adventicius* Johnsson, 2000
16. Endopod of P1 shorter than exopod . . . . . *E. nichollsi* McKinnon, 1988
– Endopod of P1 longer than exopod 17

17. Female antennule 15-segmented; third exopod of leg 4 showing 2 setae . . . . . *E. stocki* Kim, 2004
– Female antennule with more than 16 or more segments; third exopod of leg 4 showing 3 or more setae 18
18. Female antennule 16-segmented; third exopod of leg 4 showing 3 setae . . . . . *E. adriae* (Eiselt, 1959)
– Female antennule 17-segmented; third exopod of leg 4 showing 4 setae . . . . . *E. brevicaudatus* Lee & Kim, 2017

Acknowledgements

This study is part of the project "Assessment and research of sun coral in Todos os Santos Bay", a cooperation agreement between UFBA and CENPES/PETROBRAS (N° 5850.0107361.18.9). We are grateful to the Chico Mendes Institute for Biodiversity Conservation (ICMbio) for collecting permission (Sisbio Nº 15161-1). Authors would like to thank the LABIMAR team of the Federal University da Bahia (UFBA) for efforts during field activities, especially I. Bonfim. CB is grateful to Dr. R. Canário for helping during the analysis and preparation of the drawings of the new species. C.B. thanks CNPq for financial support and Programa de Pós Graduação em Biodiversidade e Evolução (PPGBioEvo/UFBA).

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