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LARVAE OF SPONGICOLIDAE (CRUSTACEA, DECAPODA, STENOPODIDEA) FROM THE PLANKTON OFF BRAZILIAN COAST[1]

(With 3 figures)

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ABSTRACT: Stenopodidea is comprised of the family Spongicolidae, which includes five genera (*Spongicoloides*, *Spongiocaris*, *Spongicola*, *Paraspongicola,* and *Microprosthema*), and the family Stenopodidae, with four genera (*Engystenopus*, *Odontozona*, *Richardina,* and *Stenopus*). In Brazil, Stenopodidea is represented by two species of the genus *Stenopus* and one of *Microprosthema.* For the present report, five larvae of two Spongicolidae collected during the cruise of the RV Thalassa between Rio Real (BA) and Cabo de São Tomé (RJ) were identified and described. Two species of *Microprosthema* were identified, one ascribed to *M. semilaeve*, the only member of Spongicolidae recorded until now in Brazil; and the other to an undescribed species of *Microprosthema*. The two species can be distinguished by the rostrum, which is as long as the carapace in *M. semilaeve* and shorter in *Microprosthema* sp.2; and by the presence of pleural spines on abdominal somites 1 to 3 in *M. semilaeve* and only on somites 2 and 3 in the second morphotype.

Key words: Spongicolidae. *Microprosthema*. Decapod larvae. Larval morphology

RESUMO: Larvas de Spongicolidae (Crustacea, Decapoda, Stenopodidea) do plâncton da região oceânica brasileira. A infraordem Stenopodidea compreende as famílias Spongicolidae, que inclui cinco gêneros (*Spongicoloides*, *Spongiocaris*, *Spongicola*, *Paraspongicola* e *Microprosthema*), e Stenopodidae, com quatro gêneros (*Engystenopus*, *Odontozona*, *Richardina* e *Stenopus*). No Brasil, a infraordem Stenopodidea é representada por duas espécies do gênero *Stenopus* e uma de *Microprosthema*. No presente estudo, cinco exemplares de duas espécies de Spongicolidae coletadas durante o cruzeiro do RV Thalassa entre Rio Real (BA) e Cabo de São Tomé (RJ) foram identificados e descritos. Duas espécies de *Microprosthema* foram identificadas, uma atribuída a *M. semilaeve*, a única espécie de Spongicolidae registrada atualmente no Brasil, e outra atribuída a uma espécie ainda não descrita de *Microprosthema*. As larvas das duas espécies podem ser distinguidas pelo rostro, que é tão longo quanto a carapaça em *M. semilaeve* e mais curto na segunda espécie, e pela presença dos espinhos pleurais nos somitos abdominais 1-3 em *M. semilaeve* e somente nos somitos 2 e 3 no segundo morfotipo.

Palavras-chave: Spongicolidae. *Microprosthema*. Larvas de Decapoda. Morfologia larvar.

INTRODUCTION

The decapod infraorder Stenopodidea includes two families and nine genera of small shrimps, commonly found associated with coral reefs, sponges, and rocks (Williams, 1984; Saito *et al.,* 2001). Stenopodid shrimps are small cleaner shrimps that share morphological similarities with the Dendrobranchiata (e.g., type of gills, number of legs with chelae) and also with Caridea (e.g., retention of eggs by females and hatching as zoeae), which sustained the old Natantia group (Glaessner, 1969; Martin & Davis, 2001). However, it is the general consensus that Stenopodidea and Dendrobranchiata share a basal position in the phylogeny of Decapoda, and therefore they do not form a monophyletic group (Ahyong & O'Meally, 2004). Despite the similarities with the Dendrobranchiata, Stenopodidea is included in the Pleocyemata mainly because of the retention of eggs on the pleopods and the absence of a naupliar phase (Burkenroad, 1981; Williams, 1984).

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Stenopodidea larval development is partially known only for *Stenopus spinosus* (Risso, 1827), *S. hispidus* (Olivier, 1811), and *Microprosthema semilaeve* Stimpson, 1860 (Gurney, 1936; Gurney & Lebour, 1941; Bourdillon-Casanova, 1960; Barnich, 1996; Raje & Ranade, 1978; Seridji, 1990; Martin & Goy, 2004). Williamson (1976) described five larvae collected in the Indian Ocean and compared them with larvae previously described by Gurney (1936) and Gurney & Lebour (1941). Williamson (1976) presented a key to identify all the larvae of Stenopodidea previously described. The following characters were used in this key: spinules on the body; postero-ventral spine on the carapace; median dorsal spine on somite 3; median ventral spine on somite 5; length of the rostrum; and pleural spines on somites 1 to 5. Williamson (1976) also made some suggestions on possible generic groupings of known stenopodid larvae.

The development of Spongicolidae is thought to include direct, abbreviated, and extended sequences. Saito & Konishi (1999) found direct development in the deep-sea shrimp *Spongicola japonica* Kubo, 1942. Bate (1888) described the late embryo of *Spongicola venusta* De Haan, 1844 and suggested that its development might be abbreviated, with few stages. Gurney & Lebour (1941) suggested that there are nine larval stages in the development of *Microprosthema semilaeve*, similar to that of *Stenopus hispidus*.

The present study aimed to describe the larvae of Spongicolidae collected in the southwestern Atlantic Ocean, off the Brazilian coast, and to review the diagnostic larval characters of the Stenopodidea.

MATERIAL AND METHODS

Samples were taken at 114 oceanographic stations during the cruise "Bahia I" of the RV THALASSA off the east coast of Brazil between Rio Real (12°S) and Cabo de São Tomé (22°S) (Fig.1). All samples were taken using a bongo net with 500 µm mesh size, and were immediately preserved in 4% buffered formaldehyde. The hauls were oblique, starting and ending at the surface. The maximum depth reached by the net was 200 meters. In the laboratory, larvae of Spongicolidae were sorted from the samples, placed in 70% ethanol, and permanently stored in the collection of the Zoology Department, Federal University of Rio de Janeiro, Brazil. Total length and rostral length of the eight larvae obtained were measured under a Zeiss Stemi SV6 stereoscope with a micrometer ruler (precision 0.1 mm). Rostral length was measured from the rostral tip to the point of eye-stalk insertion. Total length was measured from the rostral tip to the posteriormost edge of the telson, excluding setae. Larval stages were established according to the

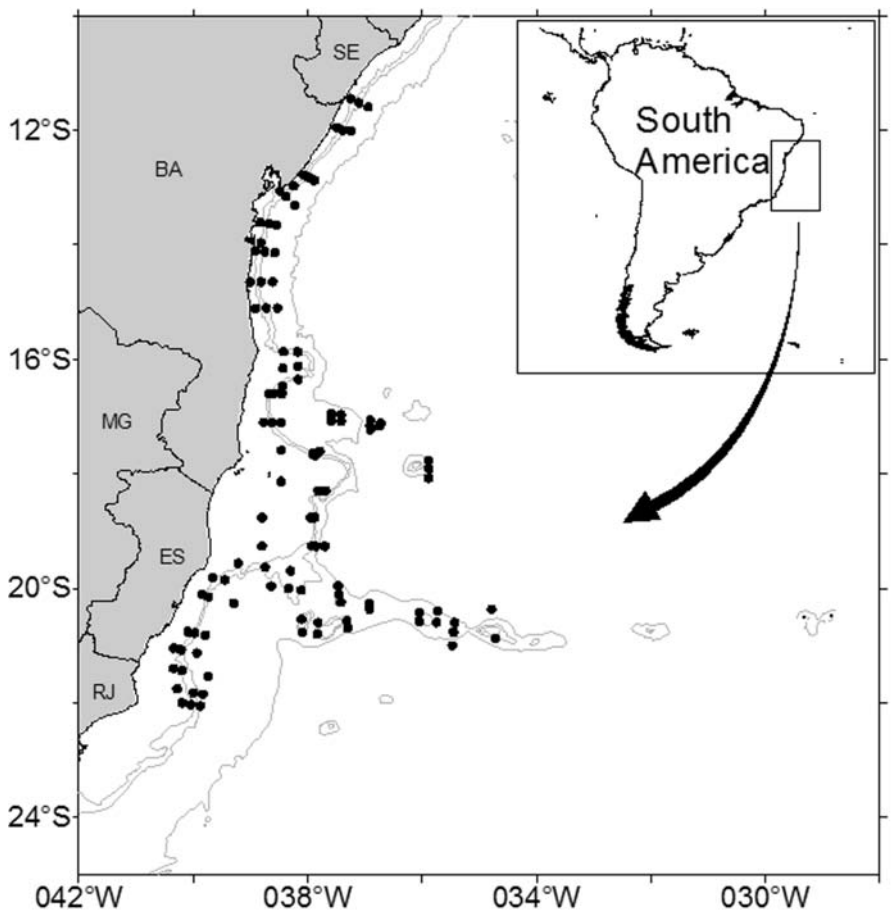

Fig.1- Map of the 114 sampling locations (•) including those stations where *Microprosthema* sp.1 (triangles) and *Microprosthema* sp.2 (squares) larvae were recorded in the western South Atlantic Ocean.

degree of development of the larval appendages. Larval appendages were dissected under an Olympus SZX12 stereoscope. Illustrations of the larvae and their appendages were made using a Zeiss Stemi SV6 stereoscope and a Zeiss Axiostar Plus optical microscope, all equipped with drawing tubes. Only well-preserved appendages with no trace of injury were completely described.

SYSTEMATICS

Suborder PLEOCYEMATA Burkenroad, 1963
Infraorder STENOPODIDEA Claus, 1872
Family Spongicolidae Schram, 1986
Genus *Microprosthema* Stimpson, 1860

Microprosthema Stimpson, 1860:44; Gurney & Lebour, 1941:169, fig.22; Martin & Goy, 2004:20, figs.1-2. Type species: by monotypy, *Microprosthema valida* Stimpson, 1860. Type locality: Ousima, Ryukyu Islands (Japan).

Stenopusculus Richters, 1880:167. Type species: by subsequent designation, *Stenopusculus crassimanus* Richters, 1880. Type locality: Seychelles Islands.

Diagnosis – Carapace with a post-rostral groove (cervical) and a medial groove; eyes triangular; supraorbital spine small or absent; mandible broad and proportionally strong; sixth abdominal somite longer than the other five somites together; pleural spine on at least one abdominal somite (except in stage I); antennal stylocerite small and with no spines; ventral spine on abdominal somite 5 small, straight and directed posteriorly (absent in some stages); first to third pereopod chelated; fourth and fifth pereopod with no exopod; first pleopod absent (except in the last stage).

Microprosthema sp.1
(Fig.2)

Material examined – BRAZIL: *Bahia*: "Arquipélago de Abrolhos", Revizee, RV THALASSA, stn T5058, 17.65°S, 37.91°W, 0–200m, DZUFRJ 971, 1 *zoea* V; stn T5067, 17.60°S, 37.79°W, 0–200m, DZUFRJ 400, 2 *zoea* VIII.

Diagnosis – Rostrum about same length as carapace; pleural spines present on abdominal somites 1 to 3.

Description.
Zoea V (fig.2Q) – TL=4.1mm; RL=0.9mm; (n=1). *Carapace* – with two dorsal grooves (cervical groove) and punctate; rostrum shorter than antennal peduncle, about same length as carapace, smooth and slightly up-turned towards its end; posterior margin of carapace partly covering first abdominal somite; eyes prominent, triangular, and stalked; supra-orbital spine small. *Abdomen* – sixth somite longer than the other five somites together; somites 1 to 3 with pleural spines; ventral spine on somite 5 straight and small; dorsal spine on abdominal somite 6. *Antennule* – elongated, with a 2-jointed peduncle; inner and outer ramus bulb-like, almost the same length. *Antenna* – peduncle small; outer ramus a scale with 15-17 setae; inner ramus stout and unjointed. *Mandible* – broad and strong. *Maxillule* – consisting of 2 inner lobes, the proximal coxopod and the distal basipod bearing 2 cuspidate setae and 3 plumose setae each. *Maxilla* – protopod with 4 inner lobes, the first and second closest and bearing 5 and 1 setae; the other lobes bearing 3 setae each; scaphognathite with 5 marginal setae, the last larger than the others; endopod with 3 terminal setae. *Maxilliped 1* – protopod 2-segmented, with 2 long setae on proximal (coxal) article and 4+3+3 setae on the distal (basal). *Maxillipeds 2* and *3* – well developed, with setose exopod, but with no well-preserved setae to be described. *Pereopods 1, 2* and *3* – well developed and biramous; exopod with 6 setae; endopod 5-jointed and chelated. *Pereopods 4 and 5* – as small buds below the carapace. *Pleopods* – as small buds on somites 2 to 5 (absent on somite 1). *Uropod* – outer ramus with immovable terminal spine and many marginal setae; inner ramus smaller and with many marginal setae. *Telson* – lateral margin parallel and smooth; posterior margin with 5+5 processes, outermost process a small tooth, second process a small seta (like an anomuran hair) and third to seventh processes consisting of long, plumodenticulate setae.

Zoea VIII (fig.2A) – TL=4.3-4.7mm; RL=0.8mm; (n=2). *Carapace* – with two dorsal grooves, less conspicuous than previously; rostrum shorter than antennal peduncle, about the same length as carapace, smooth, and slightly down-turned at the tip; posterior margin of carapace partly covering the first abdominal somite; eyes prominent, triangular, and stalked; supra-orbital spine reaching the eyes. *Abdomen* – sixth somite still longer than the other five somites together; somites 1 to 3 with pleural spines; ventral spine on somite 5 straight, small and back-turned; dorsal spine on abdominal somite 6. *Antennule* (fig.2G) – elongate with a 2-jointed peduncle, the proximal article bearing 3 setae on the inner margin and a small crown at about the middle point on the outer margin; the distal article bears 2 setae; inner ramus bulb-like, smaller than

outer ramus and with 3 apical setae; outer ramus similar, with 2 apical aesthetascs. *Antenna* (fig.2H) – peduncle small, 2-segmented; outer ramus a scale with 20-22 setae; inner ramus stout and weakly 2-segmented, the apex seeming to bear setae. *Mandible* – broad and strong, as previously. *Maxillule* (fig.2F) – consisting of 2 inner lobes, the proximal coxopod with 4 cuspidate setae and 6 plumose setae and the distal basipod with 4 cuspidate setae and 5 plumose setae; endopod consisting of a small tooth. *Maxilla* (fig.2E) – protopod with four inner lobes, the first and second closest and bearing 8 and 3 setae; the other lobes bearing 6 setae each; scaphognathite with 14 marginal setae, the last seta larger than the others; endopod unjointed, with 3 terminal setae. *Maxilliped 1* (fig.2I) – protopod 2-segmented, with small epipod on outer margin; proximal (coxal) article with 2 long setae; distal (basal) article bears 4+6+5 setae; exopod with 4 setae; endopod 3-segmented, with 2+2+4 setae. *Maxilliped 2* (fig.2J) – protopod with 3 setae; exopod with 4 setae; endopod 5-segmented with 2+1+0+2+5 setae. *Maxilliped 3* – well developed, with setose exopod (6 setae) and 5-jointed endopod, but with no well-preserved setae to be described. *Pereopods 1, 2* and *3* (figs.2K-M) – well developed and biramous; exopod with 6 setae; endopod 5-jointed and chelated, with 2 setae on dactylus. *Pereopods 4 and 5* (figs.2N-O) – uniramous, longer than pereopods 1-3 and enlarged at the tip. *Pleopods* – first pleopod absent; second (fig.2P) to fifth pleopods biramous. *Uropod* (fig.2B) – outer ramus with terminal immovable spine and many marginal setae; inner ramus smaller, with many marginal setae. *Telson* (figs.2C-D) – lateral margin parallel and smooth; posterior margin with 5+5 processes, outermost process a small tooth, second process a small seta (like an anomuran hair) and third to fifth processes consisting of long, plumodenticulate setae.

Microprosthema sp.2
(Fig.3)

Material examined – BRAZIL: *Bahia*: "Arquipélago de Abrolhos", Revizee, RV THALASSA, stn T5056, 17.64°S, 37.84°W, 0–200m, DZUFRJ 723, 1 *zoea* VI. *Espírito Santo*: "Banco Jaseur", Revizee, RV THALASSA, stn T5107, 20.40°S, 35.73°W, 0–200m, DZUFRJ 1107, 1 *zoea* IV.

Diagnosis – Rostrum very small, about half length of carapace; pleural spines on abdominal somites 2 and 3.

Description.
Zoea IV – TL=5.2mm; RL=0.6mm; (n=1) the single larvae was damaged and could not be completely described, except in regard to the following characters: the body bent at about a right angle at abdominal somite 3; carapace with 2 dorsal grooves; rostrum very short, about half length of carapace and not reaching beyond antennal peduncle; supraorbital spine reaches the eyes; pleural spines on abdominal somites 2 and 3, those on the second somite the largest; small ventral spine on abdominal somite 5; dorsal spine present on abdominal somite 6; pereopods 1 to 3 with small chelated endopods; pereopods 4 or 5 as small buds; pleopods absent.

Zoea VI (fig.3A) – TL=7.2mm; RL=0.7mm; (n=2). *Carapace* – with two dorsal grooves; rostrum very short, about half length of carapace and not reaching beyond the antennal peduncle; supraorbital spine reaches the eyes. *Abdomen* – sixth somite longer than the other five somites together; somites 2 and 3 with pleural spines, those on the second somite the largest; small ventral spine on abdominal somite 5; dorsal spine on abdominal somite 6. *Antennule* (fig.3C) – elongate, with a 2-jointed peduncle, the proximal article bearing 5 setae on the inner margin and a small crown about the middle point on the outer margin; the distal article bears 3 setae on inner margin and 5 apical; inner ramus bulb-like, smaller than outer ramus and with 1 apical setae; outer ramus similar, with 2 apical and 4 sub-apical aesthetascs. *Antenna* (fig.3B) – peduncle small; outer ramus a scale with 18 setae; inner ramus stout, 2-segmented. *Mandible* – broad and strong. *Maxillule* (fig.3D) – consisting of 2 inner lobes, the proximal coxopod with 4 cuspidate setae and 7 plumose setae and the distal basipod with 5 cuspidate setae and 3 plumose setae; endopod as a small tooth. *Maxilla* (fig.3E) – protopod with 4 inner lobes, the first and second closest and bearing 11 and 2 setae; the other lobes bearing 5 setae each; scaphognathite with 16 marginal setae, the last larger than the others; endopod unjointed, with 3 terminal setae. *Maxilliped 1* (fig.3F) – protopod 2-segmented, with 3 long setae on the proximal (coxal) article and 3+4+5 setae on the distal (basal); exopod with 4 setae; endopod 3-segmented with 2+2+4 setae. *Maxilliped 2* (fig.3G) – protopod with 3 setae; exopod with 8 setae; endopod 5-segmented, with 2+1+0+3+6 setae. *Maxilliped 3* (fig.3H) – protopod with 1 seta; exopod with 6 setae; endopod 5-segmented, with 2+1+0+2+6 setae. *Pereopods 1, 2* and *3* (figs.3I-K)– well developed and biramous; exopod with 8 setae; endopod 5-jointed and chelated, with 3 setae on dactylus. *Pereopods 4* (fig.3L) *and 5* – uniramous and not fully developed. *Pleopods* – first pleopod absent; second to fifth pleopods small buds. *Uropod* – small spine present

on the base; outer ramus with immovable terminal spine and many marginal setae; inner ramus smaller, with many marginal setae. *Telson* – lateral margin parallel and smooth; posterior margin with 5+5 processes, outermost process a small tooth, second process a small seta (like an anomuran hair) and third to fifth processes consisting of long, plumodenticulate setae.

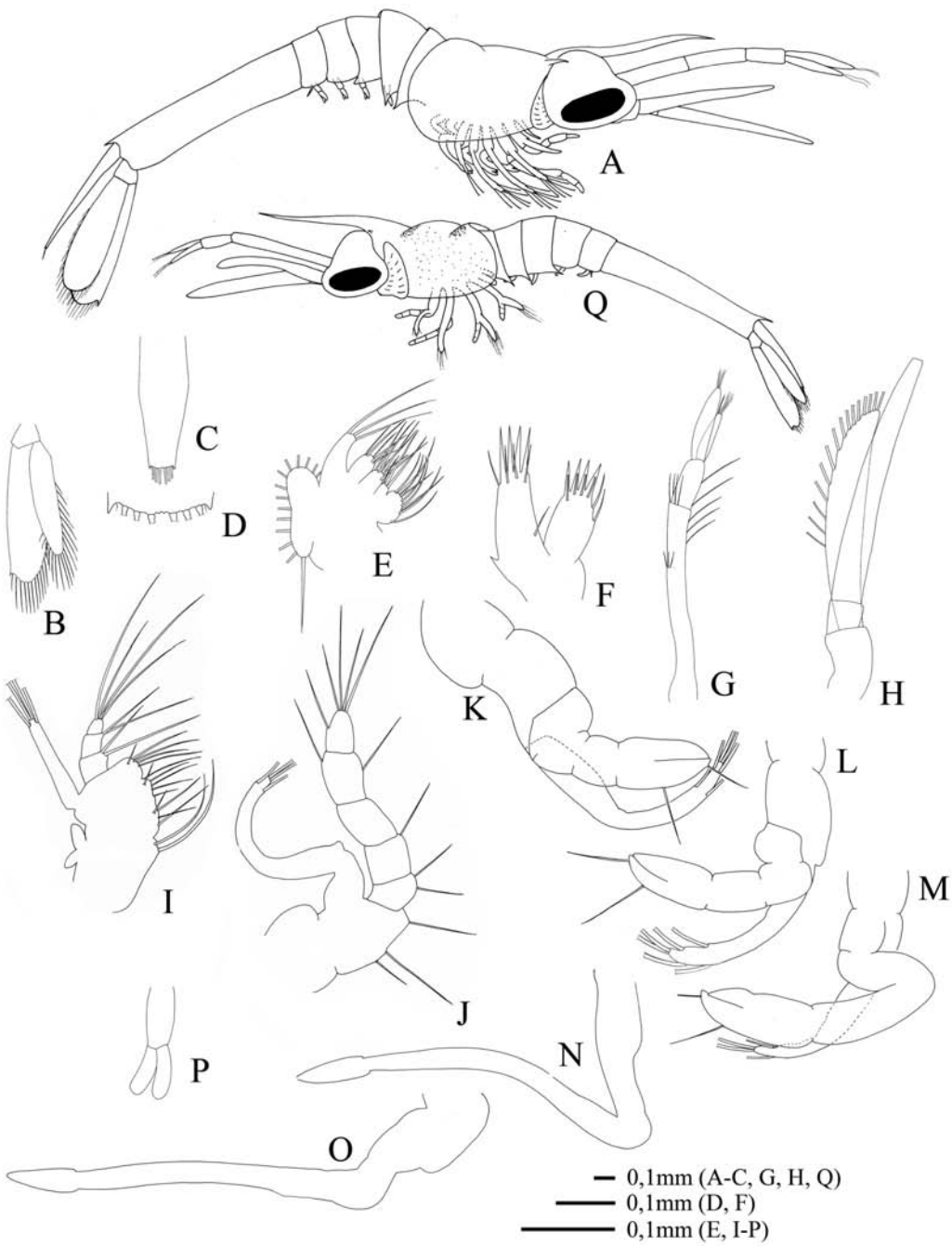

Fig.2- *Microprosthema* sp.1, *zoea* VIII (DZUFRJ 400). A, lateral view; B, uropod; C, telson; D, posterior margin of telson; E, maxilla; F, maxillule; G, antennule; H, antenna; I, first maxilliped; J, second maxilliped; K, first pereopod; L, second pereopod; M, third pereopod; N, fourth pereopod; O, fifth pereopod; P, second pleopod; Q, *Microprosthema* sp. 1, *zoea* V (DZUFRJ 971).

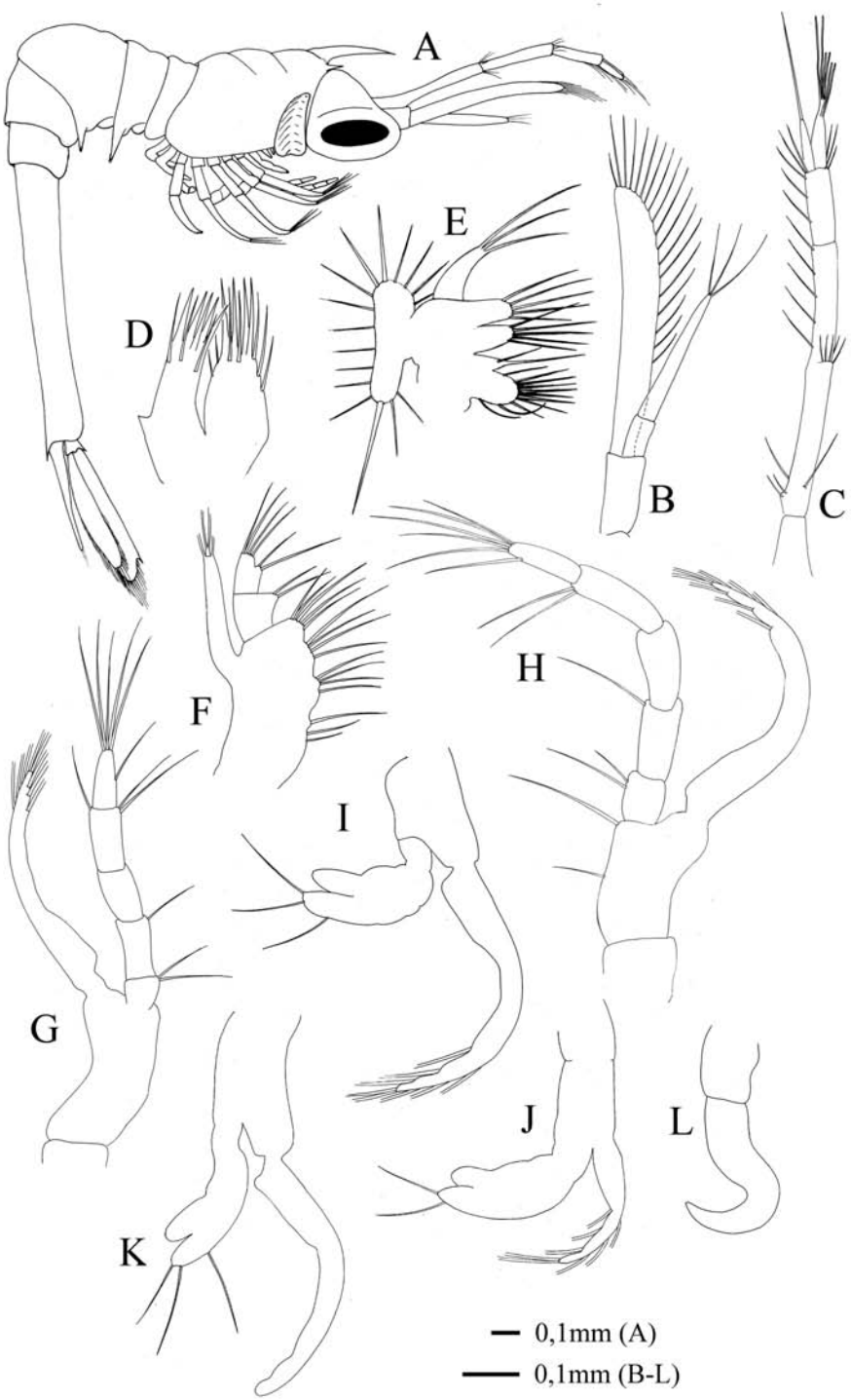

Fig.3- *Microprosthema* sp.2, *zoea* VI (DZUFRJ 723). A, lateral view; B, antenna; C, antennule; D, maxillule; E, maxilla; F, first maxilliped; G, second maxilliped; H, third maxilliped; I, first pereopod; J, second pereopod; K, third pereopod; L, fourth pereopod.

DISCUSSION

Spongicolidae are small shrimps commonly found in association with coral reefs and sponges in tropical and temperate areas the world over (Holthuis, 1993). Among the five described genera (*Microprosthema* Stimpson, 1860; *Spongicola* de Haan, 1844; *Spongicoloides* Hansen, 1908; *Spongiocaris* Bruce & Baba, 1973; and *Paraspongicola* de Saint Laurent & Cleva, 1981), only *Microprosthema* was recorded in Brazil until now. Many species of these genera are distributed worldwide, mainly in tropical and subtropical waters, with the exception of *Paraspongicola*, which is restricted to the Indo-Pacific (Saito & Takeda, 2003).

Adults of *Microprosthema semilaeve* have been recorded, in Brazil, in shallow waters off the states of Pernambuco and Bahia, and off Fernando de Noronha Island (Coelho & Ramos-Porto, 1998; Coelho *et al.*, 2006). According to Martin & Goy (2004), four other species of *Microprosthema* occur in the western North Atlantic and Caribbean: *Microprosthema granatense* Criales, 1997; *M. manningi* Goy & Felder, 1988; *M. looensis* Goy & Felder, 1988; and *M. jareckii* Martin, 2002. Three additional members of Spongicolidae are known from the western North Atlantic (Saito & Takeda, 2003): *Spongicola cubanica* Ortiz, Gomez & Lalana, 1994; *Spongiocaris hexactinellicola* Berggren, 1993; and *Spongicoloides inermis* (Bouvier, 1905). According to Martin & Goy (2004), *Microprosthema inornatum* Manning & Chace, 1990, described from Ascension Island (07°55´S – 014°19´W), can be found in the western North Atlantic, increasing to nine the number of species in the area.

Complete larval development of any Spongicolidae is still unknown. The first stage of *Microprosthema semilaeve*, hatched in the laboratory, was obtained recently by Martin & Goy (2004). Other descriptions of *Microprosthema semilaeve* were done using field-caught larvae collected in the plankton of the North Atlantic and Indian oceans (Gurney & Lebour, 1941; Williamson, 1976; Raje & Ranade, 1978). These larvae are very similar to our *Microprosthema* sp.1 and share the diagnostic characters attributed herein to the genus *Microprosthema*, except the pointed pleuras of abdominal somites 1 to 3. Martin & Goy (2004) also noted the morphological similarities between the first stage of *M. semilaeve* that they described, from Guana Island and Sombrero Key, and that of Raje & Ranade (1978), but concluded that the Indian specimens belong to an undescribed species of *Microprosthema*. Morphological variations are commonly found within and between populations of *Microprosthema semilaeve*, which can make larval identification doubtful. Misidentification of field larvae can be avoided when there is correspondence between adult and larval distributions.

Other characters shared by the larvae attributed to *Microprosthema* or a related genus by Gurney & Lebour (1941: species B, C, E and F), Williamson (1976: species Ind. 5), Raje & Ranade (1978), Martin & Goy (2004) and herein are: small length, usually less than 8mm; rostrum about the same length or shorter than the carapace; absence of spine on the posterior margin of the carapace; absence of a dorsal spine on abdominal somites 1-5; small ventral spine present on abdominal somite 5; and development of uniramous first pleopod only in the last stage.

Larvae identified as *Microprosthema* sp.1 are very similar to Lebour Stenopid C (Gurney & Lebour, 1941), and also to the first stage of *M. semilaeve* described by Martin & Goy (2004). According to Williamson (1976), Lebour Stenopid B and C share enough resemblances to *Microprosthema semilaeve* to be included in the same genus. The supra-orbital spines observed in the larval stages of Stenopid C (II to IV) described by Gurney & Lebour (1941), but absent in the first stage described by Martin & Goy (2004), could be related to differences in stages. According to Gurney (1924), such spines develop in Stenopodidea only in the second stage. Similarly, pleural spines on abdominal somites 1 to 3 can also be observed in Lebour Stenopid C, and were used by her to distinguish between her morphotypes B and C, the former with pleural spines only on abdominal somites 2 and 3. The absence of such spines in Guana Island specimens, their presence on abdominal somites 2 and 3 in Sombrero Key specimens, on abdominal somites 1 and 2 in Indian specimens, and on abdominal somites 1 to 3 in our specimens indicate that these differences could result from within- or between-population variations of the same species. Gurney (1936), describing Stenopid I from plankton collected by the *Discovery* in the South Atlantic and by the *Atlantis* in the North Atlantic, found some larvae with pleural spines on abdominal somites 1, 2 and 3, and some with pleural spines only on 2 and 3, which he assumed to be inter-specific. In addition, this highly variable character should not be considered in isolation. All the larvae found in Brazil untill now have pleural spines on at least one abdominal somite, and one of these must belong to *Microprosthema semilaeve*. If not, there are two undescribed species of Spongicolidae in the northeast region of Brazil.

The occurrence in Brazil of only one species of Spongicolidae (Coelho *et al.*, 2006) and the similarities with the first stage described by Martin & Goy (2004) led us to ascribe *Microprosthema* sp.1 and Lebour Stenopid C to *Microprosthema semilaeve*. These larvae share the following characters: rostrum about the same length as the carapace; pleural spines on abdominal somites 1 to 3; ventral spine on somite 5 straight and directed backward; first, second and third pereopods chelate and with setose exopod; fourth and fifth pereopods uniramous; first pleopod absent at least until stage V. In contrast, larvae of *Microprosthema* sp.1 are longer than Stenopid C and have no spines on the lateral margin of the telson.

Larvae of *Microprosthema* sp.2 are similar to those described by Gurney (1936) as Stenopid I and by Gurney & Lebour (1941) as Stenopid B, mainly in the following: small rostrum, half length of carapace; pleural spines on abdominal somites 2 and 3; ventral spine on abdominal somite 5 absent; two dorsal grooves on carapace. According to Gurney & Lebour (1941), this is a highly abundant larva in the plankton of the Bermudas, frequently more abundant than *Stenopus hispidus*, and which was collected also in the South Atlantic (Gurney, 1936).

Development of Spongicolidae seems to be abbreviated or direct in some species, as observed in *Spongicola japonica*, *Spongicola venusta*, and *Spongicoloides koehleri* (Bate, 1888; Kemp, 1910; Seridji, 1990; Saito & Konishi, 1999). The late embryo of *Spongicola venusta* described by Bate (1888: pl. XXIX, fig.2V) and the first larva drawn by von Willemoes-Suhm (Bate, 1888:216, fig.42) had appendages that are normally found later in development. Unfortunately, the rostra of these larvae were not illustrated, so the proportion between rostral length and total length could not be estimated. On the other hand, the larval development of *Microprosthema semilaeve* is thought to include nine stages (Gurney & Lebour, 1941), and consequently seems to be extended when compared to other members of Spongicolidae. Of the five larvae described, two had pereopods 4 and 5 as simple buds, two had small pleopods, and only one had biramous pleopods, indicating that there are several larval stages in the development. Therefore, the differences in appendage development also suggest that these larvae belong to a genus with many stages, probably *Microprosthema*.

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