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ARTICLE

A description of the first zoeal stage of *Pilumnus vinaceus* A. Milne-Edwards, 1880 (Decapoda, Pilumnidae), with a revision of the first zoea morphology of *Pilumnus* Leach, 1815

Douglas Fernandes Rodrigues Alves[1,4]; João Alberto Farinelli Pantaleão[2,5]; Rogério Caetano Costa[3,6] & Fernando Luis Mantelatto[2,7]

1 Universidade Federal de Uberlândia (UFU), Instituto de Biologia (INBIO), Laboratório de Ecologia de Ecossistemas Aquáticos (LEEA). Uberlândia, MG, Brasil.
2 Universidade de São Paulo (USP), Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto (FFCLRP), Departamento de Biologia (DB), Laboratório de Bioecologia e Sistemática de Crustáceos (LBSC). Ribeirão Preto, SP, Brasil.
3 Universidade Estadual Paulista "Júlio de Mesquita Filho" (UNESP), Faculdade de Ciências, Departamento de Ciências Biológicas, Laboratório de Biologia de Camarões Marinhos e de Água Doce (LABCAM). Bauru, SP, Brasil.
4 ORCID: https://orcid.org/0000-0003-4363-6511. E-mail: douglas_biologo@yahoo.com.br (correspondence author)
5 ORCID: https://orcid.org/0000-0003-0067-5465. E-mail: pantaleaojaf@gmail.com
6 ORCID: https://orcid.org/0000-0002-1342-7340. E-mail: rogerio.c.costa@unesp.br
7 ORCID: https://orcid.org/0000-0002-8497-187X. E-mail: flmantel@usp.br

Abstract. The morphology of the first zoeal stage of *Pilumnus vinaceus* is described and compared with the zoea I of *Pilumnus* all species in the literature. Two ovigerous females of *P. vinaceus* were maintained in the aquarium facilities until the larvae hatch. The larvae of each ovigerous female were dissected using a stereoscopic microscope. The zoea I of *P. vinaceus* has common characteristics among the Pilumnidae as: [1] antenna of type 2; [2] maxilliped 1 with 2+2+3+3 setae on the basis and with 3,2,1,2,5 setae in the endopod; [3] maxilliped 2 with 1+1+1+1 setae on the basis and 1,1,6 setae on the endopod; [4] telson with furcal rami armed with dorsal and lateral spines. Considering the species of *Pilumnus* that occur in the western Atlantic, it becomes possible to identify *P. vinaceus* zoea I by means of the verification of the following characteristics: [1] pleonites with mediolateral processes; [2] number of setae on the antennule. It is however, important to consider that there is still a great deficit in the knowledge about the morphology of the larval forms of the species assigned to *Pilumnus* and we argue in favor of new descriptions to build a more robust dataset on zoeal morphology characters and use it in a phylogenetic context on the genus.

Keywords. Brachyura; Hairy crabs; Larval development; Pilumnid; Western Atlantic.

INTRODUCTION

Pilumnus Leach, 1815 comprises about 150 species (Ng *et al.*, 2008; Magalhães *et al.*, 2021), popularly known as "hairy crabs" because they have many setae distributed over the carapace and/or pereiopods. These crabs are common in many coastal environments (*e.g.*, coral reefs [Garth, 1984; Giraldes *et al.*, 2015], rocky shores [Kyomo, 1999; Alves *et al.*, 2012; Moraes *et al.*, 2015], unconsolidated bottom [Melo *et al.*, 2000; Ng, 2000] and in association with invertebrates [Lindberg & Frydenborg, 1980; Alves *et al.*, 2012b; Alves *et al.*, 2013]), mainly in tropical regions, but also in temperate zones (Takeda & Miyake, 1969; Williams, 1984; Melo, 1996).

Pilumnus was retained in the Xanthoidea MacLeay, 1838 until about two decades ago (Martin & Davis, 2001; Karasawa & Schweitzer, 2006). Since then, all Pilumnidae Samouelle, 1819 have been assigned to Pilumnoidea Samouelle, 1819 (Ng *et al.*, 2008). Adult pilumnoid crabs share important morphological characteristics including: (1) all male abdominal segments freely articulating; (2) a long sinuous and/or slender first gonopod (G1); (3) a very short, sigmoidal second gonopod (G2); and (4) a penis which protrudes from the condyle of the fifth ambulatory coxa (Ng

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et al., 2008). The validity of Pilumnoidea has been supported by several studies based on molecular data (*e.g.,* Tsang *et al.,* 2014).

Despite the current stability in terms of the phylogenetic position of this genus, the taxonomy and systematics of the assigned species are still unsatisfactory (Guerao *et al.,* 2005; Magalhães *et al.,* 2021). The identification of *Pilumnus* species based on adult morphology is not always an easy task, as some species are very similar (Takeda & Miyake, 1969; Melo, 1996). As an example of systematic instability, *Pilumnus vinaceus* A. Milne-Edwards, 1880, previously considered to be a junior synonym of *P. dasypodus* by Rathbun (1897), was recently considered a valid species after a review based on integrative morphological and molecular data (Magalhães *et al.,* 2021). The knowledge of the larval morphology can be an important accessory tool in the search for solutions to problems of this systematics, as for many other decapod (Barros-Alves *et al.,* 2013; Clark & Cuesta, 2015; Magalhães *et al.,* 2017). In addition, larval forms of these crabs also may contribute to studies that seek to understand the structure of planktonic communities by providing information that allows the identification of its components.

Unfortunately, there is a great deficit of *Pilumnus* larval morphology knowledge because only 14 species have some larval forms described, representing less than 10% of the diversity of the genus. The larval morphology, complete or partial, was described in the following species and studies: *Pilumnus dasypodus* Kingsley, 1879 (Sandifer, 1974; Bookhout & Costlow-Jr., 1979); *P. hirtellus* (Linnaeus, 1761) (Salman, 1982; Ingle, 1983, 1992); *P. indicus* (Deb, 1987) (Terada, 1980); *P. kempi* Deb, 1987 (Siddiqui & Tirmizi, 1992; Clark & Ng, 2004); *P. limosus* Smith, 1869 (García-Guerrero *et al.,* 2005); *P. longicornis* Hilgendorf, 1878 (Clark & Paula, 2003); *P. lumpinus* Bennett, 1964 (Wear, 1967); *P. minutus* De Haan, 1835 (Aikawa, 1929, 1937; Ko, 1994); *P. novaezealandiae* Filhol, 1886 (Wear, 1967); *P. reticulatus* Stimpson, 1860 (Spivak & Rodríguez, 2002); *P. scabriusculus* Adams & White, 1849 (Terada, 1990); *P. sluiteri* De Man, 1892 (Clark & Ng, 2004); *P. spinifer* H. Milne Edwards, 1834 (Guerao *et al.,* 2005); and *P. vespertilio* (Fabricius, 1793) (Aikawa, 1929, 1937; Lim & Tan, 1981; Terada, 1990; Clark & Paula, 2003). In addition to the aforementioned species, there are others [*e.g., P. villosissimus* (Rafinesque, 1814) and *P. sayi* Rathbun, 1923] which larval morphology needs to be redescribed, since the studies present imprecise descriptions and/or did not distinguish the morphology of each larval stage (Chamberlain, 1961; Kurata, 1970). From this larval knowledge accumulated, there are only two species (*P. dasypodus* and *P. reticulatus*) from the western Atlantic region, which demonstrates the scarcity of information.

Based on this scenario, the description of the first zoeal stage of the hairy crab *P. vinaceus* is provided. *Pilumnus vinaceus* is widely distributed in the Western Atlantic Ocean, where it occurs along the USA (Texas, Florida), Caribbean Sea, Antilles, and Brazil (Piauí, Ceará, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina) (Mantelatto *et al.,* 2020; Magalhães *et al.,* 2021). This species inhabits unconsolidated sand bottoms, as well as consolidated bottoms of rocks and, mainly, corals, from five to 20 meters (Melo, 1996).

In addition to larval description, the morphology of zoea I is compared with all known *Pilumnus* larvae already described. In this comparison, although *P. indicus* has its positioning considered uncertain within the genus (*see* Ng *et al.,* 2008), it is included here in *Pilumnus.* Two other species (*P. lumpinus* and *P. novaezealandiae*), were excluded since both species have a larval development extremely abbreviated (Wear, 1967) and consequently quite different morphological characteristics from the group with extended larval development.

MATERIAL AND METHODS

Specimens were collected in two locations of the northeastern coast of the state of São Paulo, Brazil. In October 2012, one ovigerous crab was collected at Vitória Island (24°15′S, 46°59′W) from the municipality of Ilhabela, by hand for SCUBA diver on subtidal boulder fields. In January 2019, one ovigerous female was collected at Itaguá Beach, municipality of Ubatuba (23°27′07″S, 45°02′49″W). In the latter locality, the ovigerous female was found in association with the branching forms of the bryozoan *Schizoporella caudata* (Waters, 1878) (Ectoprocta, Cheilostomata) that was collected by hand during snorkeling sessions. Both ovigerous females were collected with embryos in an advanced stage of development (eye spots visible).

In the laboratory, the specimens were identified following a set of diagnostic characteristics (Melo, 1996; Magalhães *et al.,* 2021). Each ovigerous females were maintained in the aquarium facilities of both Laboratory of Biology of Marine and Freshwater Shrimp (LABCAM), at São Paulo State University (UNESP), campus of Bauru and Laboratory of Bioecology and Systematic (LBSC), at University of São Paulo (USP), campus of Ribeirão Preto (FFCLRP), until the larvae hatch. The incubation and larval rearing were carried out in individual 2-liter aquariums. The crabs were maintained at a temperature of 25 ± 1°C, a salinity of 35 ± 1 PSU and a photoperiod of 12L:12D. The water used in the aquaria was prepared using tap water purified by a reverse osmosis/DI unit and synthetic sea salt suitable for a marine aquarium (Coral Pro Salt, Red Sea).

The larvae of each ovigerous female were conserved in a mixture (1:1) of 80% ethyl alcohol and glycerin. Vouchers of the parental females and respective larvae are deposited in the Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP) and Crustacean Collection of the Biology Department (CCDB) of the Faculty of Philosophy, Sciences and Letters of Ribeirão Preto (FFCLRP) at the University of São Paulo (USP), respectively (catalog numbers: MZUSP 40081 and CCDB 4598).

Specimens were dissected using a stereoscopic microscope (Zeiss SV6) and mounted in glycerin on semipermanent slides. Observations, drawings, and measurements were made using a compound optical microscope (Zeiss Scope.A1 and Leica DM 1000), equipped with a drawing tube and ocular micrometer. The following measurements were taken: carapace length (CL), as measured from the base of the rostrum (between the eyes) to the posterior margin of the carapace; rostrodorsal length (RDL), as the distance from the tip of the rostral spine to the tip of the dorsal spine. All drawings and measurements were based on at least 10 larvae of each parental female.

Larval descriptions are based on the standards proposed by Clark *et al.* (1998) and updated by Clark & Cuesta (2015). Setal types follow the classification proposed by Garm (2004). The long terminal plumose natatory setae on the distal exopod segments of the first and second maxillipeds are truncated in the illustrations.

RESULTS

Pilumnus vinaceus **A. Milne-Edwards, 1880**
Zoea I (Figs. 1A-G; 2A-D)

Dimensions: CL: 0.23 ± 0.01 mm; RDL: 0.83 ± 0.01 mm (n = 10).

Carapace (Figs. 1A-C): dorsal spine longer than rostral spine, curved distally backward, without setae; rostral spine straight, shorter than antennal protopod; lateral spines well developed and smooth; 1 pair of posterodorsal simple setae; lateroventral margins with 8-10 denticles, without setae; eyes sessile.

Antennule (Figs. 1A, B, D): uniramous; primary flagellum unsegmented with 4 terminal aesthetascs (2 long and stout, 2 shorter and thinner) plus 2 small simple setae; accessory flagellum absent.

Antenna (Figs. 1A, B, E): uniramous, protopod well developed and long, with two rows of lateral spines unequal in size on distal half; endopod absent; exopod slightly longer than protopod, with one row of lateral spines unequal in size distally, with 1 pair of unequal medial setae.

Mandible (not drawn): incisor and molar process developed; palp absent.

Maxillule (Fig. 2A): uniramous; coxal endite with 7 sparsely plumose setae; basial endite with 2 cuspidate and 3 plumodenticulate setae, plus 2 setal buds, microtrichia on proximal margin; endopod 2-segmented, proximal article with 1 sparsely plumose seta; distal article with 6 (2 subterminal sparsely plumose, 2 terminal sparsely plumodenticulate and 2 terminal sparsely plumose) setae. Exopod and epipod setae absent.

Maxilla (Fig. 2B): biramous; coxal endite bilobed, with 5 + 4 sparsely plumose setae; basial endite bilobed, with 5 + 4 sparsely plumose setae; endopod bilobed, with 3 + 5 sparsely plumose setae; exopod (scaphognathite) with 4 marginal plumose setae and a stout distal process; microtrichia on distal margin of endopod, proximal margin of basial endite and distal process of the scaphognathite.

First maxilliped (Fig. 2C): biramous; coxa without setae; basis with 10 sparsely plumose setae (2+2+3+3); endopod 5-segmented with 3 sparsely plumose, 2 sparsely plumose, 1 sparsely plumose, 2 sparsely plumose and 5 (1 subterminal simple and 4 terminal sparsely plumose) setae, respectively; exopod 2-segmented, distal article with 4 long terminal plumose natatory setae.

Second maxilliped (Fig. 2D): biramous; coxa without setae; basis with 4 sparsely plumose setae (1+1+1+1); endopod 3-segmented, with 1 sparsely plumose, 1 sparsely plumose and 6 (2 simple and 1 sparsely plumose subterminal, and 1 simple and 2 sparsely plumose terminal) setae, respectively; exopod 2-segmented, distal article with 4 long terminal plumose natatory setae.

Third maxilliped: absent.

Pereiopods: absent.

Pleon (Figs. 1B, F): 5 pleonites; pleonite 1 without setae, pleonites 2-5 with one pair of posterodorsal simple setae and small denticles on posterodorsal margin; pleonites 2 and 3 with one pair of dorsolateral processes; pleonites 3-5 with long and acute posterolateral processes.

Pleopods: absent.

Telson (Figs. 1B, F, G): bifurcated; furcae distally spinulated, with one pair of well-developed lateral spines, one pair of small lateral spines just below the long ones, and one pair of dorsal spines; inner margin with 3 pairs of serrate setae.

DISCUSSION

The first stage larval morphology of *Pilumnus vinaceus* conforms to the general Pilumnidae pattern, with characteristics such as: [1] antenna of type 2, exopod is well developed, generally similar in size or longer than protopod and with medial setae; [2] maxilliped 1 with 2+2+3+3 setae on the basis and with 3,2,1,2,5 setae in the endopod; [3] maxilliped 2 with 1+1+1+1 setae on the basis and 1,1,6 setae on the endopod; [4] telson of type 10, furcal rami armed with dorsal and lateral spines (*see* Clark & Cuesta, 2015). Additionally, some zoea I morphological characters are common among all species within the genus: [1] carapace with lateral spines, but without setae on the ventral margin; [2] antenna lacking endopod (except for *P. kempi, P. sluiteri* and *P. vespertilio*); [3] maxillule with seven setae on the coxal endite; [4] maxilla exopod (scaphognathite) margin with only four setae (*see* Tables 1 and 2, and references therein).

Despite this great morphological similarity of zoea I within *Pilumnus,* there are consistent differences of zoea I of *P. vinaceus* comparing with some of the other species from the Indo-West Pacific (Tables 1 and 2). Some species of the Indo-West Pacific show unusual morphological variations when compared to the western Atlantic species, mainly in the following characters: [1] setae on the carapace; [2] presence of antennule endopod; [3] variable number of setae in the maxilla, first maxilliped and pleon (*see* Tables 1 and 2, and references therein). The species with the most conspicuous morphological dissimilarities in the zoea I in the genus are those with a reduced number of zoeal stages: *P. vespertilio* (3 stages) (Lim & Tan, 1981; Terada, 1990) and *P. kempi* and *P. sluiteri* (both 2 stages)

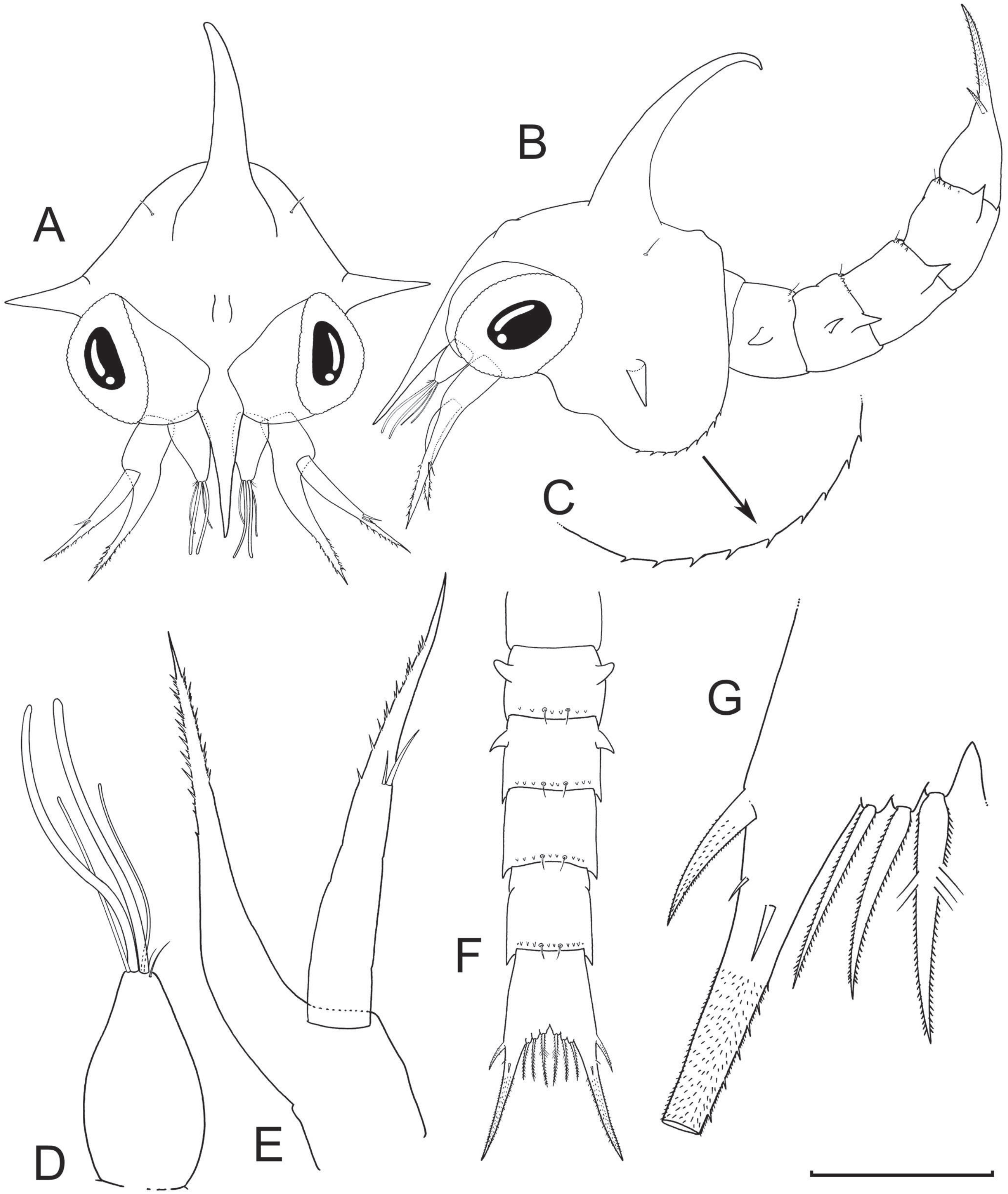

Figure 1. *Pilumnus vinaceus* (A) Milne-Edwards, 1880, Zoea I. (A) Carapace, frontal view; (B) General lateral view; (C) Magnification of the lateroventral margin of carapace. (D) Antennule; (E) Antenna. (F) Pleon, dorsal view; (G) Detail of the telson furca. (Scale bar: A, B, F = 0.3 mm; C, D, E, G = 0.1 mm).

(Siddiqui & Tirmizi, 1992; Clark & Ng, 2004). These three species are the only zoea of the genus that have the endopod of the antennule already developed in the first zoeal stage (see Tables 1 and 2, and references therein). Clark (2005) verified that the timing of appearance and rate of development of pilumnine characters occur at different stages and can be attributed to three heterochronic mechanisms: postdisplacement, predisplacement and acceleration.

Also based on the morphological comparison of already described zoeae I of *Pilumnus* species, we noted that such morphology does not fit with the general zoeal pattern reported to the genus and can be used as

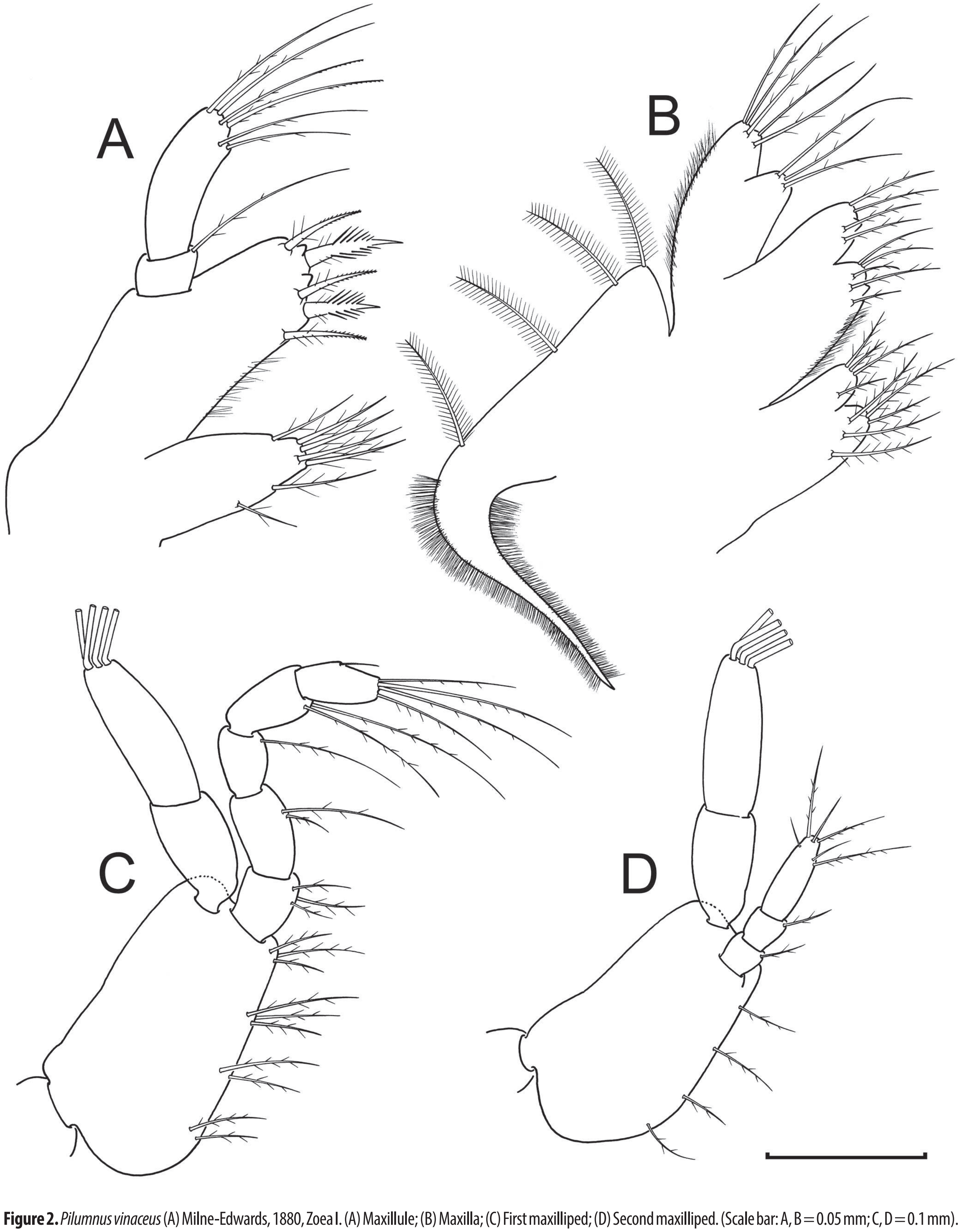

Figure 2. *Pilumnus vinaceus* (A) Milne-Edwards, 1880, Zoea I. (A) Maxillule; (B) Maxilla; (C) First maxilliped; (D) Second maxilliped. (Scale bar: A, B = 0.05 mm; C, D = 0.1 mm).

Table 1. Larval characters of the first zoeal stage of Indo-West Pacific and Eastern Pacific species of the genus *Pilumnus* Leach, 1815.

	Indo-West Pacific						Eastern Pacific	
	Pilumnus kempi	***Pilumnus longicornis***	***Pilumnus minutus***	***Pilumnus scabriusculus***	***Pilumnus sluiteri***	***Pilumnus vespertilio***	***Pilumnus indicus***	***Pilumnus limosus***
Size								
RDL (mm)	nd	nd	0.71	0.77	nd	1.78 (0.98)[b]	0.70	0.91
Carapace								
posterodorsal s	nd	0	0	nd	2	0	nd	2
s on ventral margin	1[d]	0	0	0	1	0	0**	0
Antennule								
a, s	7, 1	4, 2	3, 3	nd	5, 2	3, 2 (4, 2)[c]	2, 2 (4)	4, 1
Antenna								
endopod	Present	Absent	Absent	Absent	Present	Present[b]	Absent	Absent
Maxillule								
s on coxal end.	7	7	7	7	7	7	7	7
Maxilla								
s on coxal end.	5 + 4	6 + 4	6 + 4	6 + 4	6 + 4	4 + 3 (6 + 4)[c]	6 + 4	5 + 4
s on basial end.	4 + 4	5 + 4	5 + 4	5 + 4	5 + 4	6 + 4 (5 + 4)[b,c]	5 + 4	5 + 4
Maxilliped 1								
s on basis	11 (10)[d]	10	10	10	10	9 (10)[b,c]	10	10
s on end	3, 2, 1, 2, 5	3, 2, 1, 2, 5	3, 2, 1, 2, 5	3, 2, 1, 2, 5	3, 2, 1, 2, 5	2 (3)[b,c], 2, 1, 2, 5	3, 2, 1, 2, 5	3, 2, 1, 2, 5
Pleon								
dorsomedial s (so1)	0[d]	0	0	2	1	0	0	0
posterodorsal s (so1)	0[d]	0	0	0	1	0	0	0
dorsolateral processes	2nd–3rd so	2nd–3rd so	2nd–5th so	2nd–3rd so	2nd–5th so	2nd–3rd so	2nd so	2nd–3rd so

a = aesthetascs; end. = endopod; nd = not described; RDL = rostrodorsal length; s = setae; so = somite; ** = data from figures observation.
References: *P. kempi* (Siddiqui & Tirmizi, 1992; Clark & Ng, 2004[d]); *P. longicornis* (Clark & Paula, 2003); *P. minutus* (Terada, 1984; Ko, 1994); *P. scabriusculus* (Terada, 1990); *P. sluiteri* (Clark & Ng, 2004); *P. verpertilio* (Lim & Tan, 1981; Terada, 1990[b]; Clark & Paula, 2003[c]); *P. indicus* (Terada, 1980); *P. limosus* (García-Guerrero *et al.,* 2005).

additional support to check the taxonomic position of *P. indicus,* at least with the universe of larval description available. This suggestion is supported by some zoea I characteristics of *P. indicus,* which are distinct in relation to the other species of *Pilumnus,* such as: [1] absence of lateral spines on carapace; [2] rostral spine apparently shorter than in other species (smaller than antennule); [3] dorsolateral processes only in the second pleonite (*see* Table 1, and references therein). Therefore, the position of this species within the Pilumnidae should be reviewed since the unclear taxonomic retrospect described as *Parapilumnus indicus* by Deb (1987) but in the later brachyuran revision (Ng *et al.,* 2008) considered as *Pilumnus indicus* with no further details to adopt this status (Tatiana Magalhães, *pers. obs.*).

In the present study, it was not possible to obtain other zoeal stages of *P. vinaceus* during cultivation in the laboratory, due to the small size of zoeae I (*see* Table 2), which made it impossible to feed them with newly hatched *Artemia* nauplii, generally used as food for larvae of other species of *Pilumnus* (Bookhout & Costlow-Jr., 1979; Terada, 1990; Clark & Ng, 2004; Guerao *et al.,* 2005). Here we conjecture that *P. vinaceus* probably have four zoeal stages. This assumption is supported by the considerable morphological similarity of its zoea I in relation to all other species that have four zoeal stages in the genus (see Tables 1 and 2, and references therein). However, we suggest that future efforts should be devoted to completing the knowledge about the remaining larval stages of *P. vinaceus.* For this, we recommend that the cultivation of other organisms (*e.g.,* microalgae and/or rotifers) with smaller sizes when compared to *Artemia* nauplii may be fundamental to the successful obtention of *P. vinaceus* larval stages. Microalgae and rotifers had already been used as live food alternatives in several studies aiming the cultivation of decapod larvae (Zhang *et al.,* 1997; Simões *et al.,* 2002).

Considering only *Pilumnus* species that occur in the Atlantic, there is a relevant morphological similarity of zoea I (see Table 2, and references therein). This similarity is even greater if we consider only the species that occur in the western Atlantic, and the few differences among species are: (1) two terminal setae in the antennule (*P. vinaceus*), instead of one (*P. dasypodus* and *P. reticulatus*); (2) pleon with dorsolateral processes from the second to the fifth pleonites (*P. reticulatus*), instead of second to the third (*P. dasypodus* and *P. vinaceus*) (Table 2). Thus, considering only the morphology of zoea I, the similarity between *P. vinaceus* and *P. dasypodus* is now observed (see Table 2). Importantly, such species are also remarkably similar in the postlarval stages and they were considered synonymous until recently (*see* Magalhães *et al.,* 2021). All this nebulous scenario with some inconsistencies detected among the larvae of these species were also the subject of taxonomic doubts and proposed synonymy between some of these pairs of close related species given the enormous morphological similarity detected among adults (Magalhães *et al.,* 2021). Only after the study from Magalhães *et al.* (2021) using the molecular tool in combination with a thorough morphological analysis of a large number of specimens and the type series it was possible to elucidate these doubts.

Table 2. Comparison of selected larval characters of the first zoeal stage of *Pilumnus vinaceus* A. Milne-Edwards, 1880 and other species of *Pilumnus* with occurrence in the Atlantic Ocean.

	western Atlantic			eastern Atlantic	
	Pilumnus dasypodus	*Pilumnus reticulatus**	*Pilumnus vinaceus*	*Pilumnus hirtellus*	*Pilumnus spinifer*
Size					
RDL (mm)	1.2[b]	1.02	0.83	1.5 (1.2)[c]	0.9
Carapace					
posterodorsal s	0	0	0	0	0
s on ventral margin	0	0	0	0	0
Antennule					
a, s	4, 1 (4, 3)[b]	4, 1	4, 2	4, 2	4, 1
Antenna					
endopod	Absent	Absent	Absent	Absent	Absent
Maxillule					
s on coxal end.	7	7	7	6-7	7
Maxilla					
s on coxal end.	5 + 4	5 + 4	5 + 4	5 + 4 (4 + 4)[c]	5 + 4
s on basial end.	5 + 4	5 + 4	5 + 4	5 + 4	5 + 4
Maxilliped 1					
s on basis	10	10	10	10	10
s on end	3, 2, 1, 2, 5	3, 2, 1, 2, 5	3, 2, 1, 2, 5	3, 2, 1, 2, 5	3, 2, 1, 2, 5
Pleon					
dorsomedial s (so1)	nd	0	0	0	0
posterodorsal s (so1)	nd	0	0	0	0
dorsolateral processes	2nd–3rd so	2nd–5th so	2nd–3rd so	2nd–3rd so	2nd–3rd so

a = aesthetascs; end. = endopod; nd = not described; RDL = rostrodorsal length; s = setae; so = somite; * = It also occurs in the eastern Pacific, in the Central American region.
References: *P. dasypodus* (Sandifer, 1974; Bookhout & Costlow-Jr., 1979[b]); *P. reticulatus* (Spivak & Rodríguez, 2002); *P. vinaceus*, this study; *P. hirtellus* (Salman, 1982; Ingle, 1983, 1992[c]); *P. spinifer* (Guerao *et al.*, 2005).

After the morphological description of zoea I of *P. vinaceus* it is necessary to update the previous key for the identification of the known zoeal stages of brachyuran crabs from tropical and subtropical Brazil, southwestern Atlantic, proposed by Koettker *et al.* (2012). In this key, the morphological characters that lead to *P. dasypodus* are: rostral spine visibly shorter than antenna; no mediolateral spines on abdominal somites 4-5. However, such characters are identical to those of *P. vinaceus*. So, we suggest that this part of the key could be used as follows: a) pleonites 2-5 with a pair of mediolateral processes (*Pilumnus reticulatus*); b) pleonites 2-3 with a pair of mediolateral processes; antennule with four aesthetascs and two simple setae (*Pilumnus vinaceus*); c) pleonites 2-3 with pair of mediolateral processes; antennule with four aesthetascs and one simple setae (*Pilumnus dasypodus*) (see Table 2).

It is important to consider that there is still a great deficit in the morphological knowledge of *Pilumnus* larval forms. Of the 19 species belonging to the genus that occur in the western Atlantic (Magalhães *et al.*, 2021), only three (15.8%) have the morphology of the first zoeal stage known, considering the present description. Thus, there is still an amount of zoeal descriptive work to be undertaken for the knowledge of the real diversity of larval morphology within *Pilumnus*. Such work would also lead to a better understanding of pilumnid evolution and phylogeny, which represents one of the most diverse genus of brachyuran crabs.

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