Morphology of juvenile phase of Achelous spinimanus (Latreille, 1819) (Crustacea, Decapoda, Portunidae) reared in laboratory

Article *in* Journal of the Marine Biological Association of the UK · May 2015

DOI: 10.1017/S0025315415000508

2 authors:

Eduardo Antonio Bolla Júnior
São Paulo State University

Maria Lucia Fransozo
São Paulo State University

Journal of the Marine Biological Association of the United Kingdom, page 1 of 17.
doi:10.1017/S0025315415000508

Morphology of juvenile phase of *Achelous spinimanus* (Latreille, 1819) (Crustacea, Decapoda, Portunidae) reared in laboratory

EDUARDO ANTONIO BOLLA JÚNIOR[1,2] AND MARIA LUCIA NEGREIROS FRANSOZO[2]

[1]Instituto Federal de São Paulo, Av. Professor Celso Ferreira da Silva n. 1333, Jardim Europa, 18707-150 Avaré, São Paulo, Brazil, [2]NEBECC (Group of studies on crustacean biology, ecology and culture), Department of Zoology, Biosciences Institute, São Paulo State University, 18618-970 Botucatu, São Paulo, Brazil

The swimming crab Achelous spinimanus *is an important fishery component of several countries in the Western Atlantic; therefore, knowledge of the different phases of its life cycle is essential for good management of this resource. The juvenile development of* A. spinimanus *was investigated in the laboratory, from megalopae captured in neuston samples at Ubatuba, São Paulo, Brazil (23°26′S 46°09′W), during the summer months of 2005–2007. Rearing was performed in a constant temperature (25 ± 1°C), filtered seawater from the collection location (35 psu) and natural photoperiod. We obtained nine stages of the juvenile phase. All the morphological characters that allow the recognition of the first juvenile stage were drawn and described, as well as the main alterations that occur in the following stages. The sexual differentiation based on the number of pleopods becomes apparent from the third stage on. Some important characters in the identification of the species at the juvenile phase are the number of segments on the exopod of antennule, on the antennal flagellum and on the palp of mandible, beyond the absence of pleopods (even rudimentary) in the first stage.*

Keywords: Swimming crab, Brachyura, development, post-larval, immature

Submitted 22 January 2015; accepted 30 March 2015

INTRODUCTION

The superfamily Portunoidea Rafinesque, 1815 has numerous species of high ecological and economic importance, since they can act as water mass indicators (Taissoun, 1973). They constitute relevant fractions of fisheries of many countries in Europe, America and Japan (Paul, 1981; Román-Contreras, 1986; Hernández & Ramírez, 1990; Mantelatto & Fransozo, 1999; De Lestang *et al.*, 2003; Sforza *et al.*, 2010; Sahoo *et al.*, 2011).

As part of this superfamily, recently, some American species of the genus *Portunus* Weber, 1795, belonging to the family Portunidae Rafinesque, 1815, have undergone taxonomic changes, supported by molecular studies (see Mantelatto *et al.*, 2009). Among these species, we found *Portunus spinimanus* Latreille, 1819, *P. spinicarpus* (Stimpson, 1871), *P. ordwayi* (Stimpson, 1860), *P. gibbesii* (Stimpson, 1859) and *P. rufiremus* Holthuis, 1959, all these with occurrence in the Brazilian coast (Melo, 1996). Currently, such species belong to the resurrected genus *Achelous* De Haan, 1833 (previously, *Achelous* refers to a subgenus of *Portunus*).

The swimming crab *Achelous spinimanus* (Latreille, 1819) has wide distribution in the Western Atlantic: from New Jersey to the south of Florida (USA), Bermuda, Mexican Gulf, Antilles, Venezuela, Guiana and Brazil (from the states of Pernambuco to Rio Grande do Sul) (Melo, 1996). This species lives in brackish waters of canals and bays, in different types of substrates such as sandy bottoms, gravel, broken shells and muddy, from the intertidal zone to 90 m depth (Melo, 1996). It is commercially sold for human consumption along the Brazilian coast, and is reasonably well studied with regard to several biological aspects, including population structure, morphometric and physiological maturity, fecundity and reproductive cycle (see Santos *et al.*, 1995; Santos & Negreiros-Fransozo, 1995, 1997, 1999).

A good taxonomic approach also requires knowledge of the early phases of life cycles of species, particularly those that show complex life cycles involving metamorphosis. Furthermore, such knowledge allows several studies such as ecological, physiological, biogeographic, amongst others (Negreiros-Fransozo *et al.*, 2002; Anger, 2003; Marques *et al.*, 2003; Figueiredo *et al.*, 2008; Vergamini & Mantelatto, 2008; Sotelo *et al.*, 2009; González-Gordillo *et al.*, 2010; Demain *et al.*, 2011; Ragionieri & Schubart, 2013; Bolla Jr *et al.*, 2014).

Shen (1935) published the pioneer and detailed description of juvenile development in a brachyuran representative (the portunid *Carcinus maenas* (Linnaeus, 1758)), described up to the ninth juvenile stage. The subsequent descriptions were in their majority restricted to superficial descriptions of the first crab stage, although some authors remark on later stages.

Despite the fact that the superfamily Portunoidea has 455 living species (De Grave *et al.*, 2009), few of them have been studied regarding juvenile development. In the family Geryonidae Colosi, 1923, Ingle (1979) described only the first juvenile stage of *Geryon trispinosus* (Herbst, 1803). With respect to the family Portunidae, the genus *Callinectes*

Corresponding author:
M.L. Negreiros Fransozo
Email: mlnf@ibb.unesp.br

Table 1. *Achelous spinimanus* (Latreille, 1819). Survival, duration and size of all stages obtained during the juvenile phase.

Stage	J 1	J 2	J 3	J 4	J 5	J 6	J 7	J 8	J 9
N	27	27	27	25	22	10	4	2	2
†	0	0	2	3	12	6	2	0	2
%S	100.0%	100.0%	92.6%	81.5%	37.0%	14.8%	7.4%	7.4%	0.0%
D	5.8	12.2	23.6	36.5	48.7	72.3	116.5	139.0	–
Dm	3	10	19	28	39	51	102	127	–
DM	9	17	33	47	62	106	131	151	–
CW	2.70 ± 0.17	4.01 ± 0.21	5.54 ± 0.31	6.86 ± 0.50	8.16 ± 0.51	9.37 ± 0.61	10.73 ± 0.55	12.52 ± 0.64	14.06 ± 0.30

J1 to J9 = First to ninth juvenile stage; N = number of individuals; † = number of deaths; %S = percentage of survivors; D = duration mean (accumulated days); Dm = minimal duration; DM = maximum duration; CW = carapace width (mean ± SD).

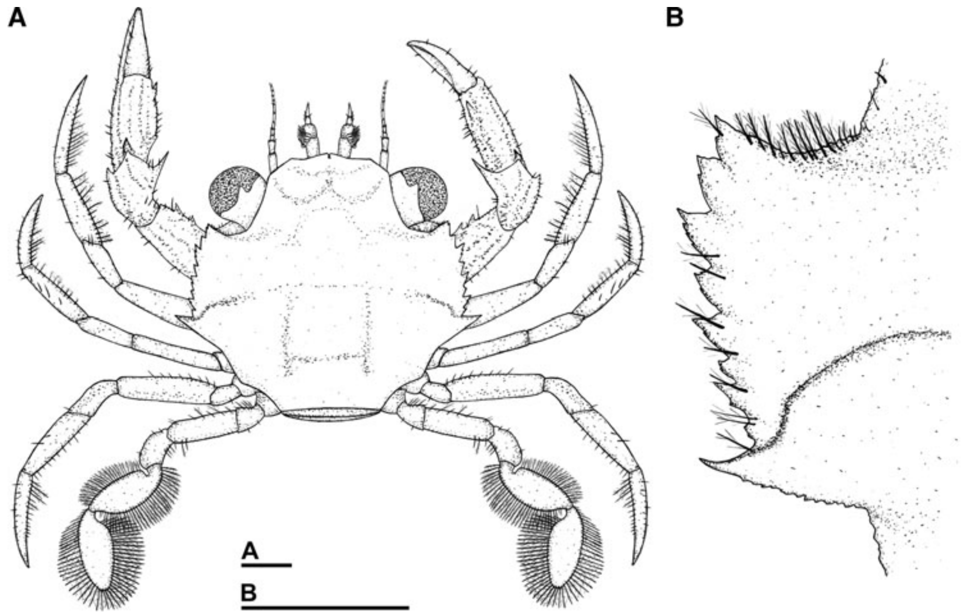

Fig. 1. *Achelous spinimanus* (Latreille, 1819), first juvenile stage: (A) dorsal view; (B) lateral spines of carapace in detail. Scale bars: 0.5 mm.

Stimpson, 1860 presents three species with detailed descriptions of juvenile development. The studied species of this genus are: *C. sapidus* Rathbun, 1896 and *C. ornatus* Ordway, 1863 studied up to the 11th stage by Barutot *et al.* (2001) and Bolla Jr *et al.* (2008), respectively; and *C. danae* Smith, 1869 studied up to the 12th stage by Bolla Jr *et al.* (2014). Regarding the genus *Portunus* Weber, 1795, only sketchy descriptions were performed by Lebour (1944a) and Yatsuzuka & Sakai (1980) to *P. anceps* (Saussure, 1858) and *P. pelagicus* (Linnaeus, 1758), respectively. For a few species of the genera *Arenaeus* Dana, 1851, *Bathynectes* Stimpson, 1871, *Charybdis* De Haan, 1833, *Liocarcinus* Stimpson, 1871, *Macropipus* Prestandrea, 1833, *Polybius* Leach, 1820 and *Portumnus* Leach, 1814 there are incomplete characterizations, most of them only about carapace shape. Moreover, for the genus *Achelous* there are no published studies concerning the juvenile development of its species as far.

The definition of peculiar characteristics of such decapods in the juvenile stages becomes a very hard task, given the scarcity of detailed descriptions about this life aspect of representatives of the superfamily Portunoidea, with occurrence in the Brazilian coast. Thus, studies based on material from laboratory rearing are fundamental for achievement of comparisons and establishment of distinctive morphological features for such species.

Recognition of the juvenile specimens of the swimming crab *A. spinimanus* in the natural environment is very difficult. Therefore, the aim of this study is to provide morphological details and relevant characteristics for the identification of its juvenile stages based on specimens reared in the laboratory.

MATERIALS AND METHODS

The material utilized in this study consisted, initially, of megalopae obtained from neuston samples collected at Ubatuba Bay, São Paulo state, Brazil (23°26′S 46°09′W). This bay has a tropical/subtropical climate, whose sea surface temperature varies at around 18°C during winter and 29°C during summer (Negreiros-Fransozo & Fransozo, 2003).

The larvae were collected by 12 nocturnal trawls of 10 min each, using neuston nets (500 μm mesh), during the summer months of 2005–2007.

The megalopae of portunids have a flattened dactyl in the fifth pereiopod, similar to the adult, and have a pair of sternal spines in the seventh somite, which can provide an easy identification in the samples (Kurata, 1975). The paper by Negreiros-Fransozo *et al.* (2007) provided the main features that allow recognition of the megalopae of *A. spinimanus*.

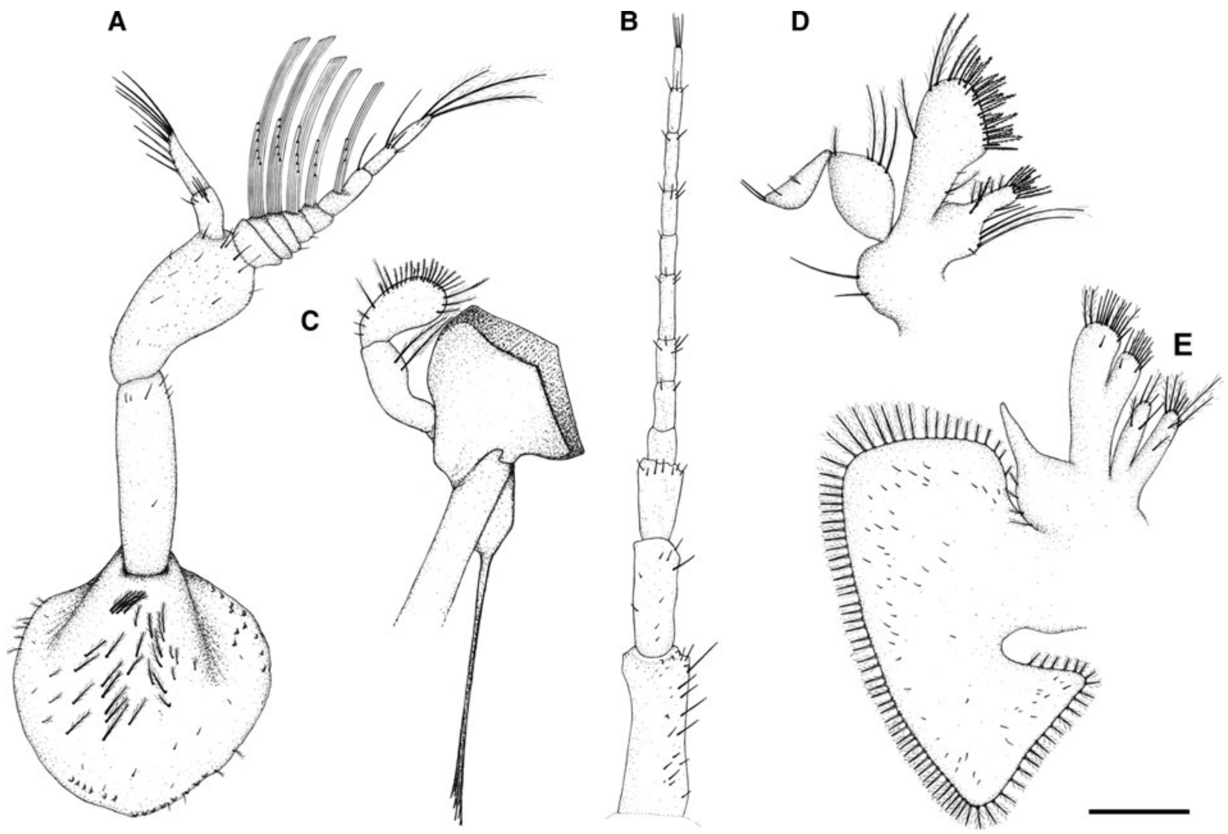

Fig. 2. *Achelous spinimanus* (Latreille, 1819), first juvenile stage: (A) antennule; (B) antenna; (C) mandible; (D) maxillule; (E) maxilla. Scale bar: 0.2 mm.

After collection and sorting, we isolated the megalopae into covered acrylic containers (30 mL) filled with filtered seawater (salinity 35) from the sampling area, and transported in thermal boxes to the NEBECC laboratory.

In general, the rearing techniques adopted were similar to those used by Bolla Jr *et al.* (2008, 2014). The megalopae and juveniles were individually raised at 24 ± 1°C in containers filled with filtered and aerated seawater (salinity 35). We inspected the containers daily, afterwards removing all debris and exuviae or dead individuals. The water renewal in the containers occurred partially over one day, and the water was completely replaced every second day with filtered and aerated seawater. After inspection, we fed individuals with newly hatched *Artemia* sp. nauplii *ad libitum*; and we offered ornamental-fish food (Tetra Color™ Tropical Granules) for juveniles from the fifth stage on. We fixed the dead individuals and the exuviae in 80% ethanol and glycerin at 2:1. Part of this material was deposited in the scientific collection (number #111, #174, #186, #236, #463, #490 and #1772) of NEBECC, Zoology Department, Biosciences Institute, São Paulo State University, Botucatu, São Paulo, Brazil.

The stages are designated as 'juveniles' because they do not have totally mature gonads, since sexual maturity is reached, generally in portunids, with larger sizes than those obtained during the rearing (see Mantelatto & Fransozo, 1996; Santos & Negreiros-Fransozo, 1996; Pinheiro & Fransozo, 1998; Corbi-Corrêa & Fransozo, 2002).

The first juvenile stage (N = 10) was dissected, drawn and described from fixed exuviae, using a stereoscopic microscope (Zeiss SV6) or a compound optical microscope (Zeiss Axioskop 2), both equipped with a drawing tube and ocular micrometer. We also dissected the later stages and recorded the main morphological modifications. We based the terminology for the descriptions of setae types on Clark *et al.* (1998) and Garm (2004). We performed the setae observations under a microscope equipped with Nomarski optics.

RESULTS

During the rearing experiments, we obtained juvenile development until the ninth stage, when the last specimen died. Such deaths are due, probably, to the lack of a more varied diet from this phase of the species' life cycle. Table 1 presents the survival, length and size (carapace width – CW) of all stages reached. It is possible to observe that larger individuals had obtained, on average, 14 mm of CW, and the highest mortality rate occurred from the fifth to sixth stage.

Morphology of the first juvenile stage of *A. spinimanus*

The general shape of the first stage is similar to that of the adult (Figure 1A). Carapace flattened dorso-ventrally and slightly convex, it has almost the same size in width and length, presents 8 lateral spines (finely serrated), besides the lateral pair commonly found in portunids (Figure 1B); small plumose setae on the orbital margin and small granules and

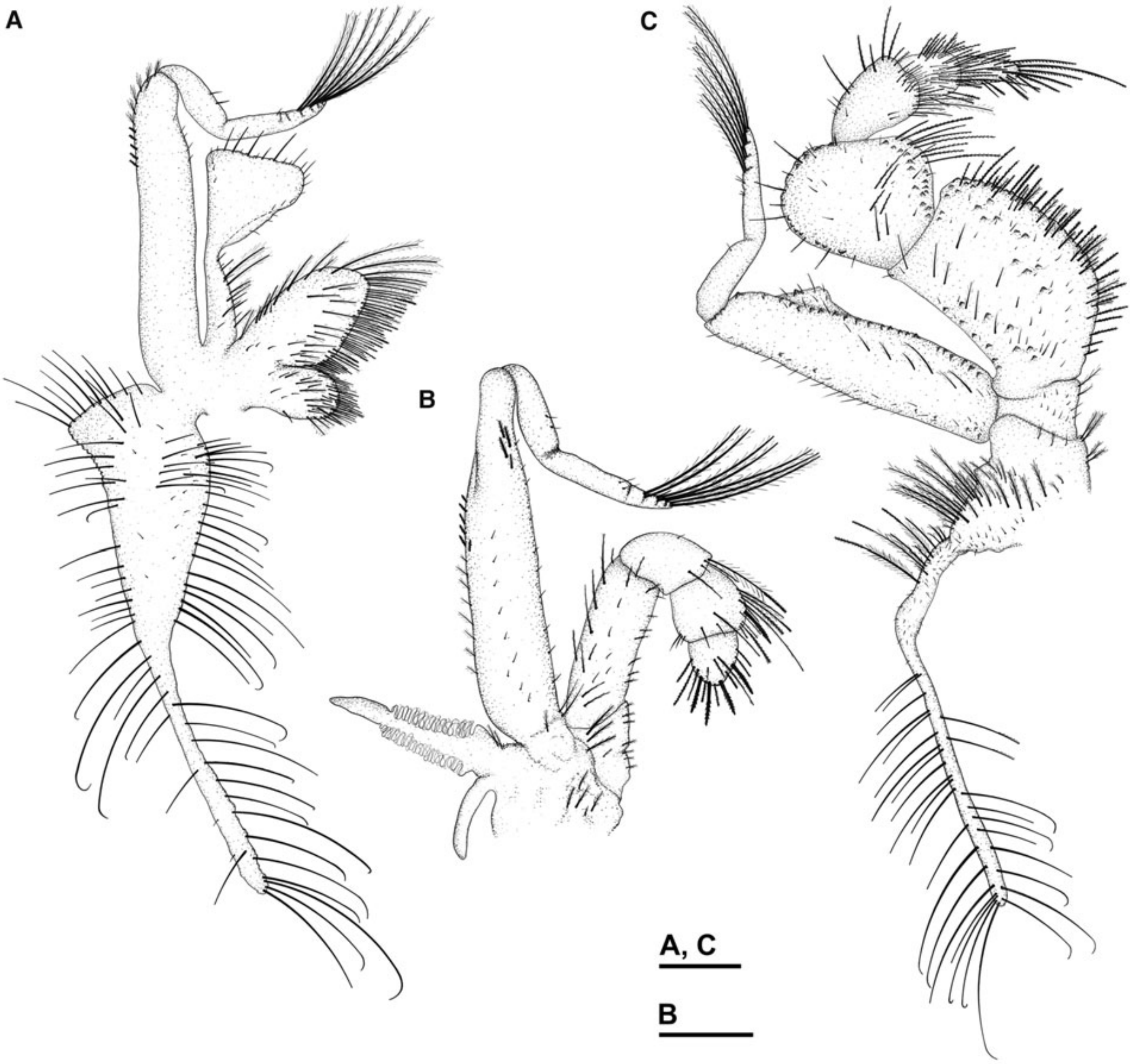

Fig. 3. *Achelous spinimanus* (Latreille, 1819), first juvenile stage: (A) first maxilliped; (B) second maxilliped; (C) third maxilliped. Scale bar: 0.2 mm.

sparse simple setae over the carapace surface, in addition to well-developed stalked eyes.

Antennule (Figure 2A) – developed basal segment bearing several plumose and simple setae, besides numerous small marginal granules; 2-segmented peduncle with sparse simple setae. Endopod 2-segmented (ventral flagellum) with 5 and 9 simple setae, respectively, on the proximal and distal segments. Exopod (dorsal flagellum) 8-segmented with 0, 12, 12, 10, 8, 6, 0 and 0 long aesthetascs, respectively; besides 0, 0, 1, 1, 0, 1, 4 and 2 simple setae, and also 3 terminal plumose setae on the last segment.

Antenna (Figure 2B) – 3-segmented antennal peduncle, provided with sparse simple setae, besides small marginal and terminal granules on the first segment. Antennal flagellum 9-segmented with 0, 2, 5, 4, 1, 4, 2, 3 and 4 simple setae, all of them terminal.

Mandible (Figure 2C) – well-chitinized blade, 2-segmented palp with 2 plumose setae on proximal segment and 17 serrate setae, 5 plumose setae, 2 simple setae and 1 plumo-denticulate seta on distal segment.

Maxillule (Figure 2D) – coxal endite bearing 6 plumose setae, 4 simple setae of several sizes and 13 serrate setae; basial endite with 4 small simple setae and 1 long seta on the proximal margin, 12 serrate setae, 2 small simple, 10 cuspidate, 3 plumose and 2 plumo-denticulate setae on distal margin. The endopod is 2-segmented with 4 plumose setae and 1 simple seta on proximal segment, and 1 plumose seta and 3 simple setae on the distal segment. Two simple setae on protopod margin.

Maxilla (Figure 2E) – bilobed coxal endite with 9 plumose setae on the proximal segment, 3 simple setae and 2 plumose setae on the distal segment; basial endite, bilobed, with 3 slightly plumose setae and 7 simple setae on the proximal segment, 2 plumose setae, 2 slightly plumose setae and 10 simple setae on the distal segment. The endopod has 4 plumose setae on distal margin. The exopod (scaphognathite) shows 86 plumose marginal setae and 57 simple surface setae.

First maxilliped (Figure 3A) – coxal endite with 19 plumose, 12 serrate and 13 simple setae; basial endite with 47 plumose setae, 17 plumo-denticulate and 4 small simple

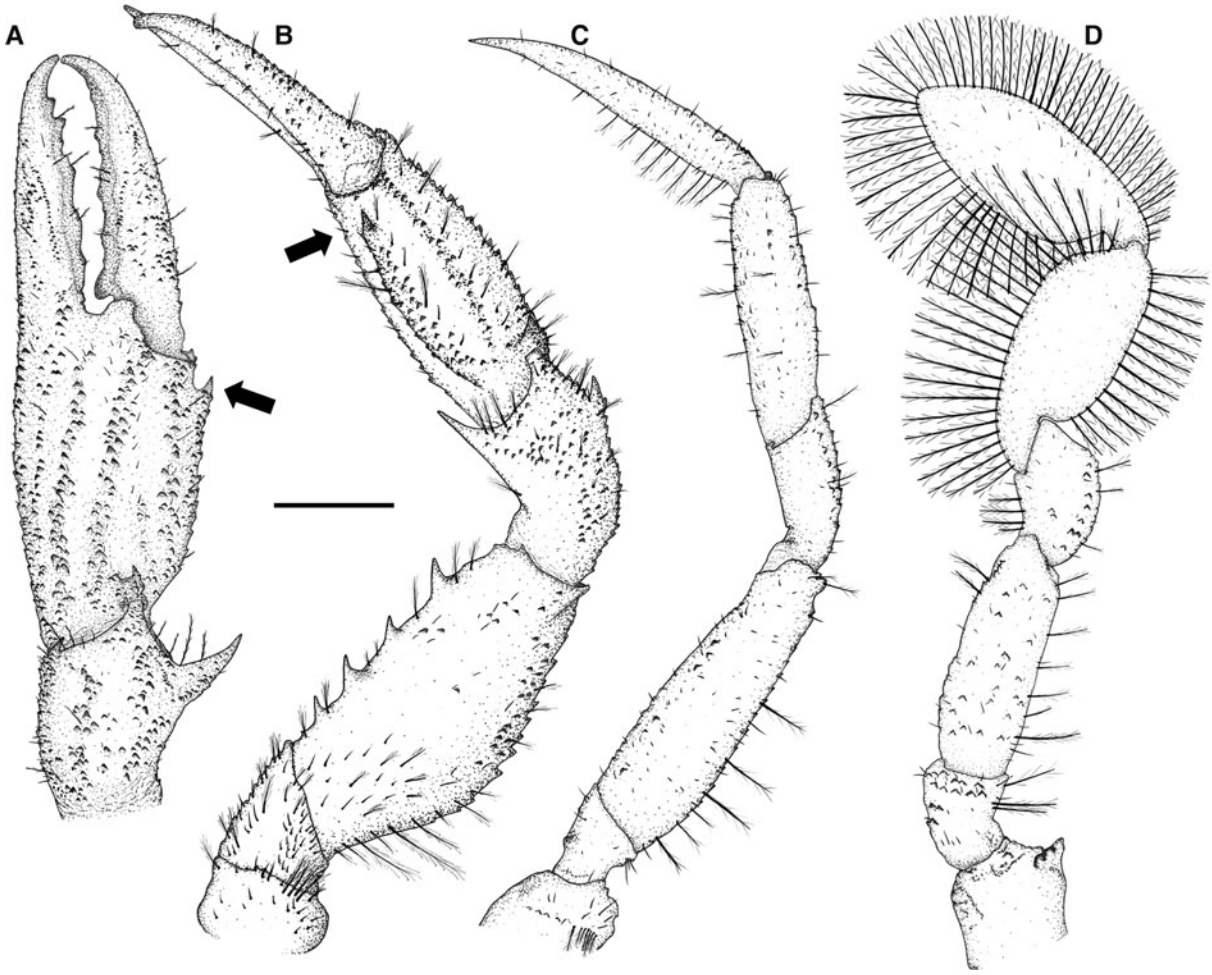

Fig. 4. *Achelous spinimanus* (Latreille, 1819), first juvenile stage: (A) cheliped (lateral view); (B) cheliped (dorsal view); (C) third pereiopod; (D) fifth pereiopod. Arrows indicate the propodus spine, characteristic of this species. Scale bar: 0.4 mm.

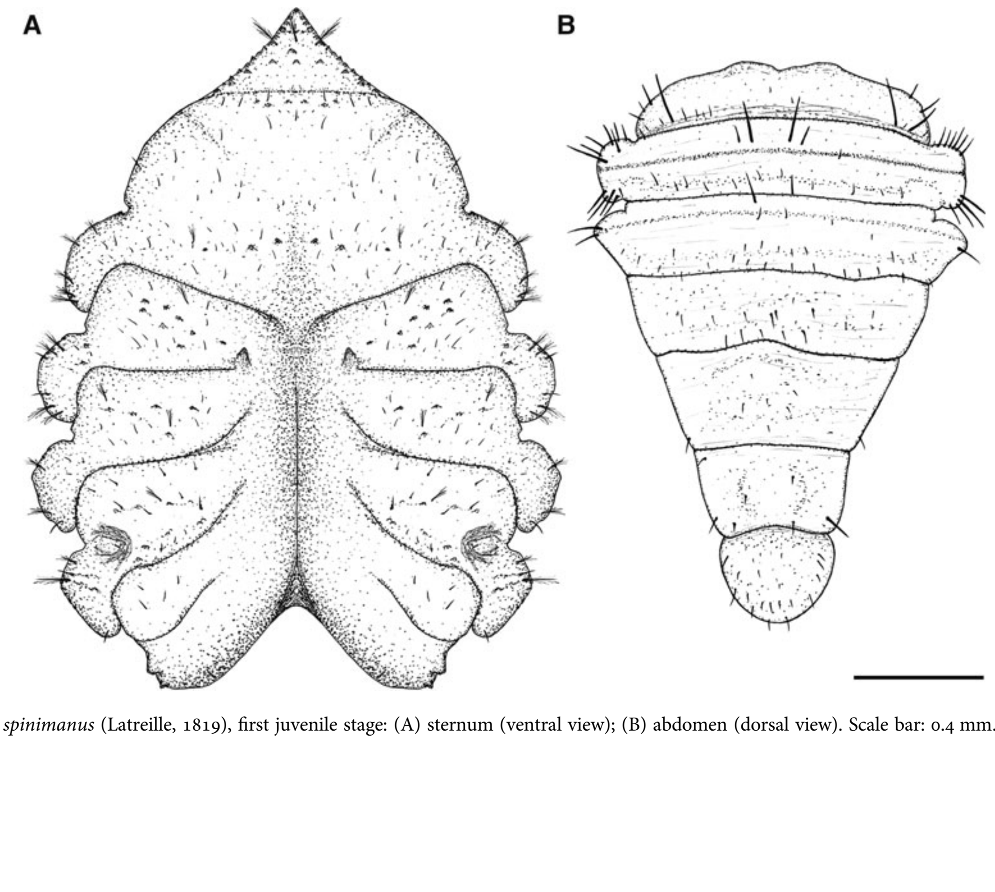

Fig. 5. *Achelous spinimanus* (Latreille, 1819), first juvenile stage: (A) sternum (ventral view); (B) abdomen (dorsal view). Scale bar: 0.4 mm.

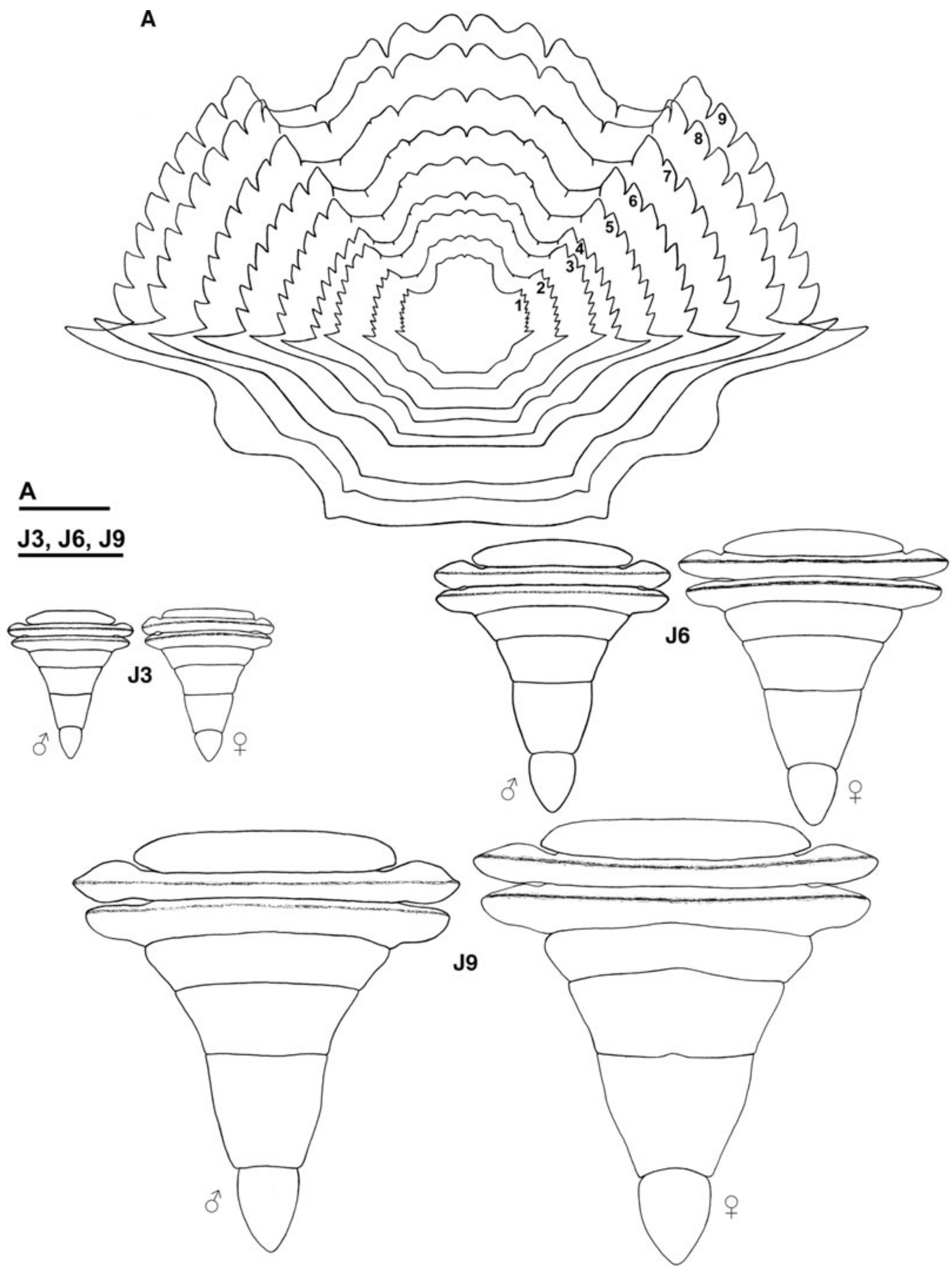

Fig. 6. *Achelous spinimanus* (Latreille, 1819): (A) carapace development throughout all juvenile stages obtained (numbers represent the stage of the juvenile phase); (J3–J6–J9) development of the abdomen shape of both males and females in third, sixth and ninth stages, respectively. Scale bars: A, 2.5 mm; J3–J9, 2 mm.

setae. The endopod is unsegmented with 6 plumose setae and 34 simple setae of several sizes; 2-segmented exopod with 6 plumose, 5 simple and 5 cuspidate setae on the proximal segment, 7 plumose and 3 simple setae on the distal segment. The epipod is large, with 77 long simple setae and 14 small simple setae.

Second maxilliped (Figure 3B) – 5-segmented endopod with 10, 17, 2, 7 and 4 plumose setae, 2 and 7 serrate setae and 1 and 4 cuspidate setae on the fourth and fifth segments, respectively; 1 plumo-denticulate setae on the third and on the fourth segment, besides 0, 6, 3, 5 and 0 simple setae. The exopod is 2-segmented with 14 plumose setae, 17 simple setae and 9 cuspidate setae on the proximal segment; 5 simple setae and 7 plumose setae on the distal segment. The protopod shows 7 plumose setae and 4 simple setae; and the epipod is rudimentary and smooth.

Third maxilliped (Figure 3C) – 5-segmented endopod with several protuberances on the first and second segments, several setae on each segment: 29, 9, 12, 25, 13 serrate setae, 29, 11, 11, 6, 0 plumose setae, 46, 20, 17, 8, 4 simple setae from the proximal to distal segment. The exopod is 2-segmented with several marginal protuberances, 8 plumose setae and 41 simple setae on the proximal segment and 8 plumose and 5 simple setae on the distal. The protopod has 34 plumose setae of several sizes and

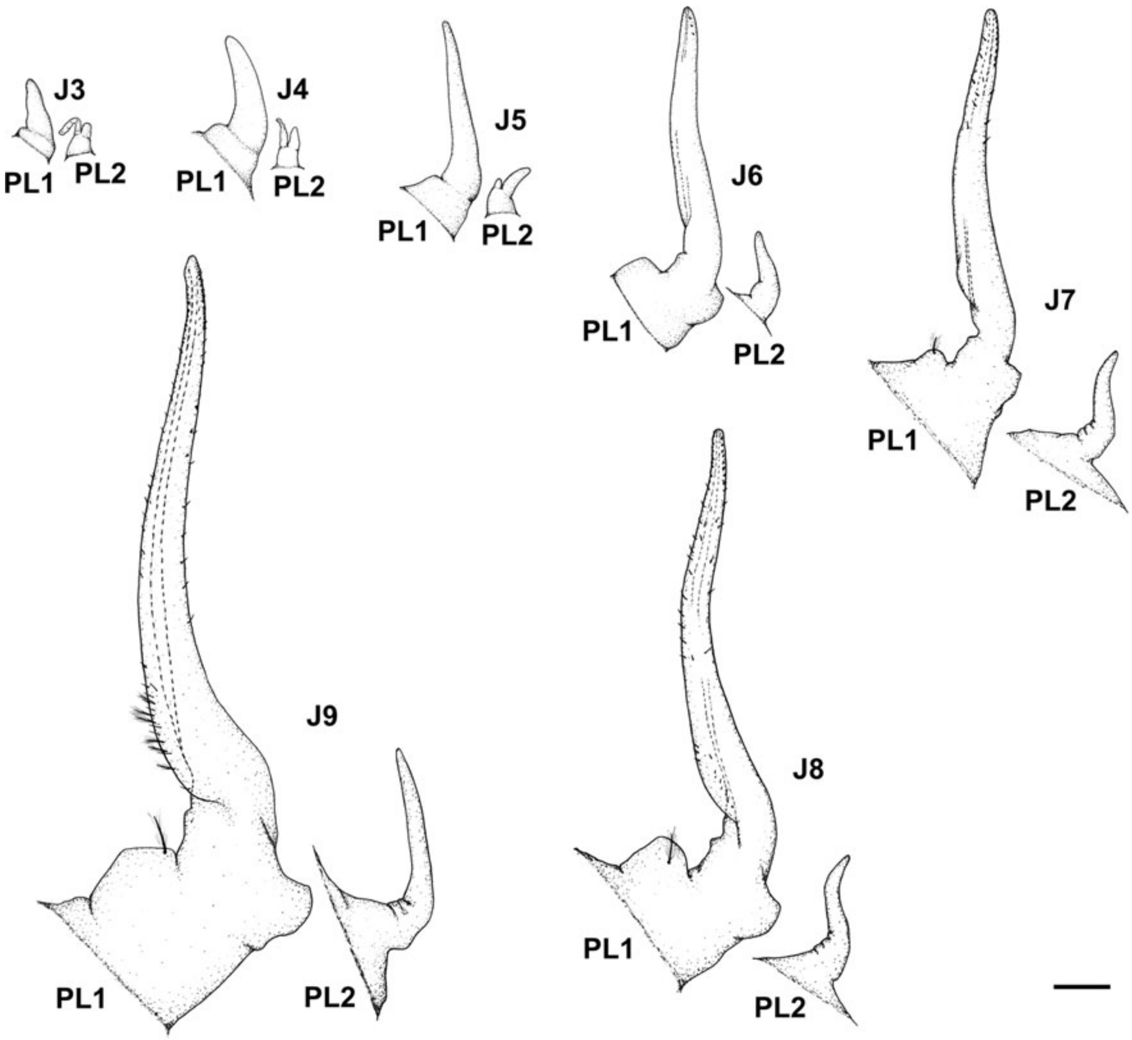

Fig. 7. *Achelous spinimanus* (Latreille, 1819), PL1 and PL2: pleopods of the first and second male abdominal somites, respectively, from third (J3), fourth (J4), fifth (J5), sixth (J6), seventh (J7), eighth (J8) and ninth (J9) stages on. Scale bar: 0.2 mm.

21 small simple setae. The epipod shows 7 plumose setae, 3 plumo-denticulate setae and around 40 small simple setae on the proximal portion, 28 long simple setae and 2 long serrate setae on the distal portion.

Chelipeds (Figure 4A, B) symmetrical, with small spines on external margin and 4 strong inner ones on merus, and 3 terminal spines on carpus with the dorsal one being the longest; its propodus presents a spine (Figure 4, arrows) in the inner margin at the level of the dactyl, characteristic of this species, as well as simple and plumose setae sparsely distributed. Second, third (Figure 4C) and fourth pereiopods are similar, with sparse simple and plumose setae present (the dactyls show several grouped setae on the inner margin). Fifth pair of pereiopods (Figure 4D) with a spine on the coxa; both propodus and dactyls flattened; dactyls are paddle-shaped with several marginal plumose setae.

Thoracic sternites (Figure 5A) with simple and plumose setae sparsely distributed over surface, concentric and semi-circular wrinkles on the seventh somite (near the coxa).

Abdomen (Figure 5B) with 6 somites, each one wider than long, with several sparse simple setae; telson with small simple setae. Pleopods absent on the inner face.

Morphology of the second to ninth juvenile stage of *A. spinimanus*

The proportion increases between carapace width and length of the juvenile individuals in each successive ecdysis, as the individuals grow up. From the ninth stage on, the carapace reaches similar proportions to those observed in the adult phase (Figure 6A).

The abdomen increased in size during the growth time and begins to show slight changes in shape, associated with sex, from the ninth stage on. Nevertheless, such changes do not allow the visual differentiation of the sex of individuals, as can be observed in male and female adults (Figure 6 J3–J9).

The main morphological changes verified from the second juvenile stage onwards refer, mostly, to the secondary sexual characteristics. The pleopods, which were absent in the first juvenile stage, rise in different numbers and degree of development, according to each sex.

For males, in the third juvenile stage, a pair of pleopods appears on the first (PL_1) and second (PL_2) abdominal somite, respectively, being PL_2 biramous (Figure 7 J3). In the fourth and fifth stages (Figure 7 J4–J5) there are no

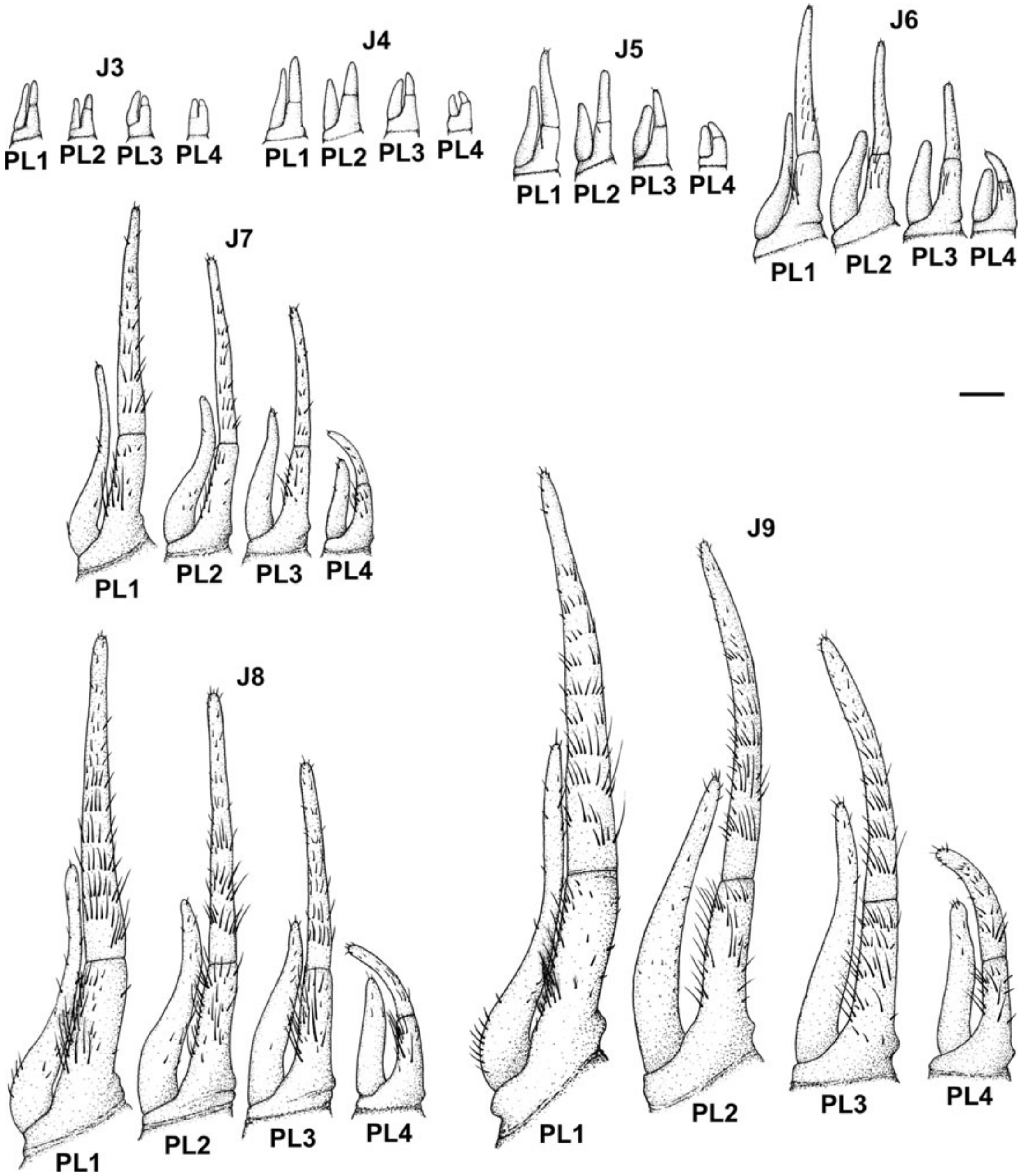

Fig. 8. *Achelous spinimanus* (Latreille, 1819), PL2 to PL5: pleopods from the second to fifth female abdominal somites, respectively, from third (J3), fourth (J4), fifth (J5), sixth (J6), seventh (J7), eighth (J8) and ninth (J9) stages on. Scale bar: 0.2 mm.

significant morphological changes, with exception of increase in sizes, especially of PL_1. In the sixth stage (Figure 7 J6) the PL_2 becomes completely uniramous and a few simple setae appear on the distal portion of PL_1. From the seventh to ninth stages (Figure 7 J7–J9) the modifications that occur on both the PL1 and PL2 are limited only to the gradual increase in size, the appearance of simple and plumose setae and emergence of some protuberances on the distal portion of PL_1. In the ninth juvenile stage, the general morphology of pleopods still differs from that of adults, mainly regarding the number of setae.

For females, in the third juvenile stage 4 pairs of biramous pleopods appear from the second to fifth abdominal somite (PL_2, PL_3, PL_4 and PL_5), all of them with endopods partially segmented and smooth (Figure 8 J3). In the fourth and fifth stages (Figure 8 J4–J5), the pleopods slightly vary in size and PL_2, PL_3 and PL_4 acquire setae. In the sixth stage (Figure 8 J6), the endopods of the pleopods exhibit a true segmentation and increase in size and number of setae. From the seventh to ninth stages (Figure 8 J7–J9), the main modifications are restricted only to the rapid increase of number of setae and size of pleopods.

We can point out some structures, which show other alterations. The most significant changes are: (1) on the endopod of the first maxilliped with a foliaceous shape and a groove in the apical region, particularly in the inner margin from the third stage on; and (2) on the first segment of the antennal peduncle, with the apical region showing a

Table 2. *Achelous spinimanus* (Latreille, 1819).

Features	Stages								
	J1	J2	J3	J4	J5	J6	J7	J8	J9
Number of segments on antennule endopod	2	3	3	3	3	4 (3)	4	4	4
Number of segments on antennule exopod	8	8	11	11	13	14	15	17	18
Number of segments of antennal flagellum	9	10	12	15	18	21	22	24	26
Antenna length	1.52	1.78	2.38	2.65	3.91	4.16	4.61	5.66	5.9
Number of setae on the basis of maxillule protopod	2	2	3	3	5	6	8 (7)	11	12
Number of marginal setae on maxilla exopod	±86	±112	±145	±159	±184	±213	±263	±304	±317
Length of maxilla exopod	0.76	0.98	1.2	1.4	1.89	2.06	2.24	2.76	3.13
Number of apical setae on 1st maxilliped	17	24	28	±33	±40	±46	±53	±66	±79
Length of basal segment of 1st maxilliped exopod	0.78	0.99	1.22	1.4	1.86	1.96	2.19	2.61	2.98
Length of basal segment of 2nd maxilliped exopod	0.8	0.96	1.24	1.44	1.92	2.09	2.23	2.68	2.97
Length of basal segment of 3rd maxilliped exopod	0.77	0.95	1.23	1.42	1.89	1.95	2.22	2.67	2.93
Length of 2nd pereiopod merus	1.07	1.68	2.14	2.52	2.81	3.43	3.83	4.6	4.86

Main morphological features that allow the identification of the first nine juvenile stages (J1 to J9). Length measurements represent average values, in mm; numbers in parentheses indicate alternative values of low frequency; '±' indicates 'approximately'.

projection that resembles the antennal scale, in the advanced stages.

No significant morphological change occurs on the remaining body appendages. However, there is an increase in the number of setae on segments of each appendage. Denticule-serrulate setae on the epipod of the third maxilliped appear from the third juvenile stage on. Setae on the epipod of all maxillipeds from the fourth stage on are of the type denticule-serrulate or harpoon-shaped setae.

The most notable morphological characters that allow the identification of the first nine stages of the juvenile development of *A. spinimanus* are shown in Table 2.

Regarding female gonopores, their vestigial aperture comes from the third juvenile stage (Figure 9A, white arrow). In males, it was not possible to verify the emergence of the gonopores.

In both sexes, the abdomen remained sealed to sternum throughout the juvenile stages obtained. The presence of 2 pairs of 'closing mechanisms' or 'sternal buttons' on the sternum was verified. There is an anterior one (located on the fifth sternite, at the level of the distal region of the sixth abdominal somite) (Figure 9A, black arrow); and another, posterior one (located on the eighth sternite, at the level of the lateral region of the second abdominal somite) (Figure 9B, black arrow). Such structures, together with cementing substances present in the contour of the abdomen, do not allow the extension of the abdomen before the beginning of the reproductive period.

The size of the chelipeds did not differ between sexes throughout the obtained juvenile stages.

DISCUSSION

Although the species studied here have recently changed to the resurrected genus *Achelous*, its early juvenile stages share morphological features with other species belonging to the genus *Portunus*, at least, for those species previously studied regarding their juvenile development. To better distinguish possible unique characteristics of these two genera we need to complete further studies.

Descriptions of the carapace of portunids show that, just in the first post-larval stage, *P. anceps* exhibits 8 lateral spines, as well the common pair of spines characteristic of this family (Lebour, 1944a). For *P. pelagicus*, besides the common features shared with *P. anceps*, Yatsuzuka & Sakai (1980) also found a serrulate rostrum, as occurs for *C. ornatus* and *C. danae* studied by, respectively, Bolla Jr

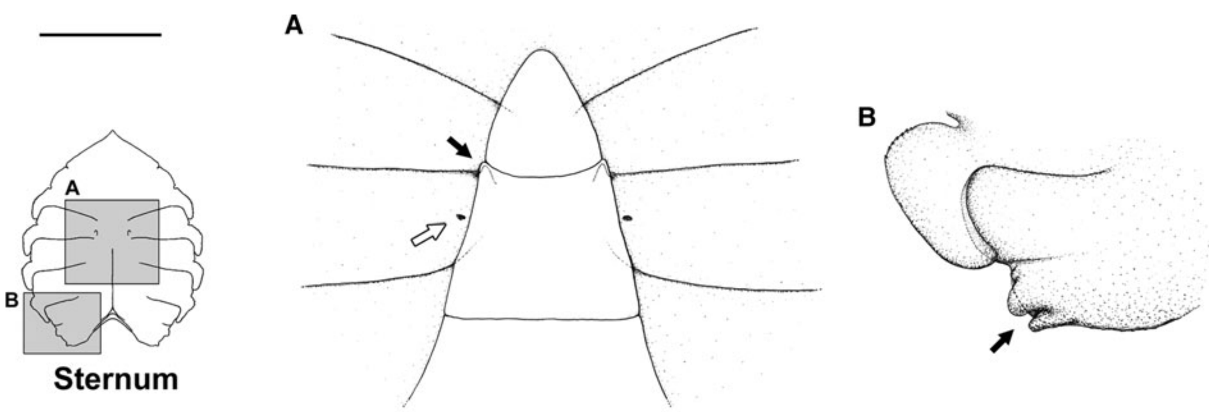

Fig. 9. *Achelous spinimanus* (Latreille, 1819), third juvenile stage: (A) white arrow, the rudimentary female gonopores; black arrow, anterior 'closing mechanism' position; (B) posterior 'closing mechanism' position, pointed by the black arrow (see schematic drawing of the position of the abdomen over the posterior 'closing mechanism' in Bolla Jr *et al.*, 2014). Scale bar: 0.5 mm.

Table 3. List of species with some stages of the juvenile phase known to date.

Family	Species	Juvenile stages described	Sexual dimorphism stage (based on pleopods)	Reference
Aethridae Dana, 1851	*Hepatus pudibundus*	1st to 8th	3rd	Hebling & Rieger (2003)
Calappidae De Haan, 1833	*Calappa flammea*	1st	?	Lebour (1944a)
	Calappa granulata	1st	?	Guerao *et al.* (1998)
	Calappa tortugae	1st to 4th	2nd	Negreiros-Fransozo *et al.* (2007)
	Cryptosoma balgueri (described as *Cycloës bairdii*)	1st	?	Lebour (1944a)
Cancridae Latreille, 1802	*Cancer pagurus*	1st to 3rd	?	Ingle (1981)
Dotillidae Stimpson, 1818	*Dotilla blanfordi*	1st	?	Rajabai (1959)
Epialtidae, MacLeay, 1838	*Pisa armata*	1st	?	Ingle & Clark (1980)
Eriphiidae MacLeay, 1838	*Eriphia gonagra*	1st to 10th	4th	Fransozo & Negreiros-Fransozo (1987)
	Eurypanopeus abbreviatus	1st to 7th	4th	Fransozo & Negreiros-Fransozo (1987)
	Eurytium limosum	1st to 10th	4th	Guimarães & Negreiros-Fransozo (2005)
	Hexapanopeus caribbaeus	1st to 11th	5th	Vieira (2000)
	Panopeus africanus	1st	?	Rodríguez & Paula (1993)
	Panopeus austrobesus (described as *Panopeus herbstii*)	1st to 15th	4th	Hebling *et al.* (1982)
	Panopeus occidentalis	1st to 14th	6th	Rodrigues (1997)
	Panopeus rugosus	1st to 14th	6th	Rodrigues (1997)
Geryonidae Colosi, 1923	*Geryon trispinosus* (described as *Geryon tridens*)	1st	?	Ingle (1979)
Grapsidae MacLeay, 1838	*Pachygrapsus marmoratus*	1st	?	Guerao *et al.* (1997)
	Pachygrapsus transversus	1st to 8th	3rd	Flores *et al.* (1998)
	Planes minutus	1st	?	Lebour (1944a)
Inachidae, MacLeay, 1838	*Inachus dorsettensis*	1st	?	Ingle (1977)
	Inachus thoracicus	1st	?	Guerao *et al.* (2002)
Inachoididae Dana, 1851	*Pyromaia tuberculata*	1st to 9th	2nd	Flores *et al.* (2002)
Majidae Samouelle, 1819	*Maja brachydactyla*	1st to 8th	4th	Guerao & Rotllant (2009)
	Maja squinado	1st to 8th	4th	Guerao & Rotllant (2010)
Menippidae Ortmann, 1893	*Menippe nodifrons*	1st to 8th	4th	Fransozo *et al.* (1988)
Ocypodidae Rafinesque, 1815	*Ocypode cordimanus*	1st	?	Rajabai Naidu (1954)
	Ocypode platytarsis	1st	?	Rajabai Naidu (1954)
Panopeidae Ortmann, 1893	*Acantholobulus bermudensis* (described as *Panopeus bermudensis*)	1st to 14th	6th	Martin *et al.* (1984)
Pinnotheridae De Haan, 1833	*Pinnixa rathbuni*	1st	?	Muraoka (1979)
Percnidae Števčić, 2005	*Percnon gibbesii*	1st	?	Paula & Hartnoll (1989)
Portunidae Rafinesque, 1815	*Arenaeus cribrarius*	1st to 3rd	?	Stuck & Truesdale (1988)
	Achelous spinimanus	1st to 9th	3rd	*Present study*
	Bathynectes longipes	4th? to 6th?	?	Ingle & Rice (1984)
	Callinectes danae	1st to 12th	4th	Bolla Jr *et al.* (2014)
	Callinectes ornatus	1st to 11th	4th	Bolla Jr *et al.* (2008)
	Callinectes sapidus	1st to 11th	4th	Barutot *et al.* (2001)
	Carcinus maenas	1st to 9th	2nd	Shen (1935)
	Charybdis hellerii	1st to 3rd	?	Dineen *et al.* (2001)
	Liocarcinus arcuatus	1st	?	Ingle & Rice (1984)
	Liocarcinus depurator	1st to 5th	2nd	Ingle & Rice (1984); Guerao & Abelló (2011)
	Liocarcinus holsatus	1st to 3rd	?	Ingle & Rice (1984)
	Liocarcinus puber	1st to 4th	?	Ingle & Rice (1984)
	Liocarcinus pusillus	1st to 4th	?	Ingle & Rice (1984)
	Macropipus tuberculatus	4th? to 6th?	?	Ingle & Rice (1984)
	Polybius henslowii	4th?	?	Ingle & Rice (1984)
	Portumnus biguttatus	1st	?	Lebour (1944b)
	Portumnus latipes	1st to 5th?	Probably before 5th	Lebour (1944b); Paula (1988)
	Portunus anceps	1st	?	Lebour (1944a)
	Portunus pelagicus	1st to 3rd	?	Yatsuzuka & Sakai (1980)
Pseudorhombilidae Hendrickx, 1998	*Bathyrhombila* sp.	1st to 14th	4th	Moraes *et al.* (2011)

Continued

Table 3. Continued

Family	Species	Juvenile stages described	Sexual dimorphism stage (based on pleopods)	Reference
Sesarmidae Dana, 1851	*Armases ricordi*	1st	?	Diaz & Ewald (1968); Guerao *et al.* (2007)
	Armases roberti	1st	?	Guerao *et al.* (2007)
	Armases rubripes	1st to 10th	5th	Diaz & Ewald (1968); Negreiros-Fransozo *et al.* (2011)
	Chiromantes eulimene	1st	?	Guerao *et al.* (2011)
	Perisesarma fasciatum	1st	?	Guerao *et al.* (2004)
	Sesarma rectum	1st to 15th	12th	Fransozo (1986/87)
Ucididae Števčić, 2005	*Uca cumulanta*	1st to 8th	3rd	Hirose *et al.* (2010)
	Uca maracoani	1st to 9th	6th to ♀; 7th to ♂	Hirose & Negreiros-Fransozo (2008)
Varunidae H. Milne-Edwards, 1853	*Cyrtograpsus angulatus*	1st to 13th	4th	Rieger & Beltrão (2000)
	Eriocheir japonica	1st to 5th	3rd	Lee *et al.* (1994)
	Neohelice granulata (described as *Chasmagnathus granulata*)	1st to 8th	3rd	Rieger & Nakagawa (1995)
Xanthidae MacLeay, 1838	*Leptodius exaratus* MacLeay, 1838	1st to 9th	4th	Lwin *et al.* (2007)
	Xantho pilipes MacLeay, 1838	1st	?	Paula & Dos Santos (2000)

'?' = the authors did not mention or did not see the stage in which the sexual differentiation occurs.

et al. (2008) and Bolla Jr *et al.* (2014), and for *A. spinimanus* (present study).

Definitions of specific morphological characteristics for each species, both portunids as well as representatives from other groups, are extremely complex due to the low number of previous studies on juvenile development among Decapoda. However, such definition is particularly crucial, as a tool for identification of juveniles of these decapods, for monitoring of areas of population growth, especially for threatened and/or invasive species.

For morphological descriptions of juvenile decapods, the authors take into account the number of segments and setae present on body appendages. Nevertheless, due to the difficulty in finding distinctive characters with light microscopy, the study of the juvenile phase has been limited to the count of setae on appendices and the mapping of its distribution throughout the body of the animal (Rieger & Beltrão, 2000).

In this study, some appendages and morphological characteristics proved to be of great importance due to some peculiarities, which are observed with minimal manipulation of specimens and, probably, could be used for future comparisons and species identification. We can point out the following characters in this procedure: (1) the spines of internal margin of merus of the cheliped (*A. spinimanus* and *P. pelagicus* show 4 spines, whereas *C. danae, C. ornatus* and *C. sapidus* show only 3); (2) the long superior spine of carpus of the cheliped (present in *A. spinimanus* and *P. pelagicus* and absent in *C. danae, C. ornatus* and *C. sapidus*); and (3) the segmentation of the mandible palp (which is 2-segmented in *A. spinimanus* and *P. pelagicus* and 3-segmented in *C. danae, C. ornatus* and *C. sapidus*). These morphological features can provide separations among the species of the genus *Callinectes* and the genera *Portunus* and *Achelous*, but not only between the last two genera.

Another two easy differentiations detected for each species are: (1) the number of segments on antennal flagellum (*C. sapidus, A. spinimanus, C. danae* and *C. ornatus* show 8, 9, 10 and 10(11) segments, respectively); and (2) the number of segments on the exopod of antennule – *A. spinimanus* is the only one among the species of these two genera that has 8 segments (other species have 7 segments), in addition to a set of aesthetascs. This feature probably could be used for quick identification, while new descriptions are not provided for the other species of this group.

Concerning the sternum, the presence of concentric and semi-circular wrinkles on the seventh somite of the first juvenile stage, observed in *A. spinimanus, C. danae* and *C. ornatus*, could be explained as a remnant of sternal spine found in the same place during the megalopa stage, and it is characteristic of this larval phase for the family Portunidae (Kurata, 1975). Additionally, such wrinkles was not found in the later stages, reinforcing this idea; however, further studies are necessary to clear up the origin of these structures. In *C. sapidus* and *P. pelagicus*, the authors did not report the presence of these wrinkles, probably because they did not note this feature.

The superior abdominal closing mechanism (located on the fifth thoracic sternite) of the juvenile phase of *A. spinimanus, C. danae* and *C. ornatus* is in accordance with the more typical system of sealing found in Eubrachyura (Guinot & Bouchard, 1998). Nevertheless, nothing is mentioned in the literature about the inferior closing mechanism (on the eighth sternite), except for *C. danae*, in which this feature is also present (see Bolla Jr *et al.*, 2014 for details). Thus, this mechanism could be exclusive to the family Portunidae, but we could only confirm this hypothesis with further studies of other species within and outside this family.

The sexual dimorphism in the abdomen shape of males and females adults is not evident throughout the stages obtained for *A. spinimanus*. For *C. sapidus, C. ornatus* and *P. pelagicus* studied, respectively, up to the 11th, 12th and third juvenile stages, the sexual dimorphism in the abdomen shape was also not observed. Thus, probably this feature appears in later stages for the Portunoidea species, in contrast to representatives of other superfamilies. For instance, in *Inachus dorsettensis* Pennant, 1777 (Majoidea) and *Pachygrapsus transversus* Gibbes, 1850 (Grapsoidea), the

Table 4. Diagnostic features that allow the differentiation and identification of the first juvenile stage of species with occurrence in the Brazilian coast, with stages of the juvenile phase known to date.

1st juvenile stage		Reference	Antennule		Antenna	Mandible	Maxillule		Maxilla	1st Maxilliped		2nd Maxilliped	3rd Maxilliped
Family	Species		Seg		Seg	Seg of palp	Seg of (E)	Setae on: (P); (CE); (BE); (E)	Setae on: (CE); (BE); (E); (Ex) (marginal)	Seg of (E)	Setae on: (CE); (BE); (E); (Ex); (Ep)	Setae on: (E); (Ex); (Ep)	Setae on: (P); (Ex); (Ep)
			(E)	(Ex)									
Aethridae	*Hepatus pudibundus*	Hebling & Rieger (2003)	2	8	3 + 7–8	2	1	4(P); 15–17(CE); 23–25(BE); 6(E)	10–12 + 6–8(CE); 8–9 + 7–10(BE); 8–10(E); 73–93(Ex)	1	20–22(CE); 32–35(BE); 29–30(E); 7–9,2–3(Ex); 24(Ep)	10,4,6,4(E); ±17,4–7(Ex); 13(Ep)	±26(P); 12,0–3(Ex); 26(Ep)
Eriphiidae	*Eriphia gonagra*	Fransozo & Negreiros-Fransozo (1987)	3	6	4 + 8	2	2	3(P); 21–22(CE); 27–32(BE); 7–9,8–9(E)	18–20 + 9–13(CE); 12–15 + 16–18(BE); 8(E); 90–95(Ex)	2	9–11(CE); 24–27(BE); 16–18,15–17(E); 19,2 + 8(Ex); 6–7 + 27–30(Ep)	Nu(E); 27–29,3 + 8(Ex); 11–14 + 17–20(Ep)	28–31(P); 14–15,1 + 9(Ex); 35–38(Ep)
	Eurypanopeus abbreviatus	Fransozo & Negreiros-Fransozo (1987)	2	3	4 + 7	3	1	2(P); 14(CE); ±22(BE); 4(E)	6 + 5(CE); 6 + 7(BE); 5–6(E); 50–55(Ex)	1	18–20(CE); 29(BE); 3 + 7(E); 1,5(Ex); 18(Ep)	Nu(E); 6–8,5(Ex); 3(Ep)	25–27(P); 7,2 + 6(Ex); 9 + 20–21(Ep)
	Eurytium limosum	Guimarães & Negreiros-Fransozo (2005)	2	5	3 + 7	2	1	3(P); 14(CE); 22(BE); 3(E)	4 + 6(CE); 7 + 9(BE); 1(E); 49–56(Ex)	1	11(CE); 25(BE); 8–9(E); 2,6(Ex); 15(Ep)	9,1,6,10(E); 10,5(Ex); 2(Ep)	36(P); 5,6(Ex); 28(Ep)
	Hexapanopeus caribbaeus	Vieira (2000)	2	5	3 + 6	2	2	2(P); 12–14(CE); 19–23(BE); 3,2(E)	2–3 + 3–4(CE); 5–6 + 7–8(BE); 6(E); 54–56(Ex)	1	14–22(CE); 25–28(BE); 8(E); 0,5(Ex); 2 + 13–15(Ep)	6,1–2,5,9(E); 6,5(Ex); 4–5(Ep)	17–19(P); 6–7,5(Ex); 11–16 + 18–20(Ep)
	Panopeus austrobesus	Hebling *et al.* (1982)	2	4	3 + 7	2	2	1(P); 10–11(CE); 15–17(BE); 2,2(E)	4 + 5(CE); 5–6 + 7(BE); 1(E); 50–53(Ex)	1	10(CE); 16–18(BE); 8(E); 2,6(Ex); 2 + 13(Ep)	6–8,2,6,11–13(E); 11–12,5(Ex); 2 + 5–6(Ep)	22–24(P); 6,6(Ex); 10 + 10–11(Ep)
	Panopeus occidentalis	Rodrigues (1997)	2	6	3 + 8	3	2	4(P); 13(CE); 24(BE); 2,2(E)	4 + 7(CE); 12 + 6(BE); 6(E); 47(Ex)	1	17(CE); 43(BE); 12(E); 4,6(Ex); 17(Ep)	1,7,2,8,11(E); 12,5(Ex); 11(Ep)	±37(P); 6,8(Ex); 8 + ±15(Ep)
	Panopeus rugosus	Rodrigues (1997)	2	6	3 + 7	2	2	3(P); 15(CE); 24(BE); 1–2,2(E)	5 + 9(CE); 8 + 12(BE); 5(E); 48–53(Ex)	1	17(CE); 35–38(BE); 11–12(E); 2–3,6(Ex); 18(Ep)	8–10,1,8,11(E); 10–13,6(Ex); 7(Ep)	39–49(P); 7,9(Ex); 15 + 21–24(Ep)
Grapsidae	*Pachygrapsus transversus*	Flores *et al.* (1998)	3	6	3 + 8	3	2	?(P); 34(CE); 35(BE); 5,6(E)	22–25 + 9(CE); 11 + 18–20(BE); 0(E); ±120(Ex)	2	Nu(CE); Nu(BE); Nu,10 + 10(E); 5,6(Ex); 68–73(Ep)	4,2,±12 + 4,4,14–16,Nu(E); 16–19 + 11,9(Ex); 25(Ep)	Nu(P); 17,3 + 6(Ex); Nu + 50–55(Ep)

Menippidae	*Menippe nodifrons*	Fransozo *et al.* (1988)	2	8	3 + 9	2	2	2(P); 21(CE); 33(BE); 2,3(E)	5–6 + 7–8(CE); 11 + 15–17(BE); 5(E); 77–78(Ex)	1	25(CE); 45(BE); 17(E); 13,6(Ex); ±59(Ep)	15,6,9,14(E); 16,6(Ex); 10–13(Ep)	±53(P); 12,8(Ex); 24(Ep)
Panopeidae	*Acantholobulus bermudensis*	Martin *et al.* (1984)	?	?	?	2	2	1(P); 14–15(CE); 23–24(BE); 2–3,2(E)	3 + 5(CE); 7 + 9(BE); 1–2(E); 43–47(Ex)	1	13–14(CE); 23–24(BE); 8–11(E); 2,5–6(Ex); 15–18(Ep)	3,1,7,11(E); 7–11,5–6(Ex); 3–4 + 2–4(Ep)	±25(P); 4–6,5–6(Ex); 7–8 + 12–15(Ep)
Percnidae	*Percnon gibbesi*	Paula & Hartnoll (1989)	?	?	3 + 10	?	?	?	?	?	?	?	?
Portunidae	*Achelous spinimanus*	*Present study*	2	8	3 + 9	2	2	2(P); 23(CE); 34(BE); 5,4(E)	9 + 5(CE); 10 + 14(BE); 4(E); 86(Ex)	1	44(CE); 68(BE); 40(E); 16,10(Ex); 91(Ep)	10,23,6,16,15(E); 40,12(Ex); 0(Ep)	55(P); 49,13(Ex); ±50 + 30(Ep)
	Callinectes danae	Bolla *et al.* (2014)	2	7	3 + 10	3	2	2(P); 19(CE); 30(BE); 4,5(E)	7 + 8(CE); 10 + 16(BE); 5(E); 85(Ex)	1	33(CE); 58(BE); 12 + 24(E); 20,12(Ex); 58(Ep)	11,24,6,15,14(E); 35,9(Ex); 3(Ep)	66(P); 69, 10(Ex); ±53 + 15(Ep)
	Callinectes ornatus	Bolla *et al.* (2008)	2	7	3 + 10–11	3	2	3(P); 20(CE); 27(BE); 3,4–5(E)	6–7 + 7(CE); 8–9 + 13–14(BE); 3–4(E); 88–90(Ex)	1	±26(CE); ±67(BE); 32–35(E); 18,11(Ex); ±49(Ep)	27,8,14,14(E); 42,10(Ex); 6(Ep)	45,11(Ex); 16 + Nu(P); Nu + 28(Ep)
	Callinectes sapidus	Barutot *et al.* (2001)	2	7	3 + 8	3	2	2(P); 15–17(CE); 23–25(BE); 4,2(E)	7–9 + 3–4(CE); 6–7 + 14–16(BE); 0(E); 60–70(Ex)	1	17–21(CE); 38–44(BE); 17(E); 11–13,5–6(Ex); 28 + 11(Ep)	12,2,3,12–14(E); 19–21,6(Ex); 0(Ep)	14–17(P); 13–15,5(Ex); 9–11 + 13(Ep)
Pseudorhombilidae	*Bathyrhombila* sp.	Moraes *et al.* (2011)	2	6	4 + 7	3	2	2–3(P); 14–17(CE); 0–6 + 12–22(BE); 0–2,2(E)	4–7 + 5–8(CE); 3–7 + 10–11(BE); 3(E); 48–54(Ex)	1	19–21(CE); 31–36(BE); 2–5 + 5–8(E); 0–3,6(Ex); 15–20(Ep)	4–5,4–9,1–2,6–8,10–13(E); 7–16,6(Ex); 0–5 + 4–7(Ep)	29–43(P); 1–14 + 3,0–2 + 4–6(Ex); 9–36 + 14–27(Ep)
Sesarmidae	*Armases rubripes*	Diaz & Ewald (1968)	ab	3	3 + 5	2	2	2(P); 11(CE); 17(BE); 2,4(E)	10 + 4(CE); 7 + 6(BE); 0(E); 50(Ex)	1	12(CE); 13(BE); 5(E); 1,4(Ex); 3 + 8(Ep)	2,1,5,9(E); 8,4(Ex); ?(Ep)	±16(P); 9,5(Ex); ±30 + 16(Ep)
	Armases rubripes (redescription)	Negreiros-Fransozo *et al.* (2011)	ab	3	3 + 6	2	1	1(P); 10(CE); 18(BE); 2(E)	11 + 5(CE); 5 + 8(BE); 0(E); 36–38(Ex)	1	10(CE); 14(BE); 5(E); 0,3(Ex); 12(Ep)	0,2,2,7–8 + 9–10(E); 8–9 + 1,5(Ex); ?(Ep)	13–19(P); 6–7,3–4(Ex); 8–10 + 14–18(Ep)
	Sesarma rectum	Fransozo (1986/87)	ab	2	3 + 5	2	2	1(P); 8–10(CE); 15–16(BE); 1,3(E)	10–11 + 4(CE); 7–8 + 6(BE); 0(E); 37–39(Ex)	1	8–11(CE); 14–16(BE); 7(E); 2,4(Ex); 3 + 6(Ep)	1,1,2,4–5,8–9(E); 8–9,5(Ex); ab(Ep)	24–28(P); 8,5(Ex); 7–8 + 14–16(Ep)

Continued

Table 4. Continued

1st juvenile stage		Reference	Antennule		Antenna	Mandible	Maxillule		Maxilla	1st Maxilliped		2nd Maxilliped	3rd Maxilliped
Family	Species		Seg		Seg	Seg of palp	Seg of (E)	Setae on: (P); (CE); (BE); (E)	Setae on: (CE); (BE); (E); (Ex) (marginal)	Seg of (E)	Setae on: (CE); (BE); (E); (Ex); (Ep)	Setae on: (E); (Ex); (Ep)	Setae on: (P); (Ex); (Ep)
			(E)	(Ex)									
Ucididae	*Uca cumulanta*	Hirose *et al.* (2010)	1	1	3 + 6	3	2	4(P); 51(CE); 21(BE); 0,3(E)	19 + 8(CE); 14 + 21(BE); 1(E); 53(Ex)	1	38(CE); 46(BE); 35(E); 4,4(Ex); 24(Ep)	3,25,3,10,9(E); 11,5(Ex); 0(Ep)	3(P); 12,7(Ex); Nu + 25(Ep)
Varunidae	*Cyrtograpsus angulatus*	Rieger & Beltrão (2000)	2	4	3 + 6–7	3	2	3(P); 23–24(CE); 25–30(BE); 2,5–6(E)	18–19 + 7–8(CE); 10–13 + 12–14(BE); 2–3(E); 57–64 (Ex)	1	19–21(CE); 18–23(BE); 3–8 + 0–2(E); 3–5,4–5(Ex); 17–21(Ep)	2,3–4,1,5–9,10–14(E); 10–15,5–6(Ex); 3–5(Ep)	40–48(P); 16–17,5–6(Ex); 49–54(Ep)
	Neohelice granulata	Rieger & Nakagawa (1995)	2	4	3 + 7	2	2	1(P); 31–35(CE); 19–21(BE); 1,3(E)	17 + 4(CE); 13 + 12–14(BE); 1(E); 76–80(Ex)	1	22(CE); 19(BE); 18(E); 3,5(Ex); 7 + 9(Ep)	1,7,1,8,14(E); 14–15,5(Ex); 7(Ep)	±51(P); 13–17,5(Ex); 25–28 + 26–29(Ep)

Seg = number of segments; (E) = endopod; (Ex) = exopod; (P) = protopod; (CE) = coxal endite; (BE) = basal endite; (Ep) = epipod; ? = the authors did not mention; ± = approximately; Nu = numerous; ab = absent. Commas separate setae by segment.

morphological sexual differentiation occurs from the third and sixth juvenile stages on, respectively (Ingle, 1977; Flores *et al.*, 1998); in *Cyrtograpsus angulatus* Dana, 1851 (Grapsoidea), the sexual differentiation begins from the fourth stage on, becoming more apparent from the eighth juvenile stage on (Rieger & Beltrão, 2000); and in *Calappa tortugae* Rathbun, 1933 (Calappoidea), the secondary sexual characters appear from the second juvenile stage on (Negreiros-Fransozo *et al.*, 2007).

The presence of rudimentary pleopods in the first juvenile stage can be different among the Portunoidea species studied; this feature is present in *C. sapidus, C. ornatus* and *P. pelagicus*, but it is absent in *C. sapidus* and *A. spinimanus*. However, with the exception of *P. pelagicus* in which the rudimentary pleopods are present up to the last stage studied (third), in all other species the pleopods totally degenerate from the second juvenile stage. They reappear (two pairs for males and four pairs for females) in later juvenile stages that can vary according with species, as can be seen in Table 3. Among Portunoidea, this occurs from the third stage in *A. spinimanus* and from the fourth stage in *C. danae, C. ornatus* and *C. sapidus*; this, apparently, could be a particular character of these genera. Nevertheless, only with a high number of species studied of distinctive genera could one get a satisfactory definition.

Another interesting differential characteristic is the biramous condition of the second pair of the pleopods of males (PL_2), from its first appearance to the fifth stage in *A. spinimanus*, until the eighth stage in *C. danae* and until the sixth stage in *C. ornatus*. In *C. sapidus*, the PL_2 remain biramous, at least, until the seventh stage (the authors did not report if they still are biramous in the later stages). With respect to the first pair of pleopods of males (PL_1), this is uniramous as of its origin in all Portunoidea species studied, except for *C. sapidus*, in which the PL_1 is also biramous until the seventh juvenile stage. These features of pleopods, both the rudimentary ones and the biramous conditions of male pleopods, are useful for species identification within the group, since they can be easily observed.

Table 4 presents the comparative studies of the main characteristics that can be used to differentiate the species with juvenile development previously studied, and which occur in the Brazilian coast.

The description of early stages of decapod crustacean species are useful in the identification of settlement areas of such species, which is necessary to the fisheries management in many areas. In addition, it could contribute towards systematic studies, since it aids in the elaboration and validation of identification keys for adult specimens (Martin *et al.*, 1984). Morphological studies also collaborate for effective separation of species of interest for carciniculture, besides their identification in planktonic or benthic samples (Guerao & Abelló, 2011; Bolla Jr *et al.*, 2014).

ACKNOWLEDGEMENTS

We thank the members of NEBECC for their assistance during this study. All sampling in this investigation was conducted in accordance with Brazilian applicable state and federal laws.

FINANCIAL SUPPORT

We are grateful to the Brazilian Council of Scientific and Technological Development (CNPq) for the first author's

Master of Science scholarship (#553174/2008-8) and to the São Paulo Research Foundation (FAPESP) for providing the financial support during neuston collections (#2004/15194-6).

REFERENCES

Anger K. (2003) Salinity as a key parameter in the larval biology of decapod crustaceans. *Invertebrate Reproduction and Development* 43, 29–45. doi: 10.1080/07924259.2003.9652520.

Barutot R.A., Vieira R.R.R. and Rieger P.J. (2001) Desenvolvimento juvenil de *Callinectes sapidus* Rathbun, 1896 (Crustacea: Decapoda: Portunidae), em laboratório, a partir de megalopas coletadas no plâncton. *Comunicações do Museu de Ciências e Tecnologia da PUCRS, Série Zoologia* 14, 23–42.

Bolla Jr E.A., Fransozo V. and Negreiros-Fransozo M.L. (2014) Juvenile development of *Callinectes danae* Smith, 1869 (Crustacea, Decapoda, Brachyura, Portunidae) under laboratory conditions. *Anais da Academia Brasileira de Ciências* 86, 211–228. doi: 10.1590/0001-37652014118912.

Bolla Jr E.A., Negreiros-Fransozo M.L. and Fransozo A. (2008) Juvenile development of *Callinectes ornatus* Ordway, 1863 (Crustacea: Decapoda: Portunidae), from megalopae obtained in the neuston. *Zootaxa* 1788, 1–20.

Clark P.F., Calazans D.D. and Pohle G.W. (1998) Accuracy and standardization of brachyuran larval descriptions. *Invertebrate Reproduction and Development* 33, 127–144. doi: 10.1080/07924259.1998.9652627.

Corbi-Corrêa E. and Fransozo A. (2002) Growth patterns of *Portunus spinicarpus* (Stimpson, 1871) (Decapoda, Portunoidea) from Ubatuba region (SP), Brazil. *Nauplius* 10, 131–137.

De Grave S., Pentcheff N.D., Ahyong S.T., Chan T.Y., Crandall K.A., Dworschak P.C., Felder D.L., Feldmann R.M., Fransen C.H.J.M., Goulding L.Y.D., Lemaitre R., Low M.E.Y., Martin J.W., Ng P.K.L., Schweitzer C.E., Tan S.H., Tshudy D. and Wetzer R. (2009) A classification of living and fossil genera of decapod crustaceans. *Raffles Bulletin of Zoology, Supplement* 21, 1–109.

De Lestang S., Hall N. and Potter I.C. (2003) Influence of a deep artificial entrance channel on the biological characteristics of the blue swimmer crab *Portunus pelagicus* in a large microtidal estuary. *Journal of Experimental Marine Biology and Ecology* 295, 41–61. doi: 10.1016/S0022-0981(03)00273-9.

Demain D.K., Gallego A., Jaworski A., Priede I.G. and Jones E.G. (2011) Diet and feeding niches of juvenile *Gadus morhua, Melanogrammus aeglefinus* and *Merlangius merlangus* during the settlement transition in the northern North Sea. *Journal of Fish Biology* 79, 89–111. doi: 10.1111/j.1095-8649.2011.02997.x.

Diaz H. and Ewald J.J. (1968) A comparison of the larval development of *Metasesarma rubripes* (Rathbun) and *Sesarma ricordi* H. Milne Edwards (Brachyura, Grapsidae) reared under similar laboratory conditions. *Crustaceana, Supplements* 2, 225–248.

Dineen J.F., Clark P.F., Hines A.H., Reed S.A. and Walton H.P. (2001) Life history, larval description, and natural history of *Charybdis hellerii* (Decapoda, Brachyura, Portunidae), an invasive crab in the Western Atlantic. *Journal of Crustacean Biology* 21, 774–805. doi: 10.1163/20021975-99990173.

Figueiredo J., Penha-Lopes G., Narciso L. and Lin J. (2008) Effect of starvation during late megalopa stage of *Mithraculus forceps* (Brachyura: Majidae) on larval duration, synchronism of metamorphosis, survival to juvenile, and newly metamorphosed juvenile size. *Aquaculture* 274, 175–180. doi: 10.1016/j.aquaculture.2007.10.052.

Flores A.A.V., Marques F.P.L. and Negreiros-Fransozo M.L. (2002) Postlarval stages and growth patterns of the spider crab *Pyromaia tuberculata* (Brachyura, Majidae) from laboratory-reared material. *Journal of Crustacean Biology* 22, 314–327. doi: 10.1163/20021975-99990238.

Flores A.A.V., Negreiros-Fransozo M.L. and Fransozo A. (1998) The megalopa and juvenile development of *Pachygrapsus transversus* (Gibbes, 1850) (Decapoda, Brachyura), compared with other grapsid crabs. *Crustaceana* 71, 197–222. doi: 10.1163/156854098X00176.

Fransozo A. (1986/87) Desenvolvimento dos estágios juvenis de *Sesarma (Holometopus) rectum* Randall, 1840 (Decapoda, Grapsidae) obtidos em laboratório. *Naturalia* 12, 77–87.

Fransozo A. and Negreiros-Fransozo M.L. (1987) Morfologia dos primeiros estágios juvenis de *Eriphia gonagra* (Fabricius, 1781) e *Eurypanopeus abbreviatus* (Stimpson, 1860) (Crustacea, Decapoda, Xanthidae), obtidos em laboratório. *Papéis Avulsos de Zoologia* 36, 257–277.

Fransozo A., Negreiros-Fransozo M.L. and Hiyodo C.M. (1988) Développement juvénile de *Menippe nodifrons* Stimpson, 1859 (Crustacea, Decapoda, Xanthidae) au laboratoire. *Revue d'Hydrobiologie Tropicale* 21, 297–308.

Garm A. (2004) Revising the definition of the crustacean seta and setal classification systems based on examinations of the mouthpart setae of seven species of decapods. *Zoological Journal of the Linnean Society* 142, 233–252. doi: 10.1111/j.1096-3642.2004.00132.x.

González-Gordillo J.I., Anger K. and Schubart C.D. (2010) Morphology of the larval and first juvenile stages of two Jamaican endemic crab species with abbreviated development, *Sesarma windsor* and *Metopaulias depressus* (Decapoda: Brachyura: Sesarmidae). *Journal of Crustacean Biology* 30, 101–121. doi: 10.1651/08-3110.1.

Guerao G. and Abelló P. (2011) Early juvenile development of Mediterranean *Liocarcinus depurator* (Crustacea: Decapoda: Brachyura: Portunidae). *Journal of Natural History* 45, 2175–2193. doi: 10.1080/00222933.2011.590948.

Guerao G., Abelló P. and Cartes J. (1998) Morphology of the megalopa and first crab instar of the Shamefaced Crab *Calappa granulata* (Crustacea, Brachyura, Calappidae). *Miscellanea Zoologica Hungarica* 21, 37–47.

Guerao G., Abelló P. and Cuesta J.A. (1997) Morphology of the megalopa and first crab stage of the mediolittoral crab *Pachygrapsus marmoratus* (Brachyura, Grapsidae, Grapsinae). *Zoosystema* 19, 437–447.

Guerao G., Anger K., Nettelmann U. and Schubart C.D. (2004) Complete larval and early juvenile development of the mangrove crab *Perisesarma fasciatum* (Crustacea: Brachyura: Sesarmidae) from Singapore, with a larval comparison of *Parasesarma* and *Perisesarma*. *Journal of Plankton Research* 26, 1389–1408. doi: 10.1093/plankt/fbh127.

Guerao G., Anger K. and Schubart C.D. (2007) Larvae and first-stage juveniles of the American genus *Armases* (Brachyura: Sesarmidae): a morphological description of two complete developments and one first zoeal stage. *Journal of Natural History* 41, 1811–1839. doi: 10.1080/00222930701500431.

Guerao G. and Rotllant G. (2009) Post-larval development and sexual dimorphism of the spider crab *Maja brachydactyla* (Brachyura: Majidae). *Scientia Marina* 73, 797–808. doi: 10.3989/scimar.2009.73n4797.

Guerao G. and Rotllant G. (2010) Development and growth of the early juveniles of the spider crab *Maja squinado* (Brachyura: Majoidea) in an individual culture system. *Aquaculture* 307, 105–110. doi: 10.1016/j.aquaculture.2010.06.006.

Guerao G., Rufino M. and Abelló P. (2002) The complete larval development and first juvenile of the spider crab *Inachus thoracicus* Roux, 1830 (Brachyura: Majidae: Inachinae). *Journal of Plankton Ressearch* 24, 875–887. doi: 10.1093/plankt/24.9.875.

Guerao G., Simoni R., Cannicci S. and Anger K. (2011) Morphological description of the megalopa and the first juvenile crab stage of *Chiromantes eulimene* (Decapoda, Brachyura, Sesarmidae), with a revision on zoeal morphology. *Invertebrate Reproduction and Development* 55, 100–109. doi: 10.1080/07924259.2011.553416.

Guimarães F.J. and Negreiros-Fransozo M.L. (2005) Juvenile development and growth patterns in the mud crab *Eurytium limosum* (Say, 1818) (Decapoda, Brachyura, Xanthidae) under laboratory conditions. *Journal of Natural History* 39, 2145–2161. doi: 10.1080/00222930500061254.

Guinot D. and Bouchard J.M. (1998) Evolution of the abdominal holding systems of brachyuran crabs (Crustacea, Decapoda, Brachyura). *Zoosystema* 20, 613–694.

Hebling N.J., Fransozo A. and Negreiros-Fransozo M.L. (1982) Desenvolvimento dos primeiros estágios juvenis de *Panopeus herbstii* H. Milne-Edwards, 1834 (Crustacea, Decapoda, Xanthidae), criadas em laboratório. *Naturalia* 7, 177–188.

Hebling N.J. and Rieger P.J. (2003) Desenvolvimento juvenil de *Hepatus pudibundus* (Herbst) (Crustacea, Decapoda, Calappidae), em laboratório. *Revista Brasileira de Zoologia* 20, 531–539.

Hernández T.I. and Ramírez G.J. (1990) Obtención de jaiba suave *Callinectes* spp en flotadores de madera en Alvarado. *Secretaría de Pesca, Serie Documentos de Trabajo (México)* 16, 1–22.

Hirose G.L., Bolla E.A. Jr and Negreiros-Fransozo M.L. (2010) Post-larval morphology, growth, and development of *Uca cumulanta* Crane, 1943 (Crustacea, Decapoda, Ocypodidae) under laboratory conditions. *Invertebrate Reproduction and Development* 54, 95–109. doi: 10.1080/07924259.2010.9652321.

Hirose G.L. and Negreiros-Fransozo M.L. (2008) Growth and juvenile development of *Uca maracoani* Latreille, 1802–1803 in laboratory conditions (Crustacea, Decapoda, Brachyura, Ocypodidae). *Senckenbergiana Biologica* 88, 161–168.

Ingle R.W. (1977) The larval and post-larval development of the scorpion spider crab, *Inachus dorsettensis* (Pennant) (Family: Majidae), reared in the laboratory. *Bulletin of the British Museum (Natural History), Zoology* 3, 331–348.

Ingle R.W. (1979) The larval and post-larval development of the brachyuran crab *Geryon tridens* Kröyer (Family Geryonidae) reared in the laboratory. *Bulletin of the British Museum (Natural History), Zoology* 36, 217–232.

Ingle R.W. (1981) The larval and post-larval development of the Edible Crab, *Cancer pagurus* Linnaeus (Decapoda: Brachyura). *Bulletin of the British Museum (Natural History), Zoology* 40, 211–236.

Ingle R.W. and Clark P.F. (1980) The larval and post-larval development of Gibbs's spider crab, *Pisa armata* (Latreille) [family Majidae: subfamily Pisinae], reared in the laboratory. *Journal of Natural History* 14, 723–735. doi: 10.1080/00222938000770601.

Ingle R.W. and Rice A.L. (1984) The juvenile stages of eight swimming crab species (Crustacea: Brachyura: Portunidae): a comparative study. *Bulletin of the British Museum (Natural History), Zoology* 46, 345–354.

Kurata H. (1975) Larvae of Decapoda Brachyura of Arasaki, Sagami Bay-V. The swimming crabs of subfamily Portuninae. *Bulletin of the Nansei Regional Fisheries Research Laboratory* 8, 39–65.

Lebour M.V. (1944a) Larval crabs from Bermuda. *Zoologica* 29, 113–128.

Lebour M.V. (1944b) The larval stages of *Portumnus* (Crustacea, Brachyura) with notes on some other genera. *Journal of the Marine Biological Association of the United Kingdom* 26, 7–15. doi: 10.1017/S0025315400014429.

Lee T.H., Yamauchi M. and Yamazaki F. (1994) Sex differentiation in the crab *Eriocheir japonicus* (Decapoda, Grapsidae). *Invertebrate Reproduction and Development* 25, 123–137. doi: 10.1080/07924259.1994.9672377.

Lwin T.T., Doi W., Yokota M., Strüssmann C.A. and Watanabe S. (2007) Juvenile morphology of the xanthid crab *Leptodius exaratus* (H. Milne-Edwards, 1834) (Decapoda: Brachyura), with notes on the appearance of sexual dimorphism. *Invertebrate Reproduction and Development* 50, 191–201. doi: 10.1080/07924259.2007.9652246.

Mantelatto F.L.M. and Fransozo A. (1996) Size at sexual maturity in *Callinectes ornatus* (Brachyura, Portunidae) from the Ubatuba region (SP), Brazil. *Nauplius* 4, 29–38.

Mantelatto F.L.M. and Fransozo A. (1999). Reproductive biology and moulting cycle of the crab *Callinectes ornatus* Ordway, 1863 (Decapoda, Brachyura, Portunidae) from Ubatuba region, São Paulo, Brazil. *Crustaceana* 72, 63–76. doi: 10.1163/156854099502871.

Mantelatto F.L.M., Robles R., Schubart C.D. and Felder D.L. (2009) Molecular phylogeny of the genus *Cronius* Stimpson, 1860, with reassignment of *C. tumidulus* and several American species of *Portunus* to the genus *Achelous* De Haan, 1833 (Brachyura: Portunidae). In Martin J.W., Crandall K.A. and Felder D.L. (eds) *Crustacean issues: decapod crustacean phylogenetics*. Boca Raton, FL: Taylor & Francis/CRC Press, pp. 537–551.

Marques F.P.L., Pohle G.W. and Vrbova L. (2003) On the larval stages of *Macrocoeloma diplacanthum* (Decapoda: Brachyura: Majidae), and a review of Mithracine phylogenetic aspects. *Journal of Crustacean Biology* 23, 187–200. doi: 10.1163/20021975-99990326.

Martin J.W., Felder D.L. and Truesdale F.M. (1984) A comparative study of morphology and ontogeny in juvenile stages of four western Atlantic xanthoid crabs (Crustacea: Decapoda: Brachyura). *Philosophical Transactions of the Royal Society B* 303, 537–604. doi: 10.1098/rstb.1984.0001.

Melo G.A.S. (1996) *Manual de Identificação dos Brachyura (Caranguejos e Siris) do Litoral Brasileiro*. 1st edition. São Paulo: Plêiade/FAPESP.

Moraes J.C.B., Negreiros-Fransozo M.L. and Melo G.A.S. (2011) Juvenile development of the crab *Bathyrhombila* sp. (Crustacea, Decapoda, Pseudorhombilidae) from megalopae obtained in the neuston. *Marine Biology Research* 7, 159–175. doi: 10.1080/17451000.2010.489754.

Muraoka K. (1979) On the post-larva of *Pinnixa rathbuni* Sakai (Crustacea, Brachyura, Pinnotheridae). *Zoological Magazine (Tokyo)* 88, 288–294.

Negreiros-Fransozo M.L., Fernandes C.S., Da Silva S.M.J. and Fransozo A. (2011) Early juvenile development of *Armases rubripes* (Rathbun 1897) (Crustacea, Brachyura, Sesarmidae) and comments on the morphology of the megalopa and first crab. *Invertebrate Reproduction and Development* 55, 53–64. doi: 10.1080/07924259.2010.548645.

Negreiros-Fransozo M.L., Fransozo A., Gonzalez-Gordillo J.I. and Bertini G. (2002) First appraisal on releasing and reinvasion of decapod larvae in a subtropical estuary from Brazil. *Acta Limnologica Brasiliensia* 14, 87–94.

Negreiros-Fransozo M.L. and Fransozo V. (2003) Morphometric study of the mud crab, *Panopeus austrobesus* Williams, 1983 (Decapoda, Brachyura) from a subtropical mangrove in South America. *Crustaceana* 76, 281–294. doi: 10.1163/156854003765911685.

Negreiros-Fransozo M.L., Wenner E.L., Knott D. and Fransozo A. (2007) The megalopa and early juvenile stages of *Calappa tortugae* Rathbun, 1933 (Crustacea, Brachyura) reared in laboratory from neuston samples. *Proceedings of the Biological Society of Washington* 120, 469–485. doi: 10.2988/0006-324X(2007)120[469:TMAEJS]2.0.CO;2.

Paul R.K. (1981) The development of a fishery for portunid crabs of the genus *Callinectes* (Decapoda, Brachyura) in Sinaloa, Mexico. Technical

Cooperation Officer, Overseas Development Administration, London, Final Report, 78 pp.

Paula J. (1988) The larval and post-larval development of Pennant's swimming crab, *Portumnus latipes* (Pennant) (Brachyura, Portunidae), reared in the laboratory. *Crustaceana* 55, 202–216. doi: 10.1163/156854088X00537.

Paula J. and Dos Santos A. (2000) Larval and early post-larval stages of the crab, *Xantho pilipes* A. Milne-Edwards, 1867 (Crustacea, Decapoda, Xanthidae), reared under laboratory conditions. *Invertebrate Reproduction and Development* 38, 253–264. doi: 10.1080/07924259.2000.9652458

Paula J. and Hartnoll R.G. (1989) The larval and post-larval development of *Percnon gibbesi* (Crustacea, Brachyura, Grapsidae) and the identity of the larval genus *Pluteocaris. Journal of Zoology* 218, 17–37. doi: 10.1111/j.1469-7998.1989.tb02522.x

Pinheiro M.A.A. and Fransozo A. (1998) Sexual maturity of the speckled swimming crab *Arenaeus cribrarius* (Lamarck, 1818) (Decapoda, Brachyura, Portunidae), in the Ubatuba littoral, São Paulo state, Brazil. *Crustaceana* 71, 434–452. doi: 10.1163/156854098X00536.

Ragionieri L. and Schubart C.D. (2013) Population genetics, gene flow, and biogeographical boundaries of *Carcinus aestuarii* (Crustacea: Brachyura: Carcinidae) along the European Mediterranean coast. *Zoological Journal of the Linnean Society* 109, 771–790. doi: 10.1111/bij.12099.

Rajabai K.G. (1959) Studies on the larval development of Brachyura. I. The early and post larval development of *Dotilla blanfordi* Alcock. *Annals and Magazine of Natural History* 13, 129–135.

Rajabai Naidu K.G. (1954) The post larval development of the shore crab *Ocypoda platytarsis* M. Edwards and *Ocypoda cordimana* Desmarest. *Proceedings of the Indian Academy of Sciences, Section B* 40, 89–101.

Rieger P.J. and Beltrão R. (2000) Desenvolvimento juvenil de *Cyrtograpsus angulatus* Dana (Crustacea, Decapoda, Grapsidae), em laboratório. *Revista Brasileira de Zoologia* 17, 405–420.

Rieger P.J. and Nakagawa C. (1995) Desenvolvimento juvenil de *Chasmagnathus granulata* Dana, 1851 (Crustacea, Decapoda, Grapsidae) em laboratório. *Nauplius* 3, 59–74.

Rodrigues M.D. (1997) Desenvolvimento larval e juvenil de Panopeus rugosus A. Milne Edwards, 1889 e de Hexapanopeus heblingi sp. n. e juvenil de Panopeus occidentalis de Saussure, 1857 (Crustacea, Decapoda, Xanthidae) em laboratório. PhD thesis. Setor de Ciências Biológicas, Universidade Federal do Paraná, Curitiba, Brazil.

Rodríguez A. and Paula J. (1993) Larval and postlarval development of the mud crab *Panopeus africanus* A. Milne Edwards (Decapoda: Xanthidae) reared in the laboratory. *Journal of Crustacean Biology* 13, 296–308. doi: 10.1163/193724093X00084.

Román-Contreras R. (1986) Análisis de la población de *Callinectes* spp. (Decapoda: Portunidae) en el sector occidental de la Laguna de Términos, Campeche, México. *Anales del Instituto de Ciencias del Mar y Limnología* 13, 315–322. http://biblioweb.tic.unam.mx/cienciasdelmar/instituto/1986-1/articulo207.html.

Sahoo D., Panda S. and Guru B.C. (2011) Studies on reproductive biology and ecology of blue swimming crab *Portunus pelagicus* from Chilika Lagoon, Orissa, India. *Journal of the Marine Biological Association of the United Kingdom* 91, 257–264. doi: 10.1017/S0025315410000354.

Santos S. and Negreiros-Fransozo M.L. (1995) Morphometric relationship and maturation in the *Portunus spinimanus* Latreille, 1819 (Crustacea, Decapoda, Portunidae). *Revista Brasileira de Biologia* 55, 545–553.

Santos S. and Negreiros-Fransozo M.L. (1996) Maturidade fisiológica em *Portunus spinimanus* Latreille, 1819 (Crustacea, Brachyura, Portunidae) na região de Ubatuba, SP. *Papéis Avulsos de Zoologia* 39, 365–377.

Santos S. and Negreiros-Fransozo M.L. (1997) Fecundity in the swimming crab *Portunus spinimanus* Latreille, 1819 (Decapoda, Portunidae) from Ubatuba, Brazil. *Interciencia* 22, 259–263.

Santos S. and Negreiros-Fransozo M.L. (1999) Reproductive cycle of the swimming crab *Portunus spinimanus* Latreille (Crustacea, Decapoda, Brachyura) from Ubatuba, São Paulo, Brazil. *Revista Brasileira de Zoologia* 16, 1183–1193.

Santos S., Negreiros-Fransozo M.L. and Fransozo A. (1995) Estructura poblacional de *Portunus spinimanus* Latreille, 1819 (Crustacea, Brachyura, Portunidae) en la ensenada de la Fortaleza, Ubatuba (SP), Brasil. *Revista de Investigaciones Marinas* 16, 37–44.

Sforza R., Nalesso R.C. and Joyeux J.C. (2010) Distribution and population structure of *Callinectes danae* (Decapoda: Portunidae) in a tropical Brazilian estuary. *Journal of Crustacean Biology* 30, 597–606. doi: 10.1651/09-3223.1.

Shen C.J. (1935) An investigation of the post-larval development of the shore-crab *Carcinus maenas*, with special reference to the external secondary sexual characters. *Proceedings of the Zoological Society of London* 1935, 1–33.

Sotelo G., Morán P. and Posada D. (2009) Molecular phylogeny and biogeographic history of the European *Maja* spider crabs (Decapoda, Majidae). *Molecular Phylogenetics and Evolution* 53, 314–319. doi: 10.1016/j.ympev.2009.05.009.

Stuck K.C. and Truesdale F.M. (1988) Larval development of the speckled swimming crab, *Arenaeus cribrarius* (Decapoda: Brachyura: Portunidae) reared in the laboratory. *Bulletin of Marine Science* 42, 101–132.

Taissoun E.N. (1973) Biogeografía y ecología de los cangrejos de la familia 'Portunidae' (Crustaceos Decapodos Brachyura) en la costa Atlántica de América. *Boletín del Centro de Investigaciones Biológicas Universidad del Zulia* 7, 7–23.

Vergamini F.G. and Mantelatto F.L. (2008) Microdistribution of juveniles and adults of the mud crab *Panopeus americanus* (Brachyura, Panopeidae) in a remnant mangrove area in the southwest Atlantic. *Journal of Natural History* 42, 1581–1589. doi: 10.1080/00222930802109157.

Vieira R.R.R. (2000) *Desenvolvimento larval e juvenil de* Hexapanopeus caribbaeus *(Stimpson, 1871) (Crustacea, Decapoda, Xanthidae), em laboratório*. MSc dissertation. Instituto de Biociências, Universidade Estadual Paulista, Botucatu, Brazil.

and

Yatsuzuka K. and Sakai K. (1980) The larvae and juvenile crabs of Japanese Portunidae (Crustacea, Brachyura). I *Portunus* (*Portunus*) *pelagicus* (LINNÉ). *Reports of the USA Marine Biological Institute, Kochi University* 2, 25–41.

Correspondence should be addressed to:
M.L. Negreiros Fransozo
NEBECC (Group of studies on crustacean biology, ecology and culture), Department of Zoology, Biosciences Institute, São Paulo State University, 18618-970 Botucatu, São Paulo, Brazil
email: mlnf@ibb.unesp.br