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Short Communication

The larval development from prezoea to megalopa and juvenile stages of *Allopetrolisthes punctatus* (Guérin, 1835) (Decapoda, Anomura, Porcellanidae)

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ABSTRACT. The external morphology of the larval steps in the development of the Anomuran crab *Allopetrolisthes punctatus* is described using material obtained under laboratory conditions and from field samples. All stages are presented with photos taken with a scanning electron microscope. For the first time in this species, and in a similar way as described for the whole family Porcellanidae, it was possible to identify one prezoea, two zoeal and one megalopa stages. The main difference between the zoeal stages is the translucid spine in the center of the telson of the zoea II, surrounded by five gross setae at each side. Also, we also studied first juvenile stages to know the size at which sexual pleopods appear, which in our samples it occurred at 1.97 mm of carapace length.

Keywords: *Allopetrolisthes*, Porcellanidae, larval stages, zoea, megalopa, pleopods.

Porcellanidae is a family of small crabs composed by approximately 277 species, characterized for inhabiting the rocky inter and subtidal habitats in tropical and temperate regions of worldwide oceans (Haig, 1960; Osawa & McLaughlin, 2010). *Allopetrolisthes punctatus* is one of the 11 species of Porcellanidae described for Chilean waters, with a distribution range between Ancón, Perú, and north of the Arauco Gulf (36º30'S) in Chile (Haig, 1955, 1960; Carvacho, 1968; Viviani, 1969; Weber, 1991; Weber & Galleguillos, 1991; Retamal & Moyano, 2010). Unlike the rest of the Porcellanids, which usually inhabit between rocks and protected crevices, this species is found in open, unprotected spaces on the exposed rocky substrate. The southernmost population of this species is located near Caleta Chome (36º46'24"S), ranged bathymetrically between 1 and 17 m, aggregated in dense swarms up to 2500 ind m^{-2} (Santa Cruz & Retamal, 2018), similar to the crab-layers previously reported by Viviani *et al*. (2010) in La Herradura, Coquimbo (29º58'36"S).

For any crab species, the external morphology description of each larval and juvenile stage is an important antecedent for its correct taxonomical identification. For the family Porcellanidae it is recognized that the larval development cycle is composed by one prezoea, two zoea (I and II), and one megalopa stage (Wehrtmann *et al*., 1996; Mujica & Pereira, 2009), however, there are still species of this family without a complete larval description. The present study shows and describes, for the first time, the entire larval cycle of *A. punctatus* from prezoea, zoea I, II, to megalopa. Also, the juvenile stage is described to determine the size at which sexual pleopods appear.

Ovigerous females in stage III (n = 8, identified by the authors as dark brown eggs, larvae with ovoid ocular cornea) were collected from field samples around the Chome fishing cove, north of Arauco Gulf. Females were maintained in a small aquarium with abundant and constant air flow, and after one week, a massive quantity of prezoeae and some specimens of zoeae I was released. Zoeae were fed with Rotifera during four days, enough time to distinguish the following known stage zoea II, using a stereo-microscope Zeiss IVB, according to reviewed material and bibliography. Some zoeae I and II were obtained under laboratory conditions, and others were later collected in the field with a plankton net towed in February 2016, used directly over the studied crab aggregation in Chome. The megalopae and juveniles live among the parental stock, so they were collected directly in the field by semi-autonomous diving. General morphology and appendages were described using 15 specimens of prezoea, 30 zoea I and 35 zoea II. The main corporal structures were observed, measu-

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red (carapace, frontal and reared spines length) and photographed using a scanning electron microscope with a high resolution of 3.0 nm, because it gives us a better resolution than the standard microscope and the resultants draw.

Description of stages

Prezoea

Carapace length: 800 µm. Hatched 15 specimens after 4 h released from the pleopods. An ovoid and oblong carapace (dorsal view) folded on itself, same the rostral spine and the future reared spines that here are present as fat digital tentacles (280 µ length), at the end of the carapace**.** The abdomen (in dorsal view) has five abdominal somites that are freely articulated, with a laterotermínal spine at the right distal portion of the fifth segment with undeveloped appendages and the telson (Fig. 1a). Telson is triangular, its distal border is concave with a strong lateral spine on both sides of the outer margin and ten fat setae, the central pair form a kind of fork (50 µ length), second, third, fourth and fifth setae has the same length (100 µ), all of them with a concave channel along the middle (Fig. 1b).

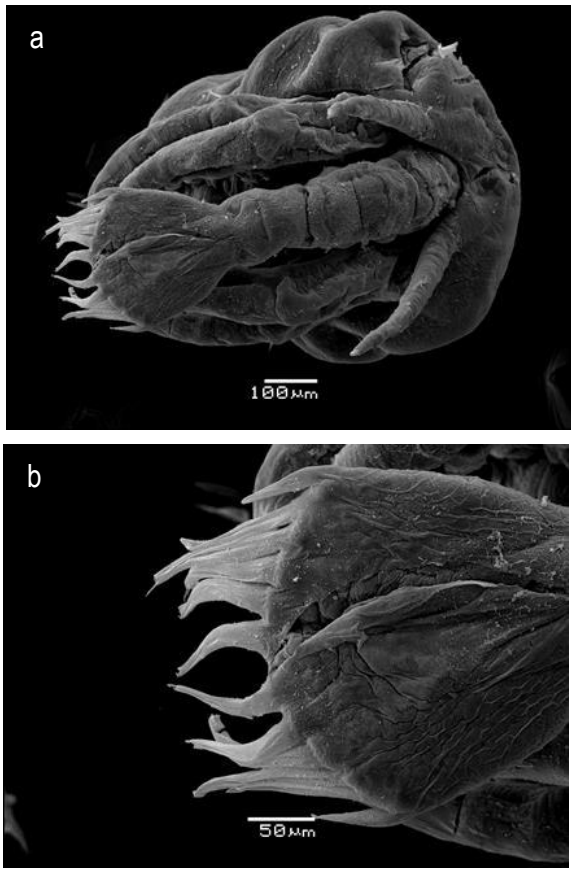

Figure 1. a) Dorsal view of the prezoea abdomen, b) dorsal view detail of the prezoea telson.

Zoea I

Carapace length: 2.60 mm. Collected mainly from plankton, except one got from the aquarium 1 h after hatching. With the characteristic spines of the Porcellanidae, the rostral straight spine is much longer (5.96 mm) than the ovoid carapace (2.60 mm) and the divergent posterolateral spines (1.65 mm), also an unsegmented antenna birramose is observed (Fig. 2a). The rostral spine covered with tiny dorsal spinules oriented forward (Fig. 2b) and the posterior spines ventrally covered with spinules distributed symmetrically (Fig. 2c) larger than those on the rostral spine (structures that are specifics in the identification of the different species, A. Mujica, *pers. comm.*).

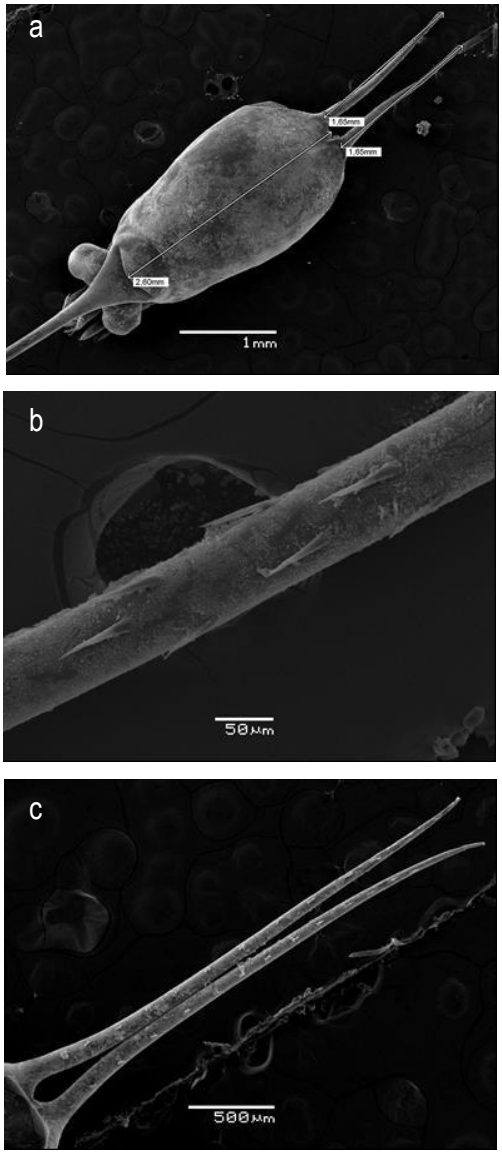

Figure 2. Zoea I. a) Dorsal view, b) detail of rostral spine, c) ventral view showing the posterior spines with spinules distributed symmetrically.

Zoea II

Carapace length: 2 mm. Almost similar in shape to the previous stage; the anterior spine (5.81 mm) and the posteriors (3.53 mm) differing in spinulation equal than in Zoea I. The upper distal borders of the fifth abdominal somite have a spine on each side that was only visible on the right-hand side of the prezoea stage. Eyes with short and strong peduncle. On the thoracic, the somites exhibited the buds of pereiopods (Fig. 3a) than in some specimens more developed is possible see the segmented pereiopods (Fig. 3b). A translucid spine appears in the middle of the fork formed by the gross central setae that has some long hairs, while on the abdomen is possible to distinguish the pleopods (Fig. 3c).

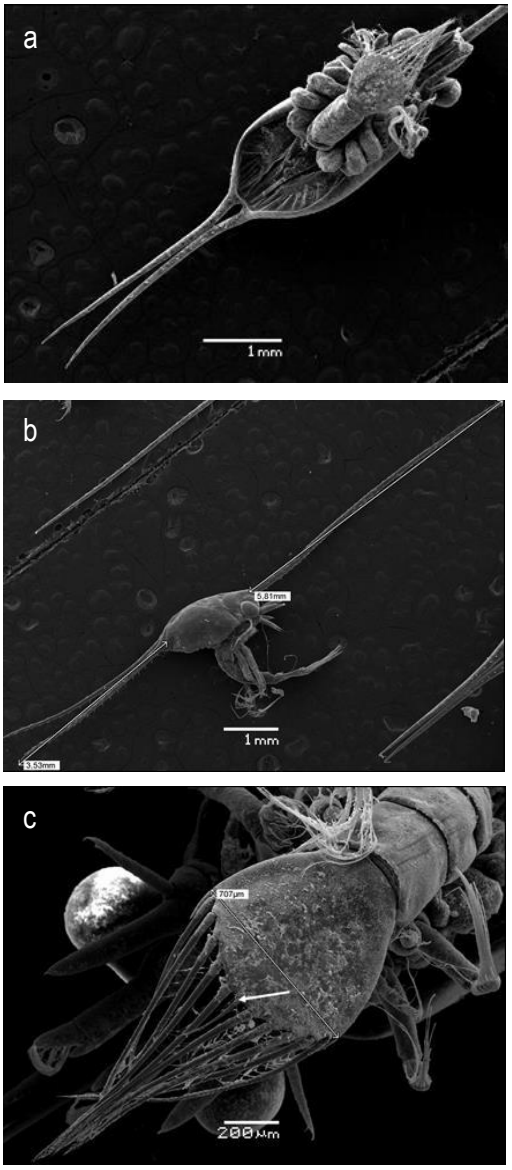

Figure 3. Zoea II. a) Ventral view, b) lateral view, c) dorsal view of the telson, with a mark in the central spine.

Megalopa

Carapace length: 2 mm. The carapace is covered with small setae, longer than wide, brownish with yellow pereiopods. However, the younger specimens are almost transparent (Figs. 4a-4b). The rostrum is acute, due to the oblicually form of the frontal region, the antennules are visible and are folded lengthwise (visible just in ventral view), the antennae are larger than the carapace length, folded backward, but mobile in all directions. The interior border of the third maxillipeds has long setae (typical of a filter feeder). In this stage, the eyes are stalked inside of wide orbits. Pereiopods are formed entirely and in the merus border of the chelipeds appear an angular tooth, well-formed, that allow distinguishing the species. Most of the mentioned characters are illustrated (Fig. 4a). On decapods, this stage usually lives on the substrate but in this species lives on the carapace or the chelipeds of the adults as shown in Figure 4b.

Figure 4. a) Megalopa on an adult chelipod, b) ventral view.

Juvenile

Carapace length: 1.97 mm. The first juvenile, in this case, a female of 1.97 mm CL, has three pairs of pleopods in segments 3, 4 and 5 (Figs. 5a-5b). Although this is different from the reduced or absent pleopods in segment three described by Haig (1960), match with the

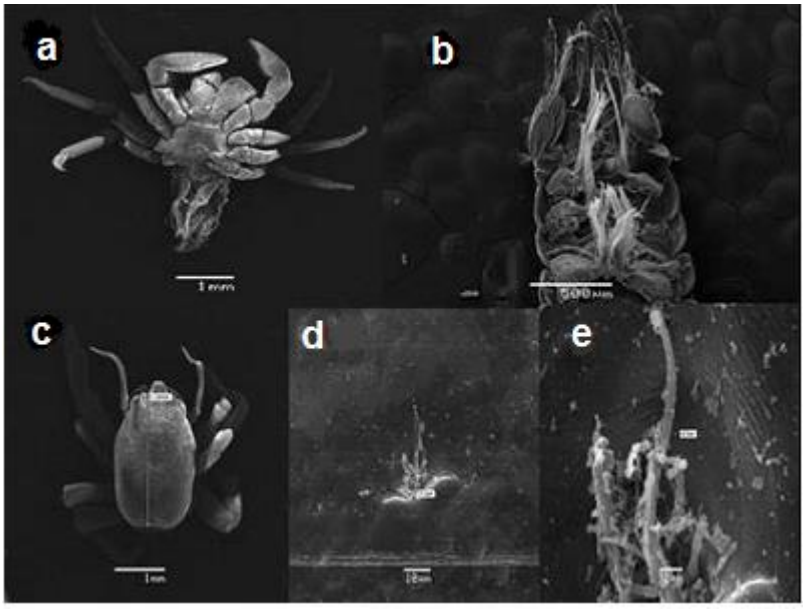

Figure 5. a-b) Ventral view of pleopods in a juvenile female, c) dorsal view of a juvenile with hairs (white points), d-e) a zoom of carapace hairs.

rudimentary pleopods in segments 2-6 described by Wehrtmann *et al*. (1996), for juveniles of 1.68 mm CL of *Allopetrolisthes angulosus*, a sympatric species of *A. punctatus* present in Chilean waters.

The larval stages of the Porcellanidae are very similar, but not equal. There are differences in the proportions and ornamentation of the rostral and posterodorsal spines, differences in number, orientation and size of spinules, and differences in telson spines than they appeared in zoea I and II (Wehrtmann *et al*., 1996). Previously, Saelzer *et al*. (1986) described the development of *Petrolisthes granulosus* Mujica & Pereira (2009) published about larvae of Chilean decapods including *Petrolisthes* spp. samples caught with plankton net in the fjords of southern Chile, without identifying the species due to the similarity among them and Ulloa & Palma (1998) analyzed the space-temporal larval distribution of *Petrolisthes violaceus*, *P. laevigatus* and *Allopetrolisthes angulosus* in the plankton of Valparaiso Bay. According to Saelzer *et al*. (1986), the prezoeal stage as a free-living stage in Porcellanids and other species of crustaceans, described by Greenwood (1965), Gonor & Gonor (1973), and Baeza & Thiel (2000), character in doubt, even when it has been observed by Pellegrini & Gamba (1985). This stage is present in species such as *Petrolisthes tuberculatus* and *A. angulosus* from central Chile (Saelzer & Quintana, *pers. observ.*) and in this study, but only Wear (1965), Greenwood (1965), Pellegrini & Gamba (1985) and Wehrtmann *et al*. (1996), have published detailed descriptions of this particular stage, and now in this work for the prezoea of *A. punctatus*.

From the first moments after the hatch, the prezoea free from the embryonic cuticle moving mainly with strong movements of the abdomen was observed by Gonor & Gonor (1973) and the authors of this paper. However, Saelzer *et al*. (1986), suggested that the movements of the prezoea were accomplished with natatory impulses produced with the antennae "whose embryonic cuticle looks like feathers or plumo-denticulate setae."

Finally, we find interesting that despite macroscopically both juveniles and females of *A. punctatus* has a variegated color and larger males has an intense dark brown, it was striking to observe under the scanning electron microscope, many isolated hairs tufts (~20 µ) located both on the carapace, pereiopods, and chelipeds (Figs. 5c-5e). A previous external description indicates that individuals have "carapace devoid of hairs" (Haig, 1960); however, this was done using stereomicroscope and magnifying glass instruments, is impossible to see this kind of microstructures.

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