Postembryonic development of *Pyromaia tuberculata* (Lockington, 1877): a review of larval and postlarval morphology*

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SUMMARY: The spider crab *Pyromaia tuberculata* (Lockington, 1877) (Decapoda, Majidae) has been recorded from eastern Pacific coasts (México to Colombia), the western Pacific (Japan and New Zealand) and the western Atlantic (southern Brazil, near Rio de la Plata estuary and Argentine). Larvae of *P. tuberculata* from one female collected on beds of oysters and mussels at 50 m depth on the Argentine continental shelf (38°21'S; 57°38'W) hatched in the laboratory and were successfully reared until the first crab stage. This paper redescribes the zoea and megalopa phases and describes the juvenil crab morphology.

Key words: Pyromaia tuberculata, larval development, zoea, megalopa, Majidae, Argentina.

RESUMEN: DESARROLLO POSTEMBRIONARIO DE *PYROMAIA TUBERCULATA* (LOCKINGTON, 1877): REVISIÓN DE LA MORFOLOGÍA LARVAL Y POSTLARVAL. – El cangrejo araña *Pyromaia tuberculata* (Lockington, 1877) (Decapoda, Majidae) ha sido reportado en la costa este del Pacífico (desde México hasta Colombia), costa oeste del Pacífico (Japón y Nueva Zelanda) y en la costa oeste del Atlántico (sur de Brasil, cerca del Río de la Plata y Argentina). Larvas de *P. tuberculata* provenientes de una hembra colectada en un banco de ostras y mejillones a 50 metros de profundidad en la plataforma Argentina (38°21'S; 57°38'W) y que eclosionó en laboratorio, fueron cultivadas con éxito hasta el primer estadio de cangrejo. Este trabajo redescribe la morfología de las fases de zoea y de megalopa y describe la morfología del primer estadio de cangrejo.

Palabras clave: Pyromaia tuberculata, desarrollo larval, zoea, megalopa, Majidae, Argentina.

INTRODUCTION

The spider crab *Pyromaia tuberculata* (Lockington, 1877), originally collected in San Diego, USA, was then found on eastern Pacific coasts from México to Colombia (Rathbun, 1925; Garth, 1958). It was introduced to Japan and New Zealand (Carlton 1987; Morgan, 1990; Furota, 1996a, b). The first record in the western Atlantic was documented by

Melo *et al.* (1989: 8-9) for southern Brazilian littoral waters (from Rio de Janeiro to Paraná). Recently, larvae and adults of *P. tuberculata* were found near Rio de la Plata and in Argentine coastal waters (Schejter *et al.*, 2002).

The zoeal morphology of *P. tuberculata* has been described from Pacific specimens (Webber and Wear, 1981; Terada, 1983), and the complete larval development from Brazilian specimens (Fransozo and Negreiros-Fransozo, 1997). In the present study additional information of larval development of *P.*

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tuberculata in the laboratory is given, the zoea and megalopa morphology is redescribed and the juvenile crab morphology is described for the first time.

MATERIAL AND METHODS

Ovigerous crabs of Pyromaia tuberculata were collected by the BIP Capitán Cánepa (Instituto Nacional de Investigación y Desarrollo Pesquero, Argentina) on the continental shelf (38°21'S; 57°38'W) on September 25, 2000. The bottom (50 m deep) was covered by beds of oysters and mussels. One female was transported alive to the laboratory, and maintained in an aquarium containing natural sea water until hatching (October 4, 2000). The larvae were transferred to 4 beakers of 250 ml capacity for mass culture (20 individuals per bowl). Natural sea water was used at a temperature of 12 or 20°C and salinity of 35 PSU. Larvae were subjected to a continual artificial light regime: 8/16 h (L/D). From zoea I to megalopa, Artemia sp. nauplii was offered as food ad libitum. Brachionus plicatilis was added as food for zoea I. The zoeae I, zoeae II and megalopae reared in the laboratory by F. Marques (Grupo de Estudos em Biologia, Ecologia e Cultivo de Crustáceos Larval Collection, Brasil, accession numbers NEBECCLC 00077 and 00097) and collected in the field (see Scheiter et al., 2002) were also examined and measured.

Larvae were dissected under an Olympus SZ40 stereomicroscope. Measurements and drawings were made using an Olympus CH30 compound microscope equipped with a camara lucida. The following measurements were made with a micrometer eyepiece (40X): for zoeae, carapace length (CL); for megalopae, carapace length (CL) and width (CW); and for first crab, carapace maximum length (CL) and width (CW), and the length of rostrum (RL, ventrally, from the insertion of antennulae to the tip). To test differences in means of measurements of zoea I, II and megalopa among larvae reared in Argentina or Brazil and larvae collected in the field, we performed a one-way ANOVA or a Kruskal-Wallis for median comparison in case of deviations from normality or homosedasticity. Drawings were based on 5 larvae, and measurements on 4-14 larvae per stage. Descriptions were arranged according to the standard proposed by Phole and Telford (1981) and Clark et al. (1998). The long setae of the first and second maxilliped of zoea I and II, aesthetascs of antennula, the distal setae of 3rd maxilliped epipod and the setae of all pleopods of megalopae and aesthetasc of antennula of first crab were drawn truncated (Figs. 1, 2, 3, 4 and 5 respectively). Samples of larvae and the adult female are deposited in the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" under the catalogue numbers MACN-In 35067.

RESULTS

The larval development includes 2 zoeae and a megalopa. The minimum duration of each stage at 20°C was: zoea I, 3 days, zoea II, 5 days, and megalopa, 6 days. The larval development, from hatching to first crab, lasted 14 to 18 days. 9 first crabs and 5 megalopas survived after 18 days of mass rearing, when we stopped the experiment. The minimum duration of the zoea I stage at 12°C was 11 days. No zoea II had moulted to megalopa after 23 days of mass rearing at 12°C.

Larval description

Pyromaia tuberculata (Lockington, 1877) (Figs. 1-6)

Pyromaia tuberculata, previous description (Webber and Wear, 1981, zoea I; Terada, 1983, zoea I and II; Fransozo and Negreiros-Fransozo, 1997, zoea I, II and megalopa)

Zoea I

Carapace (Fig. 1A), globose, smooth and without tubercles, with dorsal spine but without rostral and lateral spines. Dorsal spine long, naked and curved. One pair of anterodorsal setae and one pair of posterodorsal setae. Ventro-posterior margin with 1 pappose anterior seta and 3 plumose posterior setae. Eyes sessile. $CL = 0.69 \pm 0.02$ mm

Antennule (Fig. 1B), uniramous. Endopod absent. Exopod unsegmented with 3 terminal aesthetascs (2 long and 1 shorter and slender) and 1 simple seta.

Antenna (Fig. 1B), protopod longer than dorsal spine, without spinules and with rounded tip. Exopod elongated, shorter than protopod, with 2 medial simple setae; distal half acute, without spinules. Endopod bud present.

Mandible (Fig. 1C), with medial toothed molar process and enlarged lateral incissor process bearing 3 sharp and large, and about 7 small and blunt, marginal teeth. Endopod palp absent.



FIG. 1. – Pyromaia tuberculata (Lockington, 1877), first zoea. A, whole animal, lateral view; B, antennule and antenna; C, mandible; D, maxillule; E, maxilla; F, first maxilliped; G, second maxilliped; H, third maxilliped; I, pereiopod buds; J, abdomen. Scale bars: 0.1 mm.

Maxillule (Fig. 1D), coxal endite with 3 plumodenticulate + 1 sparsely plumose subterminal setae and 3 terminal plumodenticulate setae. Basial endite with 3 plumodenticulated + 1 sparsely plumose subterminal setae and 3 terminal plumodenticulate cuspidate setae. Endopod 2-segmented, with 4 terminal setae in distal segment, 3 long plumodenticulate and 1 shorter sparsely plumose. Exopod and epipod setae absent.

Maxilla (Fig. 1E), coxal endite bilobed, proximal lobe with 4 sparsely plumose setae and distal lobe with 3 sparsely plumose + 1 plumodenticulate setae.



FIG. 2. – *Pyromaia tuberculata* (Lockington, 1877), second zoea. A, whole animal, lateral view; B, antennule and antenna; C, mandible; D, maxillule; E, maxilla; F, first maxilliped; G, second maxilliped; H, third maxilliped; I, pereiopod buds; J, abdomen. Scale bars: 0.1 mm.

Basial endite bilobed with 5 + 4 plumodenticulate setae. Endopod simple with 2 long and 1 shorter terminal plumodenticulate setae; microtrichia on lateral margin. Scaphognathite with 10 marginal plumose setae and a long posterior process.

First maxilliped (Fig. 1F), coxa without setae. Basis with 9 plumose setae arranged 2, 2, 2, 3. Endopod 5-segmented with 3, 2, 1, 2, 5 (1 subterminal, 4 terminal) plumose and plumodenticulate setae. Exopod 2-segmented with 4 long plumose natatory setae with 1 conspicuous annuli.

Second maxilliped (Fig. 1G), coxa without setae. Basis with 3 plumose setae. Endopod 3-segmented with 0, 1 (plumodenticulate) and 4 (1 simple subterminal, 1 plumodenticulate subterminal, 2 simple terminal) setae. Exopod 2-segmented and with 4 long plumose natatory setae with 1 conspicuous annuli.

Third maxilliped (Fig. 1H), biramous, epipod bud present.

Pereiopods (Fig. 1I), present, chela bilobed.

Abdomen (Fig. 1J), with 6 somites. Somite 2 with curved dorsolateral acicular processes, "bearing spine-like terminal setal extension" as described by Pohle and Marques (2000). One pair of medio dorsal plumose setae in the proximal somite and 1 pair of postero dorsal plumose (distally) setae on 2^{nd} to 5^{th} somite. Pleopods absent.

Telson (Fig. 1J), bifurcated, with a shallow medial notch, 3 pairs of spinulated setae in the inner margin, and a proximo-dorsal spine. Forks dorsally curved and spinulated.

Zoea II

Carapace (Fig. 2A), with 3 pairs of simple setae between dorsal spine and eyes. Ventro-posterior margin with 1 anterior densely plumose seta and 5 posterior sparsely plumose setae. Eyes stalked. $CL = 0.98 \pm 0.05$ mm.

Antennule (Fig. 2B), exopod now with 4 long and 1 shorter aesthetascs and 1 simple setae, endopod absent.

Antenna (Fig. 2B), endopod longer. Otherwise unchanged.

Mandible (Fig. 2C), medial molar process with 4 teeth; enlarged lateral incissor process bearing 3 sharp teeth and about 9 blunt marginal teeth. Endopod palp bud present.

Maxillule (Fig. 2D), basial endite with 4 subterminal plumodenticulate setae and 5 terminal plumodenticulate cuspidate setae. Endopod 2-segmented, with 2 long plumodenticulate, 1 shorter plumodenticulate and 1 shorter sparsely plumose terminal setae in distal segment. Exopod present as a pappose marginal setae. Otherwise unchanged.

Maxilla (Fig. 2E), coxal endite bilobed, proximal lobe with 4 sparsely plumose setae and distal lobe with 2 sparsely plumose and 2 plumodenticulate setae. Basial endite bilobed with 5 + 5 plumodenticulate setae. Scaphognathite with 19 marginal plumose setae and a long posterior process. Otherwise unchanged.

First maxilliped (Fig. 2F), coxa without setae. Basis with 10 plumose setae arranged 2, 3, 2, 3. Exopod with 6 long plumose natatory setae with 2 conspicuous annuli. Otherwise unchanged.

Second maxilliped (Fig. 2G), exopod with 6 long plumose natatory setae with 2 conspicuous annuli. Otherwise unchanged.

Third maxilliped (Fig. 2H), biramous, epipod present.

Pereiopods (Fig. 2I), present, chela bilobed.

Abdomen (Fig. 2J), with 6 somites, proximal somite with 1 pair of sparsely plumose + 1 medio dorsal sparsely plumose setae. Pleopods with exopods well developed, without setae, and endopod buds.

Telson (Fig. 2J), unchanged.

Megalopa

Carapace (Fig. 3A), longer than broad (CL = 1.15 ± 0.05 mm, CW = 0.85 ± 0.05 mm, CL/CW = 0.74). Without spines, rostrum short, dorsally with medium ridge, a pair of anterolateral cylindrical lobes, each with 2 long setae, a posteromedial tubercle with 1 seta, and many simple setae, as figured; posterior margin with 2 groups of plumose setae.

Antennule (Fig. 3B), peduncle 3-segmented with 0, 1 and 1 simple setae respectively. Endopod unsegmented with 1 subterminal and 2 terminal simple setae. Exopod 3-segmented with 0, 9 (arranged in two tiers) and 4 lateral (arranged in one row) aesthetascs, and 0, 1 (short) and 1 (long) simple setae respectively.

Antenna (Fig. 3C), segments 1-7 with 1, 2, 3, 0, 0, 4 and 4 simple setae respectively; two of the terminal setae very long. Basal segment with lateral protrusion.

Mandible (Fig. 3D), palp 2-segmented; 1 subterminal and 4 terminal plumodenticulate setae on distal segment.

Maxillule (Fig. 3E), coxal endite with 5 subterminal and 4 terminal plumodenticulate setae. Basial



FIG. 3. – *Pyromaia tuberculata* (Lockington, 1877), megalopa. A, carapace, dorsal and lateral view; B, antennule; C, antenna; D, mandible palp; E, maxillule; F, maxilla. Scale bars: 0.1 mm.

endite with 6 plumodenticulate and 1 sparsely plumose subterminal setae and 8 plumodenticulate cuspidate terminal setae. Endopod 2-segmented, with no setae. Two basal plumose setae may represent the exopod and the epipod (Clark *et al.*, 1998).

Maxilla (Fig. 3F), coxal endite bilobed with 6 sparsely plumose on proximal lobe and 2 sparsely plumose and 1 plumodenticulate setae on distal lobe. Basial endite bilobed with 4 + 7 plumodenticulate setae. Endopod unsegmented, without setae, with microtrichia on lateral margin. Scaphognathite with 28-30 plumose marginal setae and 4 inner simple setae.

First Maxilliped (Fig. 4A), coxal endite with 2 subterminal plumose and 4 terminal plumodenticulate setae. Basial endite with 3 plumose, 1 simple and 6 plumodenticulate setae. Endopod unsegmented with no setae. Exopod 2-segmented, proximal segment with 1 distal pappose setae, distal segment with 4 long terminal plumose setae. Epipod with 5 long sparsely plumose and sparsely denticulate setae.

Second Maxilliped (Fig. 4B), coxa and basis not differentiated. Endopod 4-segmented, with 0, 1, 3 and 4 plumose, plumodenticulate and plumodenticulate cuspidate setae, as figured. Exopod 2-segmented, proximal naked and distal segment with 1 short (only observed in field-collected specimens) and 4 long terminal plumose setae. Epipod rudimentary.

Third Maxilliped (Fig. 4C), coxa and basis not differentiated, with 3 sparsely and 3 plumose setae respectively. Endopod 5-segmented, ischium, merus, carpus, propodus and dactylus with 12, 8, 5, 5 and 4 plumodenticulate or simple setae respective-



FIG. 4. – *Pyromaia tuberculata* (Lockington, 1877), megalopa. A, first maxilliped; B, second maxilliped; C, third maxilliped; D, chelae; E, pereiopod 2; F, pereiopod 3; G, pereiopod 4; H, pereiopod 5; I, abdomen; J, pleopod 1; K, pleopod 2; L, pleopod 3; M, pleopod 4; N, uropod; O, sternum. Scale bars: 0.1 mm

ly, as figured. Ischium inner margin with 6 teeth. Exopod 2-segmented, proximal naked and distal with 1 short (only observed in field-collected specimens) and 4 long terminal plumose setae. Coxa-epipod joint indistinct. Epipod elongated with 1 proximal setae, 1 long (gill-grooming) and 2 shorter distal sparsely denticulate setae.

Pereiopods (Fig. 4D-H), all segments well differentiated, without spines and with setae as figured.

Abdomen (Fig. 4I) with six somites. Somites, proximally to distally with 2-2-2-8-8-2 simple setae as shown and with 1 pair of lateral plumose setae on somite 1. Somites 2-5 with 1 pair of biramous pleopods.

Pleopods (Fig. 4J-M), exopods 1-4 with 11, 11, 11 and 10 long marginal plumose natatory setae respectively, on distal segments. Endopods 1-4 with 3 coupling hooks on inner margin respectively.

Uropods (Fig. 4N), without endopods, exopod with 2 natatory setae on distal segment.

Telson (Fig. 4I), posterior margin rounded, with 1 pair of dorsal setae.

Sternum (Fig. 4O), sternal plates not differentiated, with 1 medial (anterior) and 1 medial and 1 lateral (posterior) pairs of setae.

First crab stage

Carapace (Fig. 5A), CL = 1.57 ± 0.08 mm, including the rostrum, and CW = 1.07 ± 0.05 mm (n = 9); CL/CW = 1.47 ± 0.06 ; rostrum bifid, RL = 0.37 ± 0.01 mm, CL/RL = 4.22 ± 0.16 ; postorbital tooth short and directed outward; 2 small teeth and many simple setae on the supraorbital arc; 14 lateral teeth; a fringe of latero-dorsal setal hooks; a group of large setae and setal hooks just behind the ros-

FIG. 5. – Pyromaia tuberculata (Lockington, 1877), first crab. A, carapace, dorsal and lateral view; B, antennule; C, antenna; D, mandible palp; E, maxillule; F, maxilla. Scale bars: 0.1 mm.





FIG. 6. – *Pyromaia tuberculata* (Lockington, 1877), first crab A, first maxilliped; B, second maxilliped; C, third maxilliped; D, chelae; E, pereiopod 2; F, pereiopod 3; G, pereiopod 4; H, pereiopod 5; I, abdomen. Scale bars: 0.1 mm

trum; a posterior protuberance with 4 simple setae; and many dorsal setae and setal hooks, as figured. Anteroexternal spine of the basal antennal article well developed.

Antennule (Fig. 5B), peduncle 3-segmented with 3 plumose, 1 simple and 2 simple setae. Endopod 3-segmented with 0, 1 and 4 (1 subterminal and 3 terminal) simple setae. Exopod 4-segmented with 0, 9 (arranged in two tiers), 4 (arranged in one row) and 1 subterminal aesthetascs, and 0, 1, 0 and 2 simple setae (1 subterminal and very short, 1 terminal and very long).

Antenna (Fig. 5C), 8 segments with 8, 5, 9, 0, 2, 1, 3 and 1 simple setae respectively. Basal segment with a long lateral spine, and two tiers of teeth.

Mandible (Fig. 5D), palp 2-segmented; 1 simple setae on proximal segment and 6 (1 subterminal simple and 5 terminal plumodenticulate) setae on distal segment.

Maxillule (Fig. 5E), coxal endite with 10 sparsely plumose and plumodenticulate setae. Basial endite with 2 basal plumose setae, 7 subterminal (6 plumodenticulate and 1 sparsely plumose) setae and 7 terminal (5 long and 2 shorter plumodenticulate cuspidate) setae. Endopod 2-segmented, with 1 sparsely plumose setae on proximal segment and 1 simple setae on distal segment.

Maxilla (Fig. 5F), coxal endite bilobed, proximal lobe with 6 sparsely plumose setae, distal lobe with 2 sparsely plumose and 1 plumodenticulate setae. Basial endite bilobed with 6 + 7 plumodenticulate setae and 1 basal simple setae. Endopod unsegmented with 1 basal plumose setae. Scaphognathite with 40 plumose marginal setae and 5 inner simple setae.

First Maxilliped (Fig. 6A), coxal endite with 12 plumodenticulate setae. Basial endite with 19 plumodenticulate setae. Endopod unsegmented with 3 subterminal and 4 terminal sparsely plumose setae. Exopod 2-segmented, proximal segment with 1 subterminal plumose setae, distal segment with one subterminal and 4 long terminal plumose setae. Epipod with 9 sparsely denticulate long setae and 1 sparsely plumose setae.

Second Maxilliped (Fig. 6B), coxa and basis not differentiated with 3 sparsely plumose setae. Endopod 4-segmented, with 1, 1, 6, and 7 plumodenticulate and plumodenticulate cuspidate setae. Exopod 2-segmented, with 2 basal and 4 subterminal sparsely plumose setae on proximal segment and 4 long terminal plumose setae on distal segment. Epipod rudimentary.

Third Maxilliped (Fig. 6C), coxa and basis not differentiated, with 14 plumose and pappose setae. Endopod 5-segmented, ischium, merus, carpus, propodus and dactylus with 21, 12, 7, 7 and 5 simple, plumose, pappose and plumodenticulate seate respectively, as figured. Ischium inner margin with a row of teeth, outer margin with 1 terminal tooth. Merus inner margin with 3 teeth, outer margin with 1 proximal tooth and a distal row of small teeth. Exopod 2-segmented, proximal with 3 pappose setae and 3 teeth, and distal with 1 subterminal and 4 long terminal plumose setae. Epipod elongated with 6 proximal plumose setae and 3 distal long sparsely denticulate setae.

Pereiopods (Fig. 6D-H), propodus of cheliped with 3 inner teeth near the distal, acute, tip; dactylus of cheliped acute, dactylus of walking legs 1-4 with 0, 1, 4, 4 acute spines respectively and with 2 or 3 plumose setae, as figured; merus, carpus, and propodus of all pereiopods with long and short simple setae and with rows of setal hooks.

Abdomen (Fig. 6I), with 7 somites. Somites, proximally to distally, with 2-10-8-10-10-4-6 simple setae. Telson with 1 pair of marginal teeth.

Intraspecific variations

Larvae reared in Argentine (this study) and Brazil (NEBECCLC 00077 and 00097) did not present morphological differences. However, size (LC) differed significantly between larvae reared in the two laboratories, as well as between reared and

 TABLE 1. – Comparison of carapace length (mean ± SD) of *Pyromaia tuberculata* larvae, between larvae reared in Argentine (this study),

 Brazil (NEBECCLC 00077 and 00097) and collected in the field. Different letters indicate significant differences detected by All Pairwise

 Multiple Comparison Procedures (P<0.05): Dunn's Method after ANOVA on Ranks (zoeae 1 and 2) or Student-Newman-Keuls Method after</td>

 ANOVA (megalopae). The number of specimens measured was specified between brackets.

	Larvae reared in Argentine (mm)	Larvae reared in Brazil (mm)	Larvae collected in the field (mm)
Zoea 1 Zoea 2 Megalopa	$\begin{array}{c} 0.69 \pm 0.02 \ a \ (10) \\ 0.98 \pm 0.05 \ a \ (7) \\ 1.15 \pm 0.05 \ a \ (10) \end{array}$	$\begin{array}{l} 0.67 \pm 0.02 \ \mathrm{b} \ (10) \\ 0.90 \pm 0.05 \ \mathrm{b} \ (5) \\ 1.10 \pm 0.02 \ \mathrm{a} \ (4) \end{array}$	0.68 ± 0.03 b (10) 0.98 ± 0.03 a (10) 1.27 ± 0.04 b (14)

field-collected larvae (Table 1). Zoeae 1, zoeae 2 and megalopae from Brazil were smaller than those from Argentine (Kruskal-Wallis One Way ANOVA on Ranks, p = 0.0404 and p = 0.0345, One Way ANOVA p < 0.0001 respectively). On the other hand, field collected megalopae were the largest (One Way ANOVA p < 0.0001).

DISCUSSION

The familial and subfamilial classification, the definition of Pyromaia, and the distribution of species were recently reviewed, and are still controversial (Lemaitre et al., 2001). Pyromaia Stimpson, 1871, and nine other genera (Aepinus Rathbun, 1925; Anasimus A. Milne-Edwards, 1880. Arachnopsis Stimpson, 1871, Batrachonotus Stimpson, 1871, Collodes Stimpson, 1860, Euprognatha Stimpson, 1871, Inachoides H. Milne-Edwards and Lucas, 1842, Leurocyclus Rathbun, 1897, and Paradasygius Garth 1958; see Pohle and Marques 2000 for references) were included in the family Inachoididae (Drach and Guinot 1983; Guinot and Richer de Forges 1997) or in the subfamily Inachoidinae (Pohle and Marques 2000). On the other hand, complete larval descriptions of species belonging to this group are scarce: Anasimus latus (Sandifer and Van Engel 1972), Paradasygyus depressus (Pohle and Marques 2000) and P. tuberculata (Fransozo and Negreiros-Fransozo 1997; this paper).

Comparison with the descriptions of Fransozo and Negreiros-Fransozo (1997)

Zoeae. The morphology of the studied zoeae agreed well with the descriptions of Fransozo and Negreiros-Fransozo (1997). However, the latter did not include the following characters: carapace with 1-3 pairs of anterodorsal setae and 1 pair of posterodorsal setae (Fig. 1A, 2A), antennal protopod with rounded tip (Fig. 1A-B, 2A-B), basis of the second maxilliped with 3 plumose setae (Fig. 1G, 2G), the acicular form of dorsolateral processes of the second abdominal somite (Fig. 1A-J, 2A-J) telson with fork dorsally curved (Fig. 1A-J, 2A-J), its dorsal spine longer (Fig.1A, 2A). It is interesting to note that the antennal protopod "naked and rounded in the tip seem to be a unique character for Pyromaia, not present in any other majid" (Fernando P. L. Marquez, personal communication). The following

differences from the descriptions of Fransozo and Negreiros-Fransozo (1997) were observed in each larval stage (Table 2):

Zoea I. Larger carapace, with 1 pair of anterodorsal sete and 4 pairs of plumose setae in the ventroposterior margin (Fig. 1A), antennal endopod bud present (Fig. 1B), maxillar coxal endite with 4 + 4 plumose setae, maxillar basial endite with 4+4 plumose setae (Fig. 1E), third maxilliped biramous (Fig. 1H), presence of pereiopods (Fig. 1A-I), and abdomen with 1 pair of medio dorsal sparsely plumose setae of the proximal somite and 1 pair of postero dorsal setae of the 5th somite (Fig. 1J).

Zoea II. Larger carapace, with 3 pairs of anterodorsal setae and 6 pairs of setae in the posterior margin (Fig. 2A), basial endite of maxillule with 5 spine-like setae and 4 plumose setae (Fig. 2D), maxillar coxal endite with 4 + 4 plumose setae (Fig. 2E), distal somite of endopod of second maxilliped with 2 subterminal and 2 terminal plumose setae, unchanged respect to zoea I (Fig. 2G), epipod of the third maxilliped present (Fig. 2I), and abdomen with 1 pair of sparsely plumose + 1 medio dorsal simple setae on the proximal somite (Fig. 2J).

Megalopa. The megalopae examined during this study were larger than those described by Fransozo and Negreiros-Fransozo (1997). These authors observed the anterodorsal pair of lobes of the carapace but did not report either the long setae that ornated each one, or the medium dorsal ridge, the posteromedial tubercle with one setae, and the 2 groups of marginal posterior plumose setae (Fig. 3A, B). Their megalopae also differed in the presence of a lateral protrusion in the basal segment of antenna and a basal plumose seta of maxillule; the setation of peduncle, endopod, and exopod of antennula, antenna; mandibular palp, basial endite and endopod of maxillule, basial endite and scaphognathite of maxilla, 1st and 3rd maxilliped, pleopods, and telson (Table 2, Figs 3B-F, 4A-N). The sternum (Fig. 4O) was not described by Fransozo and Negreiros-Fransozo (1997).

Some of the differences between our observations and those of Fransozo and Negreiros-Fransozo (1997) are normally found between zoeae stages or megalopae of congeneric species (e.g. size, setation of carapace, antennula, mandibular palp, pleopods). However, considering the available larval descriptions of *Anasimus latus* (Sandifer and Van Engel, 1972) and *Paradasygyius depressus* (Pohle and Marques, 2000), some characters are consistent at high-

	this study	Fransozo and Negreiros Fransozo, 1997
Zoea		
Carapace		
Anterodorsal s (zoea I-zoea II)	1-3 pairs	nd
Posterodorsal s (zoea L and II)	1 pair	nd
Ventral margin s (zoea I-zoea II)	4-6 pairs	2-3 pairs
CL (zoea I-zoea II mm)	0.69 to 0.98	0.6-0.7
Antenna	0.07 10 0.90	0.0 0.7
Protopod tin	rounded	acute
Endopod (stage of appearance)	zoea I	zoea II
Maxillule		2000 11
Basial endite s (zoea II)	0	8
Maxilla	,	0
Coval andita s (zoon I zoon II)	A1A A1A	514 415
Resial andita s (zoca I)	4+4 - 4+4	3+4 - 4+5
Second maxillined	3+4	5+4
Desis a (zero Lond zero II)	2	4
Basis S. (Zoea I and Zoea II)	5	4
Endopod distal somite s (zoea II)	4	, , , , , , , , , , , , , , , , , , , ,
I nird maxiliped (zoea I – zoea II)	birramous, with epipod bud – epipod developed	na – birramous
Pereiopods (zoea I – zoea II)	present - present	nd – nd
Abdomen		
Dorsolateral processes of 2 nd so	acıcular	rounded
Proximal so s (zoea I-zoea II)	1 pair (plumose) – 1 pair (plumose) + 1 (simple)	1 pair (simple) – 1 pair (simple)
5^{th} so s (zoea I)	1 pair	nd
Telson	dorsally curved	not curved
dorsal spine	long	short
Megalopa		
Carapace	0.05.1.15	100
CW-CL (mm)	0.85-1.15	nd-0.9
anterolateral lobes s	2, long	nd
medium dorsal ridge	present	nd
posteromedial tubercle	present	nd
margino-posterior setae	2 groups	nd
Antennule		
Peduncle s	0,1,1	1,0,0
Endopod s	3	2
Exopod a	0,9,4	4,3,2
Exopod s	0,1,1	0,0,1
Antenna s	1,2,3,0,0,4,4	2,1,3,0,0,3,3
protrusion of proximal seg	present	nd
Mandibule		
Palp s	0,5	0,4
Maxillule		
Basial endite s	8+7	7+4
Endopod s	0,0	0,2
Basal s	2	1
Maxilla		
Basial endite s	4+7	5+7
Scaphognatite (marginal, internal) s	28-30, 4	32-35, 3
First Maxilliped		
Coxa s	2+4	7
Epipod s	5	8
Exopod s	1,4	0,3
Endopod s	0	3
Second Maxilliped		
Epipod	rudimentary	nd
Third Maxilliped		
Coxa + Basis s	3+3	4
Epipod s (proximal, distal)	1,1 long +2 short	4 (similar length)
Endopod s	12,8,5,5,4	7,5,2,4,4
Abdomen		
somite $(1^{st} \text{ to } 6^{th}) \text{ s}$	4-2-2-8-8-2	2-2-2-2-0
Pleopod		
first to fourth, exopod nat s	11-11-11-10	11-11-10-8
first to fourth, endopod hooks	3	2
Telson		
dorsal s	2	4
Sternum s	2+2+2	nd

TABLE 2. – Comparison of morphological features and setation formulae of the larval development of *Pyromaia tuberculata*, between Fransozo and Negreiros Fransozo (1997) and this study. Abbreviations: s, setation; a, aesthetacs; seg., segment; so: somites; nd: not described.

er taxonomic levels (family or subfamily). Consequently, the following differences may be mistakes in the previous description: appearance of antennal endopod in zoea I, form of 3rd maxilliped and presence of pereiopods in zoeae, setation of 5th abdominal somite in zoea I, setation of proximal abdominal somite in both zoeae, acicular form of 2nd somite abdominal processes of zoeae, and the setation of the antennular exopod, basial endite of maxillule, 1st maxilliped epipod, and 3rd maxilliped endopod of megalopae. On the other hand, the rudimentary epipod of the megalopal 2nd maxilliped was not observed in A. latus (Sandifer and Van Engel, 1972), the previous description of P. tuberculata (Fransozo and Negreiros-Fransozo, 1997) and P. depressus (Pohle and Marques, 2000). However, Clark et al. (1998), regarding the fact that this structure has not been reported for the majority of megalopae, stated that "it is uncertain whether this is due to incognizance or absence of the process".

The description of the first crab presented here is the first report of the morphology of this developmental stage in the Inachoidinae (or Inachoididae). The most obvious character observed in crab 1 was the abundant long setae and setal hooks present in the carapace (Fig. 5A) and pereiopods (Fig. 6D-H), as was also observed in other majids such as Libinia spinosa (Clark et al., 1998) and Pisa tetraodon (Rodríguez, 1997) (Pisinae). Adventitious materials collected by some majid crabs, known as decorating or masking crabs, are held in position by special hooked setae (Woods and McLay, 1994). Adults of P. tuberculata were usually found with materials attached to various parts of their bodies (Schejter et al., 2002). The presence of hooked setae in the first crab instar suggests the early acquisition of behavioural traits associated with camouflage during the ontogeny of some majid crabs.

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