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Morphological remarks on the peppermint shrimp *Lysmata ankeri* (Decapoda, Hippolytidae): implications for species identification of the *L. wurdemanni* complex

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ABSTRACT - This contribution reviews the morphology and the main diagnostic characters of the peppermint shrimp *Lysmata ankeri*. Individuals were sampled by scuba divers from August 2008 to June 2013 on the subtidal rocky bottom at Couves Island, on the coast of São Paulo State, Brazil. In the laboratory, the individuals were analyzed morphologically, with emphasis on the characters used in the diagnosis of the species; measured as carapace length (CL); and photographed. Seventeen individuals of *L. ankeri* were analyzed with an average size of 6.9 ± 2.0 mm CL. From the morphological analysis the following variations of the diagnosis were observed: five teeth on the dorsal margin of the rostrum, in the diagnosis this was 6-8; five spines on the flexor margin of the dactyli of pereiopods 2-4, in the diagnosis this was 3-4. The records of this study extend the knowledge of the variation of some morphological characteristics for this species, resulting in an overlap among the species of the *Lysmata wurdemanni* complex.

Key words: Caridea, Hippolytidae, Lysmatidae, Morphology, Peppermint shrimp.

Introduction

The genus *Lysmata* Risso, 1816, belongs to the family Hippolytidae Spence Bate, 1888 (*sensu* Chace, 1997) and contains about 40 described species (Chace, 1997; Rhyne and Lin, 2006; Rhyne and Anker, 2007; Baeza and Anker, 2008; Anker *et al.*, 2009; De Grave and Fransen, 2011), of which at least 12 species occur in the western Atlantic (Chace, 1972; Rhyne and Lin, 2006). Several studies in the last decade have provided new information, describing new species and reviewing the geographic distribution of this genus (e.g. Wicksten, 2002a; 2002b; Rhyne and Anker, 2007; Baeza and Anker, 2008; Anker *et al.*, 2009; Laubenheimer and Rhyne, 2010).

The genus *Lysmata* can be distinguished from other genera by its moderately slender body, a long and thickened second pereiopod with a multi-articulated carpus, the rostrum armed with teeth on both dorsal and ventral margins, the well-developed arthrobranchs and exopods on the third maxilliped and the absence of a supraorbital spine (Abele and Kim, 1986; Holthuis, 1993; Chace, 1997).

These shrimps can display different and, in some cases, striking color patterns, which can be also used for species identification, such as *Lysmata amboinensis* (De Man, 1888) and *Lysmata grabhami* (Gordon, 1935) (Lin, 2004). However, the identification by means of the color pattern should be used with caution, since the coloration can be lost in animals preserved in formalin or

alcohol solutions. Furthermore, differences can be subtle; for example, the species belonging to the *Lysmata wurdemanni* complex (Gibbes, 1850), which have a color pattern consisting of semi-translucent bodies with longitudinal and lateral red bands (Rhyne and Lin, 2006).

Based on a revision of the species of the *L. wurdemanni* complex, Rhyne and Lin (2006) described four species: *Lysmata ankeri*, *Lysmata bahia*, *Lysmata boggessi* and *Lysmata pederseni*, and redescribed two species, *Lysmata rathbunae* Chace, 1970 and *L. wurdemanni*, all restricted to the western Atlantic. In addition, *Lysmata udoi* was described by Baeza *et al.* (2009a), but its morphology and color pattern suggest that this species also belongs to the *L. wurdemanni* complex.

Rhyne and Lin (2006) proposed a key for identification of the species pertaining to the *L. wurdemanni* complex, based on distinct morphological characteristics. Although these morphological characteristics present a wide variation for most of the species of the *L. wurdemanni* complex, they still have a great taxonomic importance (Rhyne and Lin, 2006). Thus the constant revision and expansion of such morphological variations is essential to ensure the correct identification of the species. In this study we reviewed the morphology of the main diagnostic characters of *L. ankeri* obtained on the northern coast of São Paulo State, southeastern Brazil.

Material and Methods

Specimens of *Lysmata ankeri* (Fig. 1) were sampled during collections of other decapod crustaceans from August 2008 to June 2013 on the subtidal rocky bottom at Couves Island (23°25'15"S 44°51'39"W), Couves Archipelago, Ubatuba, Brazil. Samples were taken during daytime sessions of scuba diving, conducted by two divers from five to 15 m depth.

In the laboratory, the individuals were identified according to Rhyne and Lin (2006). Each specimen was measured for the rostrum (RL) and carapace length (CL), using a stereomicroscope equipped with an imaging and measurement tool (Zeiss Stemi DV4, accuracy 0.01 mm). Each specimen of *L. ankeri* was analyzed for the diagnostic morphological characters presented by Rhyne and Lin (2006).

The specimens were deposited in the Scientific Collection of Carcinology, Laboratory of Marine Biology, University of Taubaté and in the Carcinological Collection of the Museum of Zoology of the University of São Paulo (MZUSP 32641, two specimens).

Results

A total of 17 individuals of *Lysmata ankeri* were sampled on the rocky bottom and in crevices and natural burrows formed by the rocks. The individuals were apparently solitary, or in small or large groups (fewer than 10 individuals or more than 30 individuals, respectively). Other shrimps of the *Lysmata wurdemanni* complex live in groups, such as *L. wurdemanni*, *Lysmata boggessi*, *Lysmata bahia* and *Lysmata udoi*. However, some species, such as *L. udoi* and *Lysmata pederseni,* show symbiotic behavior (e.g. living in association with fishes and sponges) (Rhyne and Lin, 2006; Baeza *et al.*, 2009a; 2009b; Baeza, 2010).

The CL ranges from 3.6 ≤ 10.3 mm (mean 6.9 ± 2.0 mm CL) and RL from 2.8 to 8.2 mm (mean 5.4 ± 1.6 mm RL) (n = 13). Rostrum 0.65-0.9 times as long as carapace, rarely reaching the end of third segment of antennular peduncle; dorsal margin of rostrum with 5-7 teeth (predominantly six) (Fig. 2A-C); ventral margin of rostrum with 3-6 teeth (predominantly four) (Fig. 2A-C). Carapace robust, three-fourths as high as long, forming an obtuse angle at most ventral margin; ventro-posterior margin of carapace not well rounded, flattened posteriorly. Eyes large, covering the dorsal surface of rostrum. Antennule with stylocerite reaching just beyond distal margin of eye. Antennal scale with a disto-lateral tooth, 3.4-4.5 times as long as wide. Carpus of second pereiopod with 32-35 segments. Third-fifth pereiopods with dactyli biunguiculate; flexor margin with 2-4 spines (Fig. 2D-F). Fifth pereiopod with merus armed with 0-6 spines. Color in life - Body semi-translucent with red longitudinal, transverse, and oblique bands and stripes; carapace with broad and narrow oblique and transverse bands, some forming shallow U or V; abdominal pleura with narrow longitudinal stripes; telson and uropods with relatively narrow longitudinal stripes (see Fig. 1 A, B).

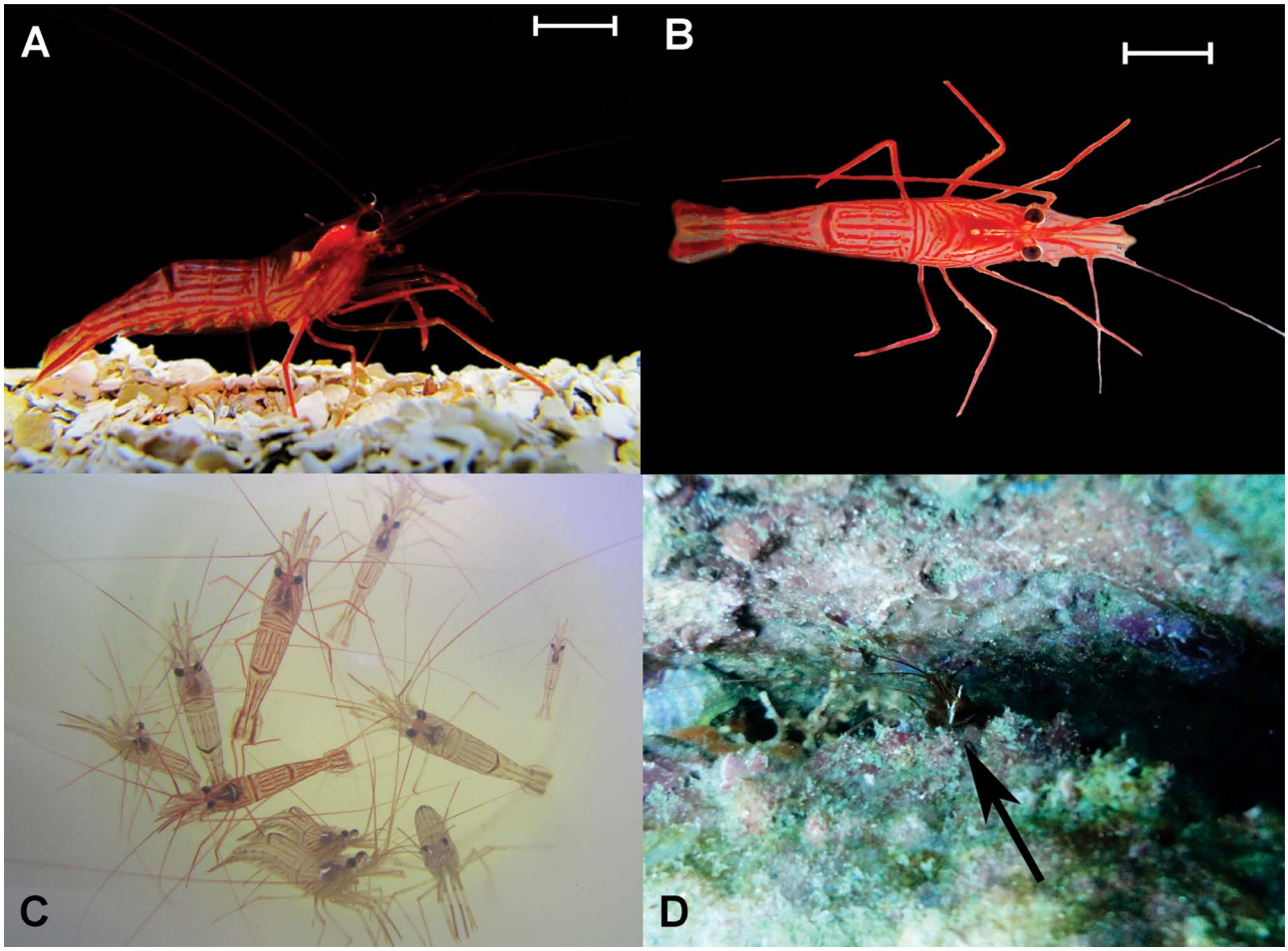

Figure 1. *Lysmata ankeri.* (A) Lateral view; (B) dorsal view; (C) some specimens in the laboratory after sampling; (D) an individual (indicated by the arrow) in rock crevice at the sampling site, on the subtidal rocky bottom at Couves Island, Ubatuba, Brazil (Photographs: DFR Alves). Scale bars = 5 mm.

Discussion

The identification of shrimp used in this study was confirmed from different characters identified by Rhyne and Lin (2006). Among the characters that support this identification we can mention: 1) rostrum rarely reaching the end of third segment of antennular peduncle; 2) number of teeth in the ventral margin of rostrum; 3) number of spines in the merus of the fifth pereiopod; 4) number of segments in the carpus of the second pereiopod; 5) color pattern; 6) ecological remarks (see Tab. 1).

However, for two morphological characteristics, differences were recorded in relation to the diagnosis of *Lysmata ankeri*: 1) five teeth on the dorsal margin of the rostrum (6-8 teeth in the diagnosis) and 2) two spines on the flexor margin of the dactyli of pereiopods 3-5 (3-4 spines in the diagnosis). It is noteworthy that these specimens were in perfect condition, with no signs that the rostrum could have been broken or was regenerating.

Based on these data, we suggest the expansion of the lower limit of the variation in the dentition of the dorsal surface of the rostrum and the spines on the flexor margin of the dactyli, proposed in the diagnosis of this species by Rhyne and Lin (2006). Thus, *L. ankeri* may have five teeth on the dorsal margin of the rostrum, similarly to *Lysmata boggessi*, *Lysmata rathbunae*, *Lysmata udoi* and *Lysmata wurdemanni;* and it may also have two spines on the flexor margin of the dactyli of pereiopods 3-5, similarly to *Lysmata bahia*, *Lysmata pederseni*, *L. udoi* and *L. wurdemanni* (Rhyne and Lin, 2006; Baeza *et al.*, 2009a) (see Tab. 1).

Many species descriptions are based on a small number of specimens, from one or a few localities. Indeed, the total variation in morphological diagnostic characters may be unknown (e.g. Burukovsky, 2000; Rhyne and Anker, 2007; Okuno and Fiedler, 2010).

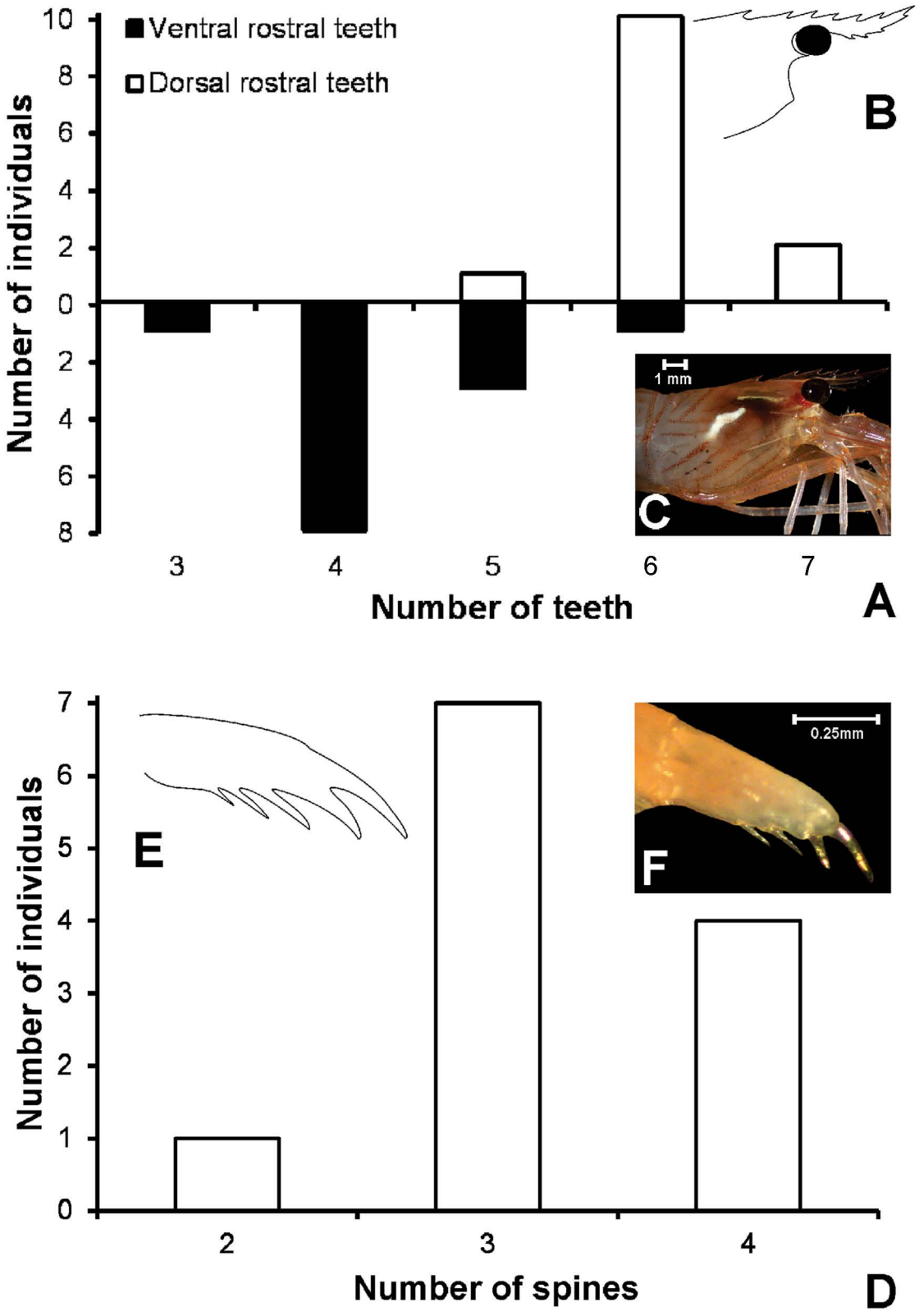

Figure 2. *Lysmata ankeri.* (A) Variation in the number of rostral teeth on the dorsal and ventral margins; (B) predominant rostral dentition; (C) dorsal rostral dentition with 5 teeth (Photograph: DFR Alves); (D) variation in the number of spines on the flexor margin of the dactylus of the pereiopod; (E) dactylus with the predominant number of spines; (F) dactylus with 2 spines (Photograph: DFR Alves).

Table 1. Comparison of morphological characteristics of *Lysmata ankeri* captured on the subtidal rocky bottom at Couves Island, northern coast of São Paulo State with other species on the on the *Lysmata wurdemanni* complex.

Characteristics	*Lysmata ankeri*[1]	*Lysmata ankeri*[2]	*Lysmata bahia*[2]	*Lysmata boggessi*[2]	*Lysmata pederseni*[2]	*Lysmata rathbunae*[2,3]	*Lysmata udoi*[4]	*Lysmata wurdemanni*[2]
Rostrum length	0.65-0.9 times as long as carapace, reaching usually to middle, rarely past the end of third segment of antennular peduncle	0.6-0.8 times as long as carapace, reaching usually to middle, rarely past the end of third segment of antennular peduncle	0.5 times as long as carapace, reaching level of middle of intermediate segment of antennular peduncle	0.6-1.0 (rarely > 0.8) times as long as carapace, reaching at least to middle, or to distal margin of intermediate segment of antennular peduncle	0.7-1.1 times as long as carapace, reaching at least level of end of distal segment of antennular peduncle	Long, reaching beyond distal margin of third segment of antennular peduncle	0.9 times as long as carapace, slightly surpassing end of antennular peduncle	0.4-0.7 times as long as carapace, reaching at least to middle of intermediate segment of antennular peduncle
Number of dorsal rostral teeth	5-7	6-8	6-7	4-5 (rarely 3 or 6)	7-8 (rarely 9, 10 or 11)	5-6	6	4-6
Number of ventral rostral teeth	3-6	3-7	3-4	3-5 (rarely 2, 6 or 7)	5-7 (rarely 8 or 9)	3-5	5	4 (rarely 2, 3, 5, or 6)
Number of spines on merus of pereiopod 5	3-5	0-6	1-6	3-6	3-6	3-5	3	1-4
Number of carpal segments on pereiopod 2	33-35	33-41	29-31	25-32	33-41	30-35	20	27-30
Number of spines on the flexor margin of the dactylus of pereiopods 3-5	2-4	3 (rarely 4)	2 (rarely 3)	4-5 (rarely 3 or 6)	3 (rarely 2)	3-4 (usually 3)	7	3 (rarely 2 or 4)

References: [1] Present study; [2] Rhyne & Lin (2006); [3] Baeza *et al.* (2009a); [4] Chace (1970).

For example, Laubenheimer and Rhyne (2010) described a new species of peppermint shrimp, *Lysmata rauli*, and in a subsequent study, Soledade *et al*. (2013) showed, based on morphological characters, color pattern and genetics, that *L. rauli* is not a new species endemic to Brazil but rather is a junior synonym of *Lysmata vittata* (Stimpson, 1860) from the Indo-Pacific.

This study contributes to the expansion of the variation limits of the number of teeth on the dorsal margin of the rostrum and the number of spines on the flexor margin of the dactyli in *L. ankeri*. Recognition of the morphological variation is useful for the correct identification of individuals from *L. wurdemanni* complex (Rhyne and Lin, 2006; Anker *et al*., 2009). Thus, we encourage continuous reviews of diagnostic morphological characters for the largest possible number of individuals obtained throughout the geographic distribution of a species.

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