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JUVENILE DEVELOPMENT OF *DILOCARCINUS PAGEI* STIMPSON, 1861 (BRACHYURA, TRICHODACTYLIDAE) REARED IN THE LABORATORY, WITH EMPHASIS ON SETAE MORPHOLOGY

BY

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ABSTRACT

The juvenile development of the freshwater crab *Dilocarcinus pagei* Stimpson, 1861 was studied under laboratory conditions, focusing on setae morphology. The ovigerous females were collected manually associated with water hyacinth at the Municipal Dam of São José do Rio Preto (São Paulo, Brazil). The specimens were raised in the laboratory under constant aeration, photoperiod (12 : 12 h) and temperature (27 ± 1°C). Twelve juvenile stages were obtained with descriptions of the main morphological characters that allow their identification are presented. Fourteen types of setae were discovered: dentate, denticulate, serrulate, papposerrate, cuspidate, plumose, plumodenticulate, plumoserrulate, simple, pappose, brush, curved, nail and setules. The greatest diversity of setae was found on the mouth appendages, especially the maxillule. The gill ontogeny and sexual dimorphism becomes apparent from the second juvenile stage onwards. At the third juvenile stage, the carapace begins to exhibit a wider shape, becoming similar to that of the adults.

RESUMO

Foi estudado, o desenvolvimento juvenil do caranguejo de água doce *Dilocarcinus pagei* Stimpson, 1861, sob condições de laboratório, com foco na morfologia de cerdas. As fêmeas ovígeras, as quais estavam associadas a aguapé, foram coletadas manualmente na Represa Municipal de São José do Rio Preto (São Paulo – Brasil). No laboratório, os especimens foram mantidos sob aeração constante, fotoperíodo (12 : 12 h) e temperatura (27 ± 1°C). Após a eclosão, foram obtidos doze estágios juvenis e foram descritos os principais caracteres morfológicos que permitem sua identificação. Quatorze tipos de cerdas foram encontradas: dentada, denticulada. serrilhada,

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paposerrada, cuspidada, plumosa, plumodenticulada, plumoserrilhada, simples, paposa, escova, curvada, unha e sétulas. A maior diversidade de cerdas foi encontrada nos apêndices bucais, especialmente na maxílula. A ontogenia branquial e o dimorfismo sexual tornam-se completas a partir do segundo estágio juvenil. No terceiro estágio, a carapaça torna-se mais larga que longa, similar ao que ocorre nos adultos.

INTRODUCTION

Freshwater crabs spend all their life cycle in this environment, exhibit direct development, with the juveniles exhibiting characteristics similar to the adults (sensu Williamson, 1969). Studies of the juvenile phase are crucial because the traits used in species identification are based only on descriptions of the adults, which hinders the identification of species when individuals are collected in the juvenile phase. In addition to facilitating the identification of juveniles, these studies may help to establish the phylogenetic relationships within the Brachyura Latreille, 1802 (cf. Martin et al., 1984). In Brazil, few studies and then only involving marine species, have been conducted on this phase of the Brachyura (cf. Diaz & Ewald, 1968; Hebling et al., 1982; Fransozo, 1986/1987; Fransozo & Negreiros-Fransozo, 1987; Fransozo et al., 1988; Paula & Hartnoll, 1989; Rieger & Nakagawa, 1995; Flores et al., 1998, 2002; Rieger & Beltrão, 2000; Barutot et al., 2001; Dineen et al., 2001; Hebling & Rieger, 2003; Guimarães & Negreiros-Fransozo, 2005; Negreiros-Fransozo et al., 2007; Bolla Jr. et al., 2008; Vieira et al., 2010). The only known study on the juvenile development of freshwater brachyuran species is that by Müller (1892), who described the first stage of the juvenile and adult phase of a species of Trichodactylidae H. Milne Edwards, 1853 (*Trichodactylus* sp.) collected at the Itajaí-Açu River in Santa Catarina (Brazil).

Martin & Davis (2001) transferred the Trichodactylidae from the superfamily Potamoidea Ortmann, 1896 to the superfamily Portunoidea Rafinesque, 1815, and Ng et al. (2008) to the Trichodactyloidea H. Milne Edwards, 1853. To date, the family contains 49 species distributed in 15 genera (Ng et al., 2008), comprises crabs that live exclusively in fresh water and is represented in Brazil by 29 species distributed in 10 genera, with sizes ranging from 15 to 90 mm carapace width (Magalhães, 2003). These crabs are found in river plains in almost every river basin in Brazil (Magalhães & Turkay, 1996). Three species of *Dilocarcinus* H. Milne Edwards, 1853 occur: *Dilocarcinus pagei* Stimpson, 1861, *Dilocarcinus septemdentatus* (Herbst, 1783) and *Dilocarcinus truncatus* Rodriguez, 1992. *Dilocarcinus pagei* is found in Peru, Bolivia, Paraguay and Argentina, as well as in Brazil in the states of Acre, Amapá, Amazonas, Rondônia, Pará, Mato Grosso and Mato Grosso do Sul (Magalhães, 2003). The species has nocturnal habits and cryptic behaviour, remaining hidden in burrows, in holes in tree trunks submerged among the aquatic vegetation or under rocks and plants during the day, with a key role in the food chain, operating at different levels of the aquatic environments (Magalhães, 2003; Magalhães & Türkay, 2008).

The setae of crustaceans are specialised cuticular structures with basal articulation and varied size/shape, for facilitating interactions between the living tissue and the external environment, and are homologous within the Crustacea Brünnich, 1772 (cf. Garm, 2004). The setae have been widely used in differentiating species, stages, sexual dimorphism of Crustacea and the number and position of setae on the appendages might provide an important diagnostic character (Pohle & Telford, 1981; Ingle, 1992; Garm, 2004; Bauer & Caskey, 2006). Different definitions have been proposed for the setae of Crustacea, since the pioneering study of Thomas (1970), who studied the appendages of *Austropotamobius pallipes* (Lereboullet, 1858). Fish (1972) described the setae of *Eurydice pulchra* Leach, 1815, and Farmer (1974) described the setae of the mouthparts of *Nephrops norvegicus* (Linnaeus, 1758), dividing them into three basic types: simple, plumose and serrate. Drach & Jacques (1977) proposed the most complex classification of decapod setae. However, Jacques (1989) pioneered a classification based on the functional morphology of the setae, which was used by Watling (1989) in his study of homology of crustacean setae. Garm (2004) defined seven types of setae — pappose, plumose, serrulate, serrate, papposerrate, simple and cuspidate — according to mechanical functions and not evolutionary history.

In Brazil, few studies have been conducted on crustacean setae, for instance in the study of adult Anomura MacLeay, 1838 (Bond-Buckup et al., 1996; Bueno & Bond-Buckup, 1996) and Parastacidae Huxley, 1879 (Horn & Buckup, 2004); in larval stages of shrimp (Calazans & Ingle, 1998) and crabs (Rieger & Santos, 2001; Rieger et al., 2003), and the oral appendages of Thalassinidea Latreille, 1871 (Coelho et al., 2000), with functional importance in the capture, selection and manipulation of food.

This study is the first complete description of juvenile development of Trichodactylidae found in the freshwater rivers of Brazil, focusing on setal morphology. Therefore, the present study aims to provide a complete description of the first juvenile stage of *Dilocarcinus pagei* under laboratory conditions, as well as morphological changes in the subsequent juvenile stages and describe the different types of setae and their topographic locations in the first juvenile stage.

MATERIAL AND METHODS

Four ovigerous females of *Dilocarcinus pagei* were collected manually, associated with water hyacinth (*Eichornia crassipes*, (Mart.) Solms-Laubach, 1883) at the Municipal Dam of São José do Rio Preto (São Paulo – Brazil) and stored in coolers containing water and water hyacinth for transport to the Laboratório de Biologia de Crustáceos, FCAV, UNESP Jaboticabal. In the laboratory, the females were placed in individual 30-l aquaria containing water from the collection site, previously filtered with net 300 μm of mesh, kept under constant aeration, photoperiod (12 : 12 h) and temperature (27 $\pm$ 1°C).

After hatching, the juveniles were kept individually into 50 ml plastic jars containing freshwater treated with 0.02% potassium phenoxymethylpenicillin (Vieira & Rieger, 2004). The jars were then stored in a biochemical oxygen demand (BOD) incubator at a temperature and photoperiod regime identical to those stated above. The animals were fed daily with pieces of shrimp. After 2 h of feeding, the water in the jars was replaced by new water, well aerated and treated with antibiotics. The juvenile development was monitored until the 12th stage, during which the animals died. The exuviae and dead individuals were assessed daily and fixed in a mixture of alcohol and glycerin in a proportion of 1 : 1.

Drawings, appendage measurements and the morphologies of the setal types in the first juvenile stage were obtained using the fixed animals and exuviae with the aid of an Olympus BX-40 microscope equipped with camera lucida and a micrometric ocular. The small letters in fig. 1 indicate: a, a1-a4, pappose setae; b, b1-b7, plumose setae; c, c1-c9, papposerrate setae; d, simple setae; e, aesthetascs; f, setules; g, plumodenticulate setae; g1 and i, cuspidate; h, plumoserrulate setae; i1-i2, denticulate setae; j, serrulate setae; k, dentate setae; l, brush setae; m, curved setae; n, nail. The setae were drawn under a 100$\times$ objective lens. The number of specimens used in the preparations of drawing and description of appendages in the juvenile stages studied (J-I to -XII) were as follows: J-I to J-X (first to tenth stages) ($n = 5$), J-XI (eleventh stage) ($n = 4$) and J-XII (twelfth stage) ($n = 3$). The numbers in parentheses indicate less frequent values in the appendages mentioned. The system proposed by Garm (2004) was used to classify the setae.

RESULTS

Twenty juveniles were separated and the duration and survival of each stages of the juvenile phase are shown in table I. Only three specimens reached the twelfth juvenile stage at a mean of 253.4 days after hatching.

Fourteen types of setae were discovered, the seven described by Garm (2004) and an additional seven: plumodenticulate, plumoserrulate, denticulate, dentate, brush, curved and nail (fig. 1). Most of the setae present variations in size. The appendages of *Dilocarcinus pagei* contain the following types of setae: antennules with four types (pappose, papposerrate, plumose and simple setae) and short

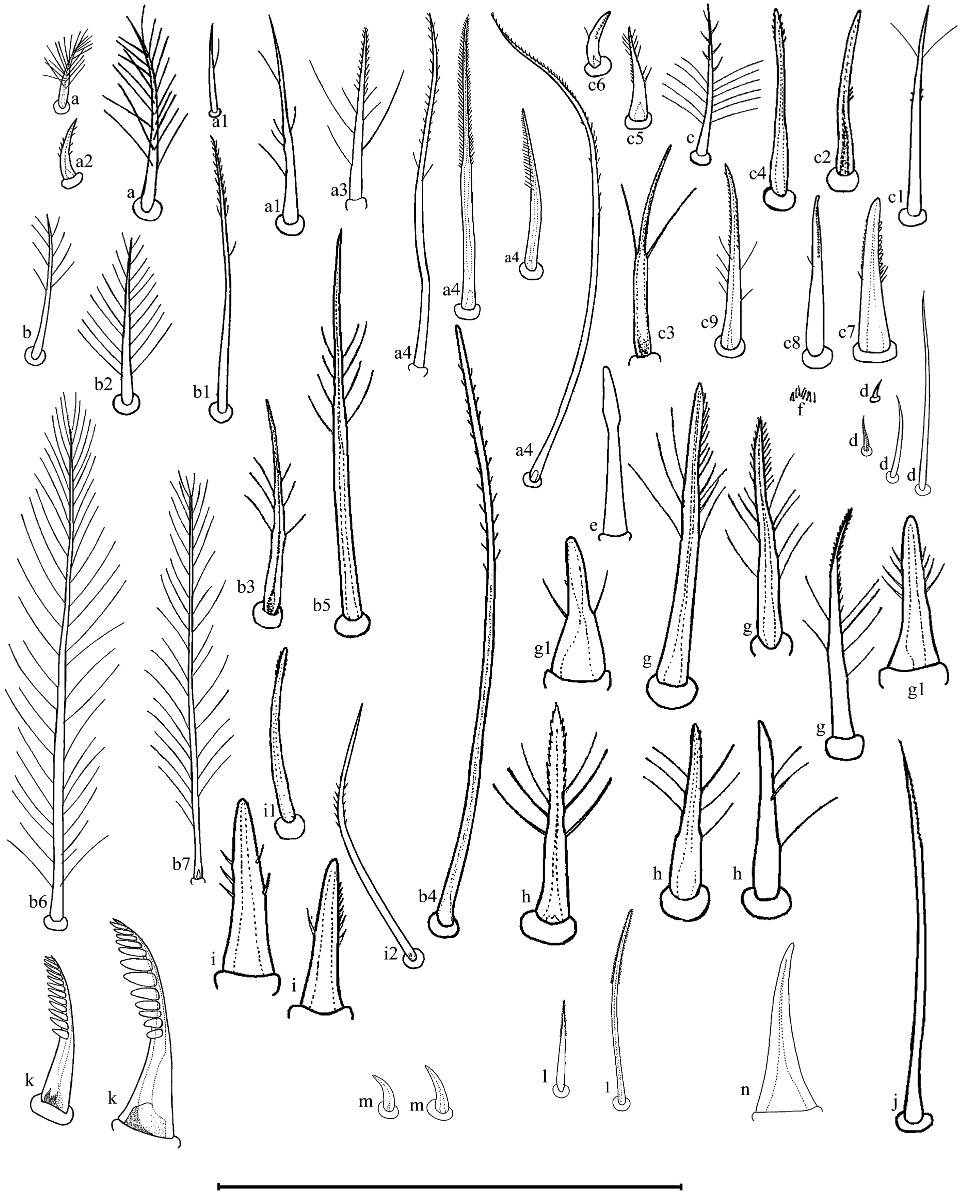

Fig. 1. *Dilocarcinus pagei* Stimpson, 1861. Scheme of main setae found in different appendages of juvenile stages. a, a1-a4, pappose; b, b1-b7, plumose; c, c1-c9, papposerrate; d, simple; e, aesthetascs; f, setules; g, plumodenticulate; g1 and i, cuspidate; h, plumoserrulate; i1-i2, denticulate; j, serrulate; k, dentate; l, brush; m, curved; n, nail. Scale bar = 0.1 mm.

aesthetascs in all stages; antenna with two types (plumose and simple setae), maxillule with eight types (cuspidate, denticulate, pappose, plumodenticulate, plumose, plumoserrulate, serrulate and simple setae), maxilla with five types

TABLE I
Duration and survival of juvenile stages from hatching in *Dilocarcinus pagei* Stimpson, 1861

	J-I	J-II	J-III	J-IV	J-V	J-VI	J-VII	J-VIII	J-IX	J-X	J-XI	J-XII
N	20	19	18	17	16	12	12	11	10	8	4	3
S (%)	95	90	85	80	60	60	60	55	50	40	20	15
D	4	7	9	12	10	10	8	7	6	10	21	20
D'	15	28	36	60	40	65	46	28	33	63	38	37
$\bar{X}$	5.5	10.1	21.3	21.6	21	28.7	18.7	20.4	18.6	30.9	29.3	27.3

N, number of live individuals; S, survival percentage; D and D', minimum and maximum duration (in days), respectively; $\bar{X}$, average duration (in days).

(denticulate, pappose, papposerrate, plumose and simple setae), maxillipeds with six types (dentate, denticulate, pappose, papposerrate, plumose and simple setae), chelipeds and pereopods with six types (brush, curved, nail, pappose, plumose and simple setae). The greatest diversity of setae was found in the mouth appendages, especially the maxillule.

Please note that, though "denticulate setae" may superficially resemble the "serrate setae" of Garm (2004), they are still distinct. Denticulate setae are long and slender, with a length/width ratio of >8 when width is measured at the base of the seta. The proximal half is naked, they have a few denticles of different size only at the middle, or denticles only tip the seta; there are no setules. A comparable situation exists in the case of the present "nail setae" versus the "cuspidate setae" as defined by Garm (2004). These nail setae are smooth, and do not have rows of denticles or setules. They have no articulation. The nail seta is found only at the end of the dactylus of pereopods.

Description of the first juvenile stage
Dilocarcinus pagei Stimpson, 1861
(figs. 1-9)

Carapace (fig. 2A, B). Quadrangular with a deflected bilobed front, convex in the anteroposterior direction, without a rostral projection. The maximum length is slightly greater than the width. The dorsal region is convex with early differentiation of the gastric region, heart, gut and gill. The anterolateral margins have 2 miniscule spines. The carapace is covered by pappose, simple and plumose setae, except in the central region, and 14 pappose setae, 4 long simple setae and 4 plumose setae are found in the frontal region. Long simple setae are found in the anterolateral extremities, and 1 long simple seta is found on the first and second anterolateral spine.

Sternum (fig. 2C). Without setae on its surface. Abdomen (fig. 2D) with 6 somites, all wider than long. The first somite with 4 simple and 2 pappose setae;

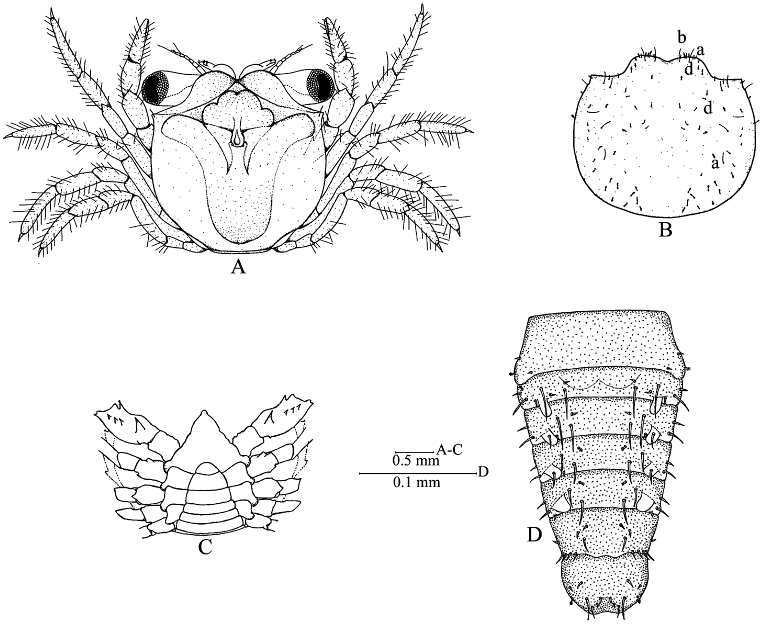

Fig. 2. *Dilocarcinus pagei* Stimpson, 1861. Juvenile I. A, dorsal view; B, dorsal view of carapace with setae; C, ventral view (sternum) and D, abdomen.

the second with 14 simple and 1 pappose setae; the third with 14 simple and 1 pappose setae; the fourth with 11 simple and 2 pappose setae; the fifth with 10 simple and 2 pappose setae; and the sixth somite with 13 simple and 2 pappose setae. Telson with 12 simple and 2 pappose setae. The ventral face of the abdomen with four pairs of rudimentary pleopods from the second to fifth somite.

Antennule (fig. 3A). With a well-developed basal segment with 24(18-23) setae, arranged in 2 rows, containing 3 pappose, 9 plumose, 2 papposerrate and 10 simple setae. Peduncle is two-segmented, the first without setae and the second with 4(3) simple setae. The endopod (ventral flagellum) is two-segmented with 1 simple seta on the proximal segment and 4(5) simple setae on the distal segment, 2 subterminal and 3 terminal. The exopod (dorsal flagellum) is three-segmented with the first segment without setae; the second with 1 simple seta and 4 short aesthetascs with dilated ends; and the third segment with 2 simple setae and 3(4) short aesthetascs with dilated ends. Microscopic setules cover the entire appendage.

Antenna (fig. 3B). Three-segmented antennal peduncle with the first segment containing 3(2) setae, 2 simple and 1 plumose; the second segment containing 1(2) simple seta; and the third containing 3(1-2) simple setae. The antennal flagellum has 5 segments, with 0, 0, 4, 1 and 3 simple setae, of which 1 seta is extremely long.

Eye (fig. 3C). Peduncle with simple, pappose setae and covered setules.

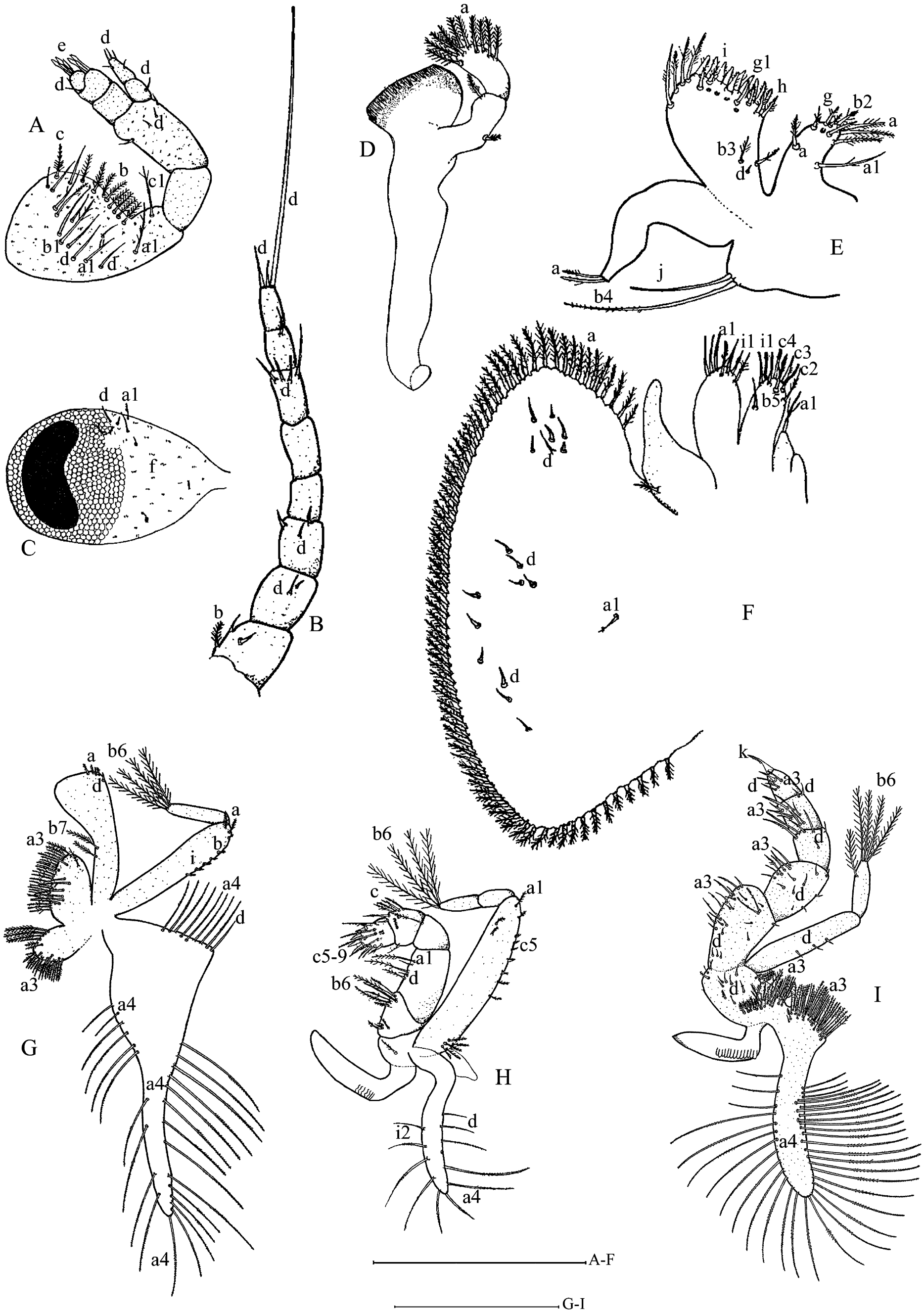

Fig. 3. *Dilocarcinus pagei* Stimpson, 1861. Juvenile I. A, right antennule, lateral view; B, right antenna, dorsal view; C, left eye, lateral view; D, right mandible, lateral view; E, left maxillule, lateral view; F, left maxilla, lateral view; G, right first maxilliped, lateral view; H, right second maxilliped, lateral view and I, right third maxilliped lateral view. Scale bar = 0.5 mm.

Mandible (fig. 3D). Displays a cutting blade and a two-segmented palp with 2 pappose setae on the proximal segment and 10 pappose setae on the distal segment.

Maxillule (fig. 3E). Coxal endite with 12(9-13) setae: 5 pappose, 6 plumodenticulate and 1 plumose. Basal endite with 27(25-28) setae: 5 plumoserrulate, 4 plumodenticulate, 4 denticulate, 7 cuspidate, 6 plumose and 1 simple seta. The endopod is unsegmented with 2 pappose setae. The protopod has 2 long setae, 1 plumose and 1 serrulate.

Maxilla (fig. 3F). Coxal endite bilobed, with a proximal lobe without setae and distal lobe with 1 pappose seta. Basal endite bilobed, with 9(8-11) setae on the proximal lobe: 4 simple setae, 2 pappose, 1 plumose, 1 papposerrate and 1 denticulate setae; distal lobe with 9(8-10) setae: 6 simple setae, 1 plumose, 1 denticulate and 1 pappose setae. Endopod with 1 plumose seta in the inner basal margin. Exopod (scaphognathite) with 85(86-94) marginal pappose setae: 18 setae on the dorsal surface, 17(18-20) simple setae and 1 pappose seta.

First Maxilliped (fig. 3G). Coxal endite with 16-28 pappose setae. Basal endite with 34(33-37) pappose setae. Endopod with 6(7-9) distal setae (5 pappose and 1 simple setae) and 2 subdistal plumose setae. Exopod two-segmented with 8(9-13) setae: 2 plumose setae, 1 denticulate and 5 pappose setae on the proximal segment and 4 plumose setae on the distal segment. Epipod ranging from 30-40 setae, 9-14 are pappose, 1-3 proximal simple setae and 21-26 pappose setae that are median and distal. There are no gills.

Second maxilliped (fig. 3H). Endopod five-segmented. Ischium contains 10(8-9) setae with 6 pappose, 1 plumose and 3 simple setae; merus with 5(4-6) setae: 3 pappose and 2 simple setae; carpus with 1(0) pappose seta; propodus with 11 setae: 3 papposerrate, 3 pappose and 5 simple setae; dactylus with 13(12-15) setae: 4 pappose and 9 papposerrate setae. The exopod is three-segmented, with the first segment containing 16(13-18) setae: 10 pappose and 5 papposerrate setae and 1 denticulate seta. The second segment without setae, and the third segment with 4 distal plumose setae. The protopod with 1 pappose seta. The epipod with 12(10-13) setae: 2 simple, 2 denticulate and 8 pappose setae. The podobranch exhibits early lamellae and rudimentary arthrobranch formation.

Third maxilliped (fig. 3I). Protopod with 41 setae: 26 pappose, 9 simple and 6 plumose setae. The endopod is five-segmented, with 26(21-27) setae: 19 simple and 7 pappose setae on the ischium; merus with 15(13-14) setae, 10 simple and 5 pappose setae; carpus with 6(5-7) setae: 3 simple and 3 pappose setae; propodus with 10(7-9) setae: 4 simple and 6 pappose setae; dactylus with 6(5) setae: 1 simple, 3 pappose and 2 dentate setae. The exopod is two-segmented, with 3(4) simple setae on the proximal segment and 4(5) plumose setae in the distal segment. The epipod contains 36 pappose setae. A rudimentary arthrobranch is also present.

Chelipeds (fig. 4Q). Symmetrical. The coxa with 36 long plumose setae located at the junction between the appendix and the body wall. The basis with 4 setae: 2 simple and 2 small plumose in the inner wall of the segment. The ischium with spines and 17 setae: 7 simple, 4 pappose and 7 plumose that are primarily concentrated in the inner margin of the segment. This region also displays 1 spiny prominence on the inner proximal margin. The merus has spines and 13 simple, 11 pappose, 1 plumose and 1 brush setae. The central spiny prominences with 6 curved setae, and with 4 spiny prominences on its central region with 2 spines arranged differently on the dorsal and ventral margins and 1 tuberculiform spine on the distal region. The carpus with 2 markedly different spines in the distal margin and 29 setae: 18 simple and 11 pappose setae. The propodus with 1 spiny prominence on the upper distal margin and 47 simple, 17 pappose and 3 brush setae. The dactylus with 34 simple and 11 pappose setae. Two lamellar arthrobranchs and one podobranch are also present.

Pereopods (fig. 4P2-P5). Similar, with pappose, simple, plumose and brush setae. The distal end of the dactylus is nail shaped. The second and third pereopods with pleurobranchiae.

Pleopods (figs. 4Pl2-Pl5). Rudimentary, without setae, grouped in 4 pairs located ventrally on the second to the fifth abdominal somite.

Morphology of second to twelfth juvenile stage

During juvenile ontogeny, no changes occur in the shape of the cephalic and thoracic appendages, but the size and number of aesthetascs and setae of the appendages increase. The gill ontogeny is complete at the second juvenile stage. Fig. 9 shows the sequential change in the carapace shape over the first ten stages. The carapace measurements at each stage are shown in table II. At the third juvenile stage, the carapace begins to exhibit a wider shape, becoming similar to that in the adults. No morphological differences can be noted between the male and female abdomens until the tenth juvenile stage.

The greatest changes occur in the pleopods (figs. 5-8). Sexual differentiation begins in the second juvenile stage, with the males presenting two pairs of pleopods (fig. 5 J-II) in the first and second abdominal somites and the females presenting 4 pairs (fig. 5 J-II) located from the second to the fifth abdominal somites. There are no significant morphological changes except to the size of pleopods of third juvenile to the fifth juvenile stages. The female pleopods (fig. 5 J-VI) become biramous only after the sixth juvenile stage. Both the male and female pleopods have no setae until the seventh stage (fig. 5 J-VII). After the eighth stage, simple setae appear in the male pleopods (figs. 5 J-VIII, 6 J-IX, X and 7 J-XI) and are located distally. In the females, the setae appear only in the twelfth (fig. 8 J-XII)

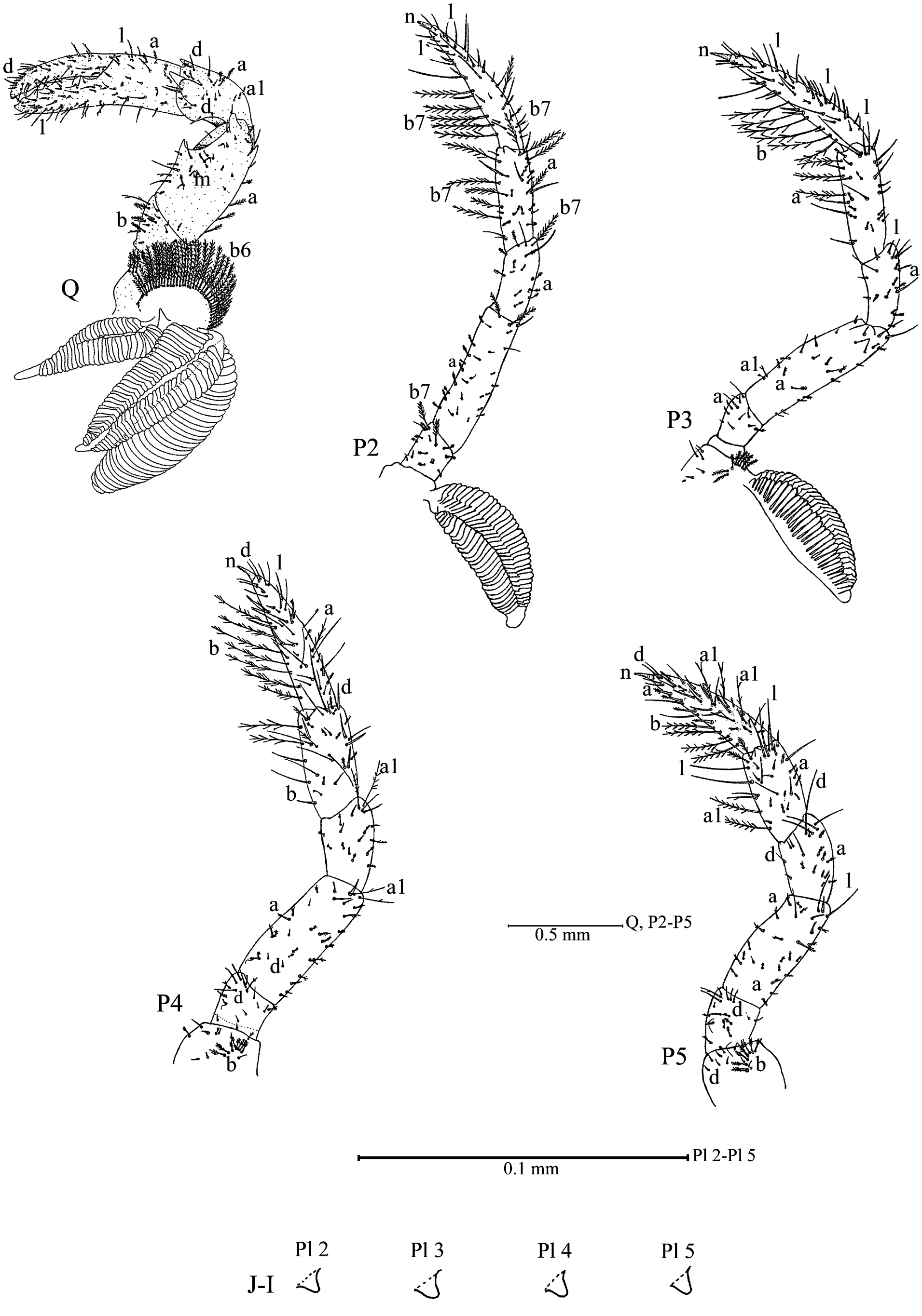

Fig. 4. *Dilocarcinus pagei* Stimpson, 1861. Juvenile I. Q, right cheliped; P2-P5, right second to fifth pereopods; Pl2 to Pl5, second to fifth pleopods.

TABLE II
Measurements (in mm) of carapace width (CW) and length (CL) of juvenile stages JI-JX of *Dilocarcinus pagei* Stimpson, 1861

Stage	*N*		$\bar{X}$	SD	Range	CW/CL
J-I	10	CW	1.25	0.03	1.18-1.28	0.91
		CL	1.37	0.02	1.35-1.42	
J-II	10	CW	1.59	0.05	1.52-1.63	0.98
		CL	1.61	0.03	1.56-1.69	
J-III	10	CW	2.02	0.04	1.98-2.08	1.00
		CL	2.01	0.04	1.97-2.09	
J-IV	10	CW	2.41	0.09	2.22-2.51	1.01
		CL	2.37	0.04	2.30-2.43	
J-V	10	CW	2.96	0.08	2.85-3.08	1.07
		CL	2.75	0.05	2.66-2.81	
J-VI	10	CW	3.59	0.20	3.33-3.92	1.15
		CL	3.11	0.05	3.03-3.17	
J-VII	10	CW	4.07	0.03	4.03-4.12	1.15
		CL	3.54	0.04	3.50-3.60	
J-VIII	6	CW	4.52	0.06	4.42-4.60	1.08
		CL	4.18	0.03	4.15-4.23	
J-IX	5	CW	4.81	0.03	4.76-4.85	1.03
		CL	4.66	0.03	4.62-4.70	
J-X	4	CW	5.29	0.57	5.27-5.33	1.04
		CL	5.07	0.03	5.04-5.10	

N, number of individuals; $\bar{X}$, average; SD, standard deviation; CW/CL, carapace width/carapace length ratio.

juvenile stage. The number of setae in the pleopods increases with moulting and the consequent increase in animal size.

DISCUSSION

The hatching of freshwater species at the juvenile phase is characterized as epimorphic development in which segments and appendages form inside the egg (Kaestner, 1980) to allow adaptation of the species to their freshwater environments, preventing them from being carried off by the water currents. The hatching of *Dilocarcinus pagei* in this phase demonstrates that the species is adapted to the environment because with direct development they can colonize bodies of fresh water with weak or strong currents (Magalhães & Walker, 1988).

Muller (1892) described the first juvenile stage of a species of *Trichodactylus*. The principal differences between juveniles of *Dilocarcinus pagei* and *Trichodactylus* sp. are as follows: *D. pagei* exhibits lateral spines, exopodite of the first maxilliped two-segmented and exopodite of the second maxilliped three-segmented, while *Trichodactylus* sp. exhibits no lateral spines, exopodite of

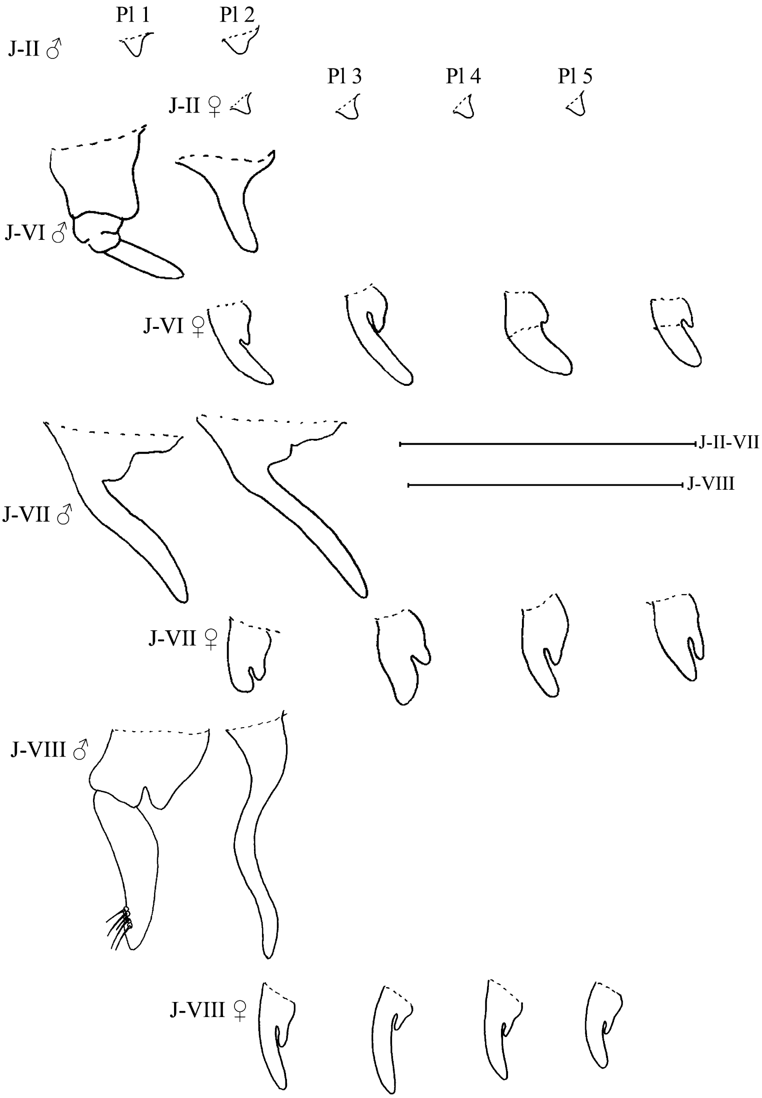

Fig. 5. *Dilocarcinus pagei* Stimpson, 1861. Pleopods (Pl1 to Pl5), second and sixth to eighth juvenile stages. Scale bars = 0.1 mm.

the first maxilliped three-segmented and exopodite of the third maxilliped five-segmented. These differences are essential to species identification because they are easily observable without the need to dissect the specimens. Other differences between the two species are shown in table III.

As in *Trichodactylus* sp., no sexual differentiation occurs in the first juvenile stage of *D. pagei* with both species displaying four pairs of pleopods. In *D. pagei*, the sexual dimorphism occurs at the second juvenile stage: In the male, two

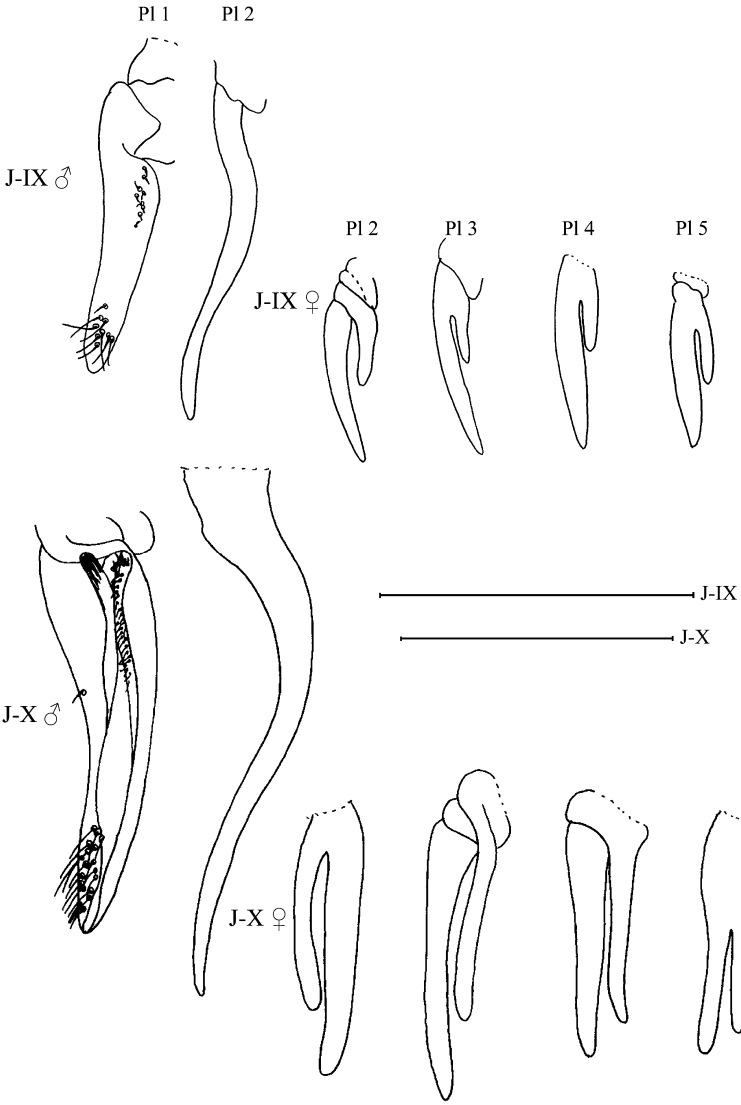

Fig. 6. *Dilocarcinus pagei* Stimpson, 1861. Pleopods (Pl1 to Pl5), ninth and tenth juvenile stages. Scale bar = 0.1 mm.

pleopods appear on the first and second abdominal somites, and in the female four pairs of pleopods appear on the second to fifth abdominal somites. No assertions can be made for *Trichodactylus* sp. because Muller (1892) described only the pleopods of the first juvenile stage and those of the adults.

The great diversity of setae located on the mouthparts is due to the functions that they perform, which include collecting, manipulating and transporting particles

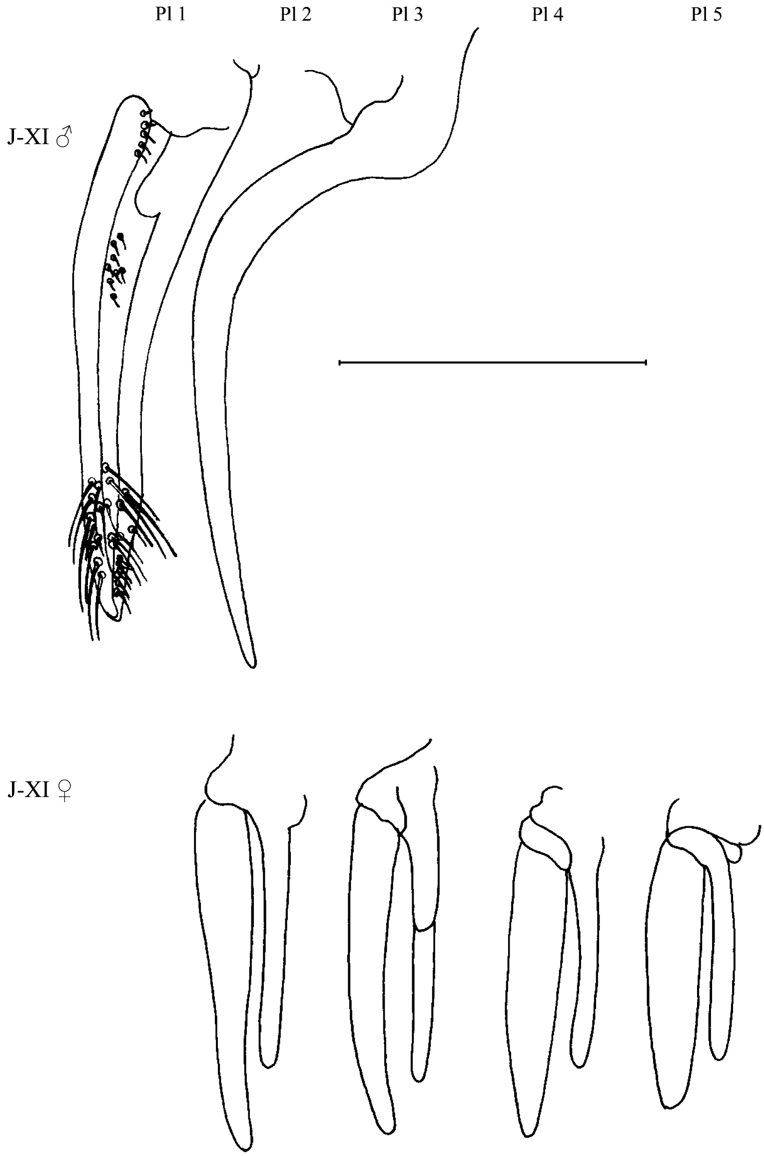

Fig. 7. *Dilocarcinus pagei* Stimpson, 1861. Pleopods (Pl1 to Pl5), eleventh juvenile stage. Scale bar = 0.1 mm.

efficiently from the first pair of pereopods into the oesophagus (Coelho et al., 2000). The plumose setae are specialized for particle retention or promoting water flow (Thomas, 1970; Alexander & Hindley, 1985). The serrate setae are adapted to scrape and brush other setae or surfaces, or to abrade food (Thomas, 1970; Farmer, 1974; Martin & Felgenhauer, 1986). Felgenhauer & Abele (1983) noted that the

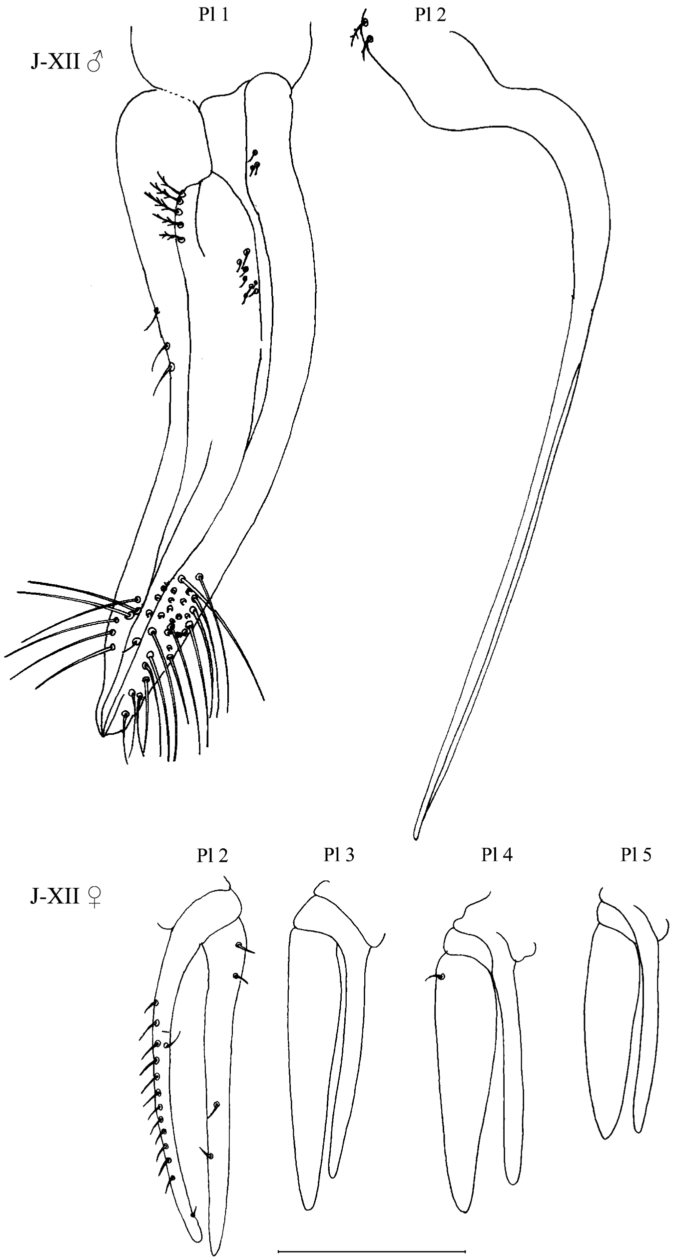

Fig. 8. *Dilocarcinus pagei* Stimpson, 1861. Pleopods (Pl1 to Pl5), twelfth juvenile stage. Scale bar = 0.1 mm.

plumodenticulate (termed papposerrate in Garm, 2004) setae are used to scrape and release periphyton from their substrates. Coelho et al. (2000) argue that the

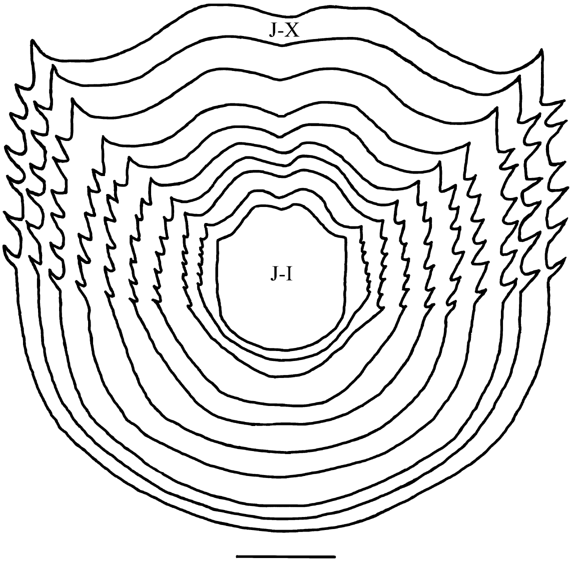

Fig. 9. *Dilocarcinus pagei* Stimpson, 1861. Carapace. First to tenth juvenile stages. Scale bar = 1.00 mm.

plumodenticulate setae may retain particles with less efficiency than the serrulate (termed serrate in Garm, 2004) setae. Some types of setae found in the present study, including the dentate setae on the endopodite of the third maxilliped and the brush setae on the chelipeds, are likely used for scraping other setae or abrading food in a manner similar to the serrate setae. In freshwater crabs, the aesthetascs are short and stout with a dilated distal portion and according to Shenoy et al. (1993) and Meusy & Payen (1998) are specialized in chemo-and-mechanoreception and are also involved in sex pheromone detection.

TABLE III

Diagnostic characters that allow differentiation and identification of the first juvenile stages of *Dilocarcinus pagei*, Stimpson, 1861 in the present study and *Trichodactylus* sp. described by Muller (1892)

	Dilocarcinus pagei	*Trichodactylus* sp.
Lateral spines on carapace	+	–
Antennule exopodite (number of segments)	3	2
Antenna (number of segments)	3 + 5	3 + 6
Mandible (number of segments of palp)	2	3
Maxillule (number of segments of endopodite)	1	2
First maxilliped (number of segments of exopodite)	2	3
Third maxilliped (number of segments of exopodite)	2	5

+, present; –, absent.

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