

# First zoeae of *Pachycheles garciaensis* (Ward) and *Pachycheles sculptus* (H. Milne Edwards) (Crustacea: Decapoda: Anomura: Porcellanidae) reared under laboratory conditions

MASAYUKI OSAWA

*Department of Aquatic Biosciences, Tokyo University of Fisheries, 4–5–7 Konan, Minato-ku, Tokyo 108, Japan*

Received 19 February 1997; accepted 17 March 1997

**Abstract:** First zoeae of *Pachycheles garciaensis* and *P. sculptus* are described based on laboratory-reared material. The zoea of *P. garciaensis* closely resembles that of *P. sculptus* morphologically, but the former is distinguished from the latter by the setation on the basal endite of the maxillule, and the basis and first endopod segment of the second maxilliped. These two species differ from the other representatives of the previously described *Pachycheles* zoeae in the setal numbers on the endopods of the maxillule and maxilla, and coxa of the first maxilliped. Although the presence or absence of ventral setae on the coxa of the first maxilliped has been considered only the difference between the zoeae of *Pachycheles* and *Neopisosoma*, this morphological difference is rejected by the present examination. Accordingly, there are no morphological distinctions between the zoeae of the two genera.

**Key words:** Crustacea, Decapoda, *Pachycheles*, zoeal larva, systematics

## Introduction

Zoeal larvae of the family Porcellanidae are easily distinguished from other decapod zoeae by the extremely elongated rostral spine and a pair of posterior spines. These morphological characteristics allow the immediate recognition of the larvae in plankton samples. However, larval descriptions have not been made for enough species to allow exact identification to the species level in plankton samples from the field.

Crabs of the porcellanid genus *Pachycheles* Stimpson are characterized by the robust che-lipeds and the pterygostomial flaps divided into anterior and posterior plates, and inhabit the underside of rocks and corals or live on sponges in shallow waters (Haig 1960, 1966; Nakasone & Miyake 1968; Miyake 1982). Larval descriptions of the genus have been made world-wide for seven species, and three of them, *P. stevensii* Stimpson, *P. natalensis* (Krauss), and *P. tomentosus* Henderson, were reported from the Indo–West Pacific region (Kurata 1964; Shenoy & Sankolli 1973; Tirmizi & Yaqoob 1979; Yaqoob 1979; Konishi 1987). Although *Pachycheles*, like *Petrolisthes*, is a common porcellanid genus in tidal or subtidal areas, studies on the larval development of *Pachycheles* are fewer than those of *Petrolisthes* (see Osawa 1995).

In this study, I describe and illustrate the first zoeae of the two common species of *Pachycheles* in the Ryukyu Islands, *P. garciaensis* (Ward) and *P. sculptus* (H. Milne Edwards), based on material reared under laboratory conditions.

### Materials and Methods

Ovigerous females of the two species were collected from Kuroshima Island, in the Yaeyama Islands, southwest component of the Ryukyus, in August 1992 and 1993. *Pachycheles garciaensis* and *P. sculptus* were found in the crevices of dead corals near the outer edge of the reef flat. They were kept individually in 3-liter plastic aquaria in the laboratory of the Yaeyama Marine Park Research Station. Newly hatched zoeae were transferred to round plastic vessels (13 cm in diameter, 10 cm in depth) with a large-bore pipette. Filtered sea water from the collection site was used for rearing. The rearing was carried out at a temperature of 29.0–29.5 °C and salinity of 34.0–35.0‰. Zoeae were fed daily on newly hatched *Artemia* nauplii. The excrement of the larvae was removed with a pipette and the water in each vessel was maintained at a constant level by the daily addition of sea water.

Dead larvae, exuviae, and several living larvae were fixed in 5% neutralized formalin and preserved in 70% ethanol for morphological observation. Microscopic observation was done in 50% glycerin solution. Measurements of carapace length (CL), rostral spine length (RSL), and posterior spine length (PSL) follow those of Osawa (1995). Setae on appendages were counted from proximal to distal. The setal formula for a segment is shown as “A+B”, where setae appear in groups of “A” or “B”, numbered proximally to distally. The “setae” on the appendages are distinguished from “spines” by their elongated and flexible character. The “spines” are stiff and stout. Drawings and measurements were made with a NIKON OPTIPHOT stereomicroscope equipped with a camera lucida.

### Results

I obtained first and second zoeae of both species, but could not examine the second zoeal specimens in detail because of the bad condition of the preservation. Only one morphological difference in the second zoea to the characters in the first zoea, the addition of a median short plumose seta on the posterior margin of the telson, is recognized.

Descriptions of the first zoeal stages of *P. garciaensis* and *P. sculptus* are made below.

#### *Pachycheles garciaensis* (Ward, 1942)

##### First zoea (Figs 1, 2; Table 1)

*Duration*.—8–9 days.

*Number of specimens examined for appendage morphology*.—5.

*Size*.—CL 1.59–1.70 mm (5 specimens, mean 1.66 mm), RSL 14.50 mm (1 specimen), PSL 5.99–6.37 mm (2 specimens).

*Carapace* (Fig. 1A, B).—Typically porcellanid; rostral spine extremely elongated with spinules over entire length, 8.57 times as long as CL; posterior spines elongated, with pointed spinules along whole ventral margin increasing in length proximally and small spinules on dorsoproximal part, 3.51–3.75 times as long as CL; lower posterior margin (Fig. 1C) with approximately 30 small spinules. Eyes sessile.

*Abdomen* (Fig. 1D).—Five somites and telson; fourth and fifth somites with pair of lateral spines increasing in size posteriorly; posterodorsal margins of third to fifth somites with

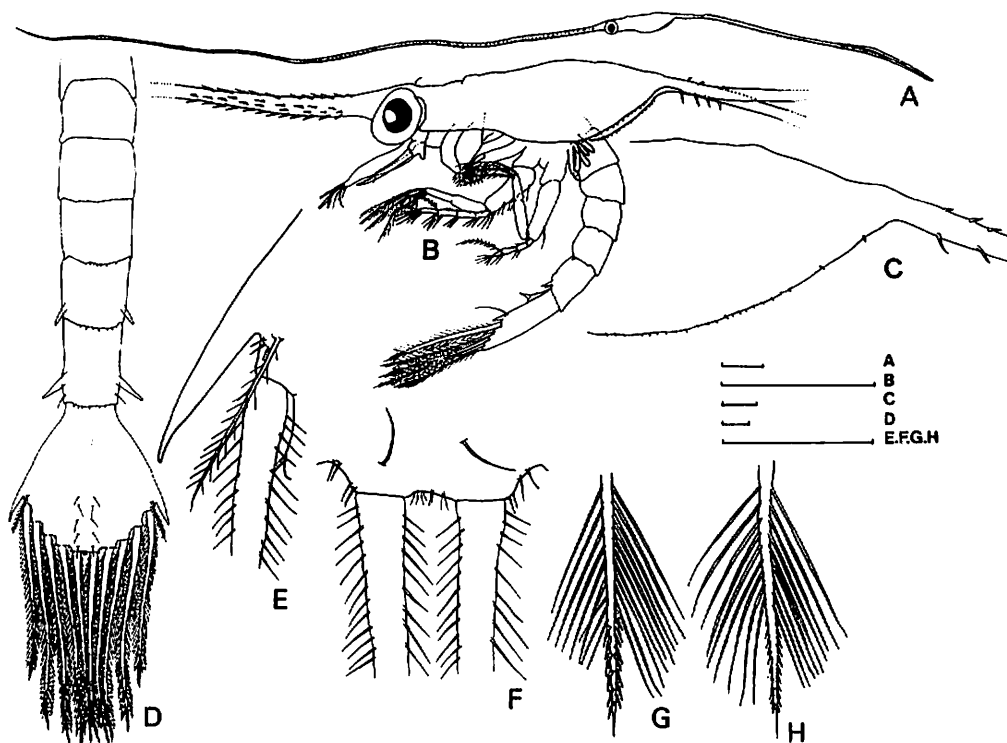


Fig. 1. *Pachycheles garciaensis* (Ward, 1942), first zoea. A. Carapace, lateral view. B. Carapace, abdomen, and appendages. C. Lower posterior margin of carapace. D. Abdomen and telson. E. Posterolateral region of telson. F. Posteromedian region of telson. G. Distal part of first long plumose seta on telson. H. Distal part of third long plumose seta on telson. Scales=1.0 mm for A, B; 0.1 mm for C-H.

minute teeth; fifth somite longest of five somites, with short seta near each posterolateral end.

**Telson (Fig. 1D).**—1.09 times longer than broad at mesial bases of lateral spines; posterior margin produced into broad trapezoid, with 5 pairs of long, stout plumose setae, first (outermost) and second setae (Fig. 1G) with short part of distal end armed with distinct hooklets, hooklet size on first seta larger than that on second seta, third to fifth setae (Fig. 1H) serrated but lacking hooklets on distal part; bases of long plumose setae (Fig. 1D, E) bearing 1–4 spinule-like setules; posteromedian region (Fig. 1F) narrow, flattish or slightly concave, bearing setules; lateral corner (Fig. 1E) terminating into stout, smooth spines, with short plumose seta (anomuran hair) at mesial base; dorsal surface with 5 pairs of fine setae along midline; anal spine present.

**Antennule (Fig. 2A).**—Elongated, slightly swollen, narrowing distally, with 3 aesthetascs and 3 setae at distal end.

**Antenna (Fig. 2B).**—Endopod fused with protopod, with minute distal spine and subdistal seta; exopod slender, tapering, overreaching endopod, 1.67 times as long as endopod, with 3 or 4 spinules along distal half of mesial margin.

**Mandible (Fig. 2C).**—Asymmetrical, heavily dentate, palp absent.

**Maxillule (Fig. 2D).**—Coxal endite with 8 plumodenticulate setae; basal endite with 6 strong spines armed with several denticles, and 2 simple setae submarginally; endopod unsegmented, with 1 distomesial and 2 distolateral setae at distal end.

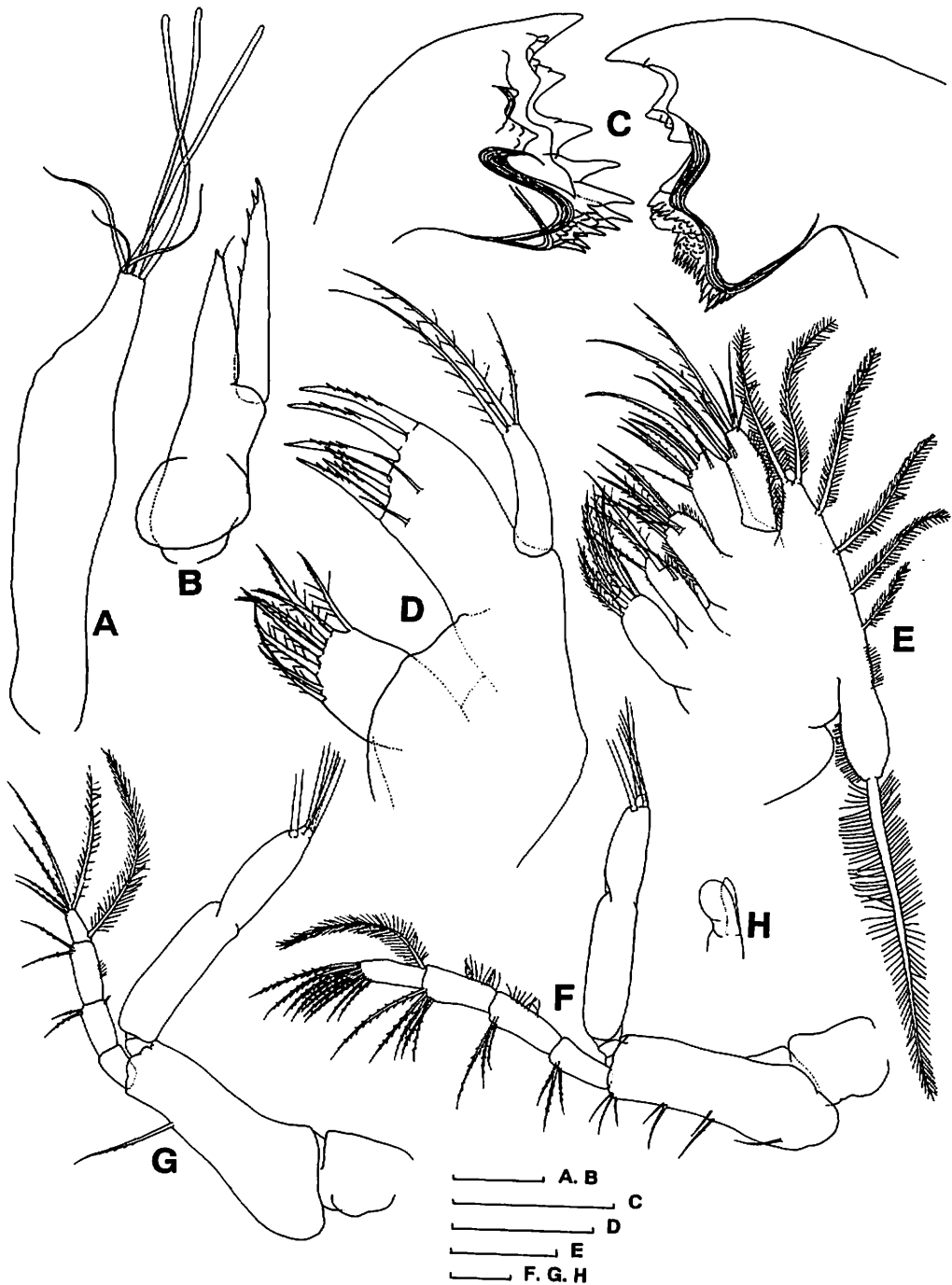


Fig. 2. *Pachycheles garciaensis* (Ward, 1942), first zoea. A. Antennule. B. Antenna. C. Mandibles. D. Maxillule. E. Maxilla. F. First maxilliped. G. Second maxilliped. H. Third maxilliped. Scales=0.1 mm.

*Maxilla* (Fig. 2E).—Coxal endite bilobed, proximal lobe with 5 subterminal and 2 terminal setae, distal lobe with 2 subterminal and 2 terminal setae; basal endite bilobed, proximal lobe with 2 or 3 subterminal and 4 terminal setae, distal lobe with 1 subterminal and 6 terminal setae, all setae on both endites plumodenticulate; endopod unsegmented, with 3 subdistomesial, 2 distomesial, and 3 distolateral setae; scaphognathite with 5 or 6 plumose setae on distal lobe and one long plumose seta at apex of proximal lobe.

*First maxilliped* (Fig. 2F).—Bilobed; coxa without setae; basis with 1+1-2+2+3 setae on ventral margin; endopod 4-segmented, first to third segments with 3, 3, 4-5 ventral setae, respectively, second and third segments with fine setules on dorsal margin, fourth segment with 8 or 9 distal setae and one plumose seta at dorsoproximal end; exopod indistinctly 2-segmented, with 4 long plumose natatory setae at terminal end.

*Second maxilliped* (Fig. 2G).—Bilobed; coxa naked; basis with 1 seta on distal one third of ventral margin; endopod 4-segmented, first segment without setae, second and third segments

Table 1. Dimensional (CL, carapace length; RSL, rostral spine length; PSL, posterior spine length; mean values in brackets) and morphological (the presence and number of: a, aesthetascs; ps, plumose setae; s, setae; sp, spines) characters of the first zoeae of *Pachycheles garciaensis* and *P. sculptus*.

	<i>P. garciaensis</i>	<i>P. sculptus</i>
Carapace:		
CL (mm)	1.59-1.70 (1.66)	1.40-1.46 (1.43)
RSL (mm)	14.50	11.26-11.54
PSL (mm)	5.99-6.37	4.83-5.00
RSL/CL	8.57	7.77-8.18
PSL/CL	3.51-3.75	3.43-3.46
Antennule:		
protopod	3a+3s	3a+3s
Antenna:		
exopod	(3-4)sp	3sp
Mandible:		
palp	absent	absent
Maxillule:		
coxal endite	8s	8s
basal endite	6sp+2s	6sp+3s
endopod	(1+2)s	(1+2)s
Maxilla:		
coxal endite	(7+4)s	(7+4)s
basal endite	(6-7+7)s	(6-7+6-7)s
endopod	(3+2+3)s	(3+2+3)s
scaphognathite	(5-6+1)ps	(5-6+1)ps
First maxilliped:		
coxa	naked	naked
basis	(1+1-2+2+3)s	(1+2+2+3)s
endopod	3s, 3s, (4-5)s, (8-9)s+1ps	3s, 3s, 4s, 9s+1ps
Second maxilliped		
coxa	naked	naked
basis	1	1+2
endopod	0s, 2s, 2s, 5s+1ps	2s, 2s, 2s, 5s+1ps
Abdomen:		
somites with posterolateral spines	4-5	4-5
somites with posterodorsal teeth	3-5	3-5

each with 2 setae on ventral margin and fine setules on dorsal margin, fourth segment with 5 distal setae (one seta slightly stouter than others) and one plumose seta at dorsoproximal end; exopod as in first maxilliped.

*Third maxilliped* (Fig. 2H).—Biramous, small unsegmented buds.

*Pereiopods* (Fig. 1B).—Small bud.

*Color in life*.—Rostral and posterior spines pale brown. Red chromatophores around mouthparts.

***Pachycheles sculptus*** (H. Milne Edwards, 1837)

*First zoea* (Figs. 3, 4; Table 1)

*Duration*.—8–9 days.

*Number of specimens examined for appendage morphology*.—5.

*Size*.—CL 1.40–1.46 mm (4 specimens, mean 1.43 mm), RSL 11.26–11.54 mm (2 specimens), PSL 4.83–5.00 mm (3 specimens).

*Carapace* (Fig. 3A).—Typically porcellanid; rostral spine extremely elongated, with spinules over entire length, 7.77–8.18 times as long as CL; posterior spines elongated with pointed spinules along whole ventral margin increasing in length proximally and small spinules on dorsoproximal part, 3.43–3.46 times as long as CL; lower posterior margin (Fig. 3B) with approximately 30 small spinules. Eyes sessile.

Morphological structures of abdomen, telson, and appendages as for those of *P. garciaensis* except for the following points:

*Telson* (Fig. 3C).—1.28 times as long as broad at mesial bases of lateral spines.

*Antenna* (Fig. 4B).—Exopod with 3 spinules along distal one third of mesial margin.

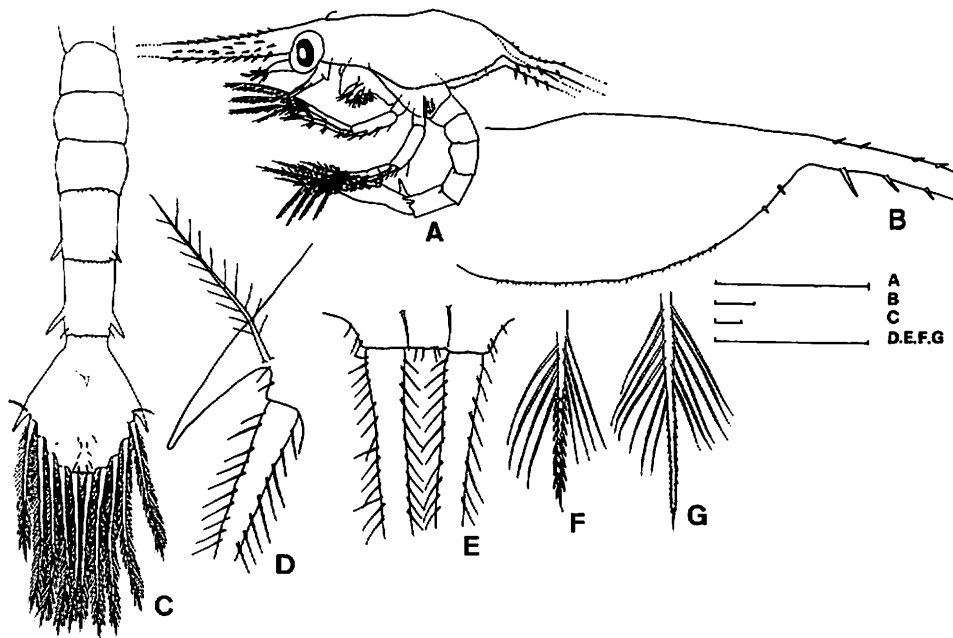


Fig. 3. *Pachycheles sculptus* (H. Milne Edwards, 1837), first zoea. A. Carapace, abdomen, and appendages, lateral view. B. Lower posterior margin of carapace. C. Abdomen and telson. D. Posterolateral region of telson. E. Posteromedian region of telson. F. Distal part of first long plumose seta on telson. G. Distal part of third long plumose seta on telson. Scales=1.0 mm for A; 0.1 mm for B–G.

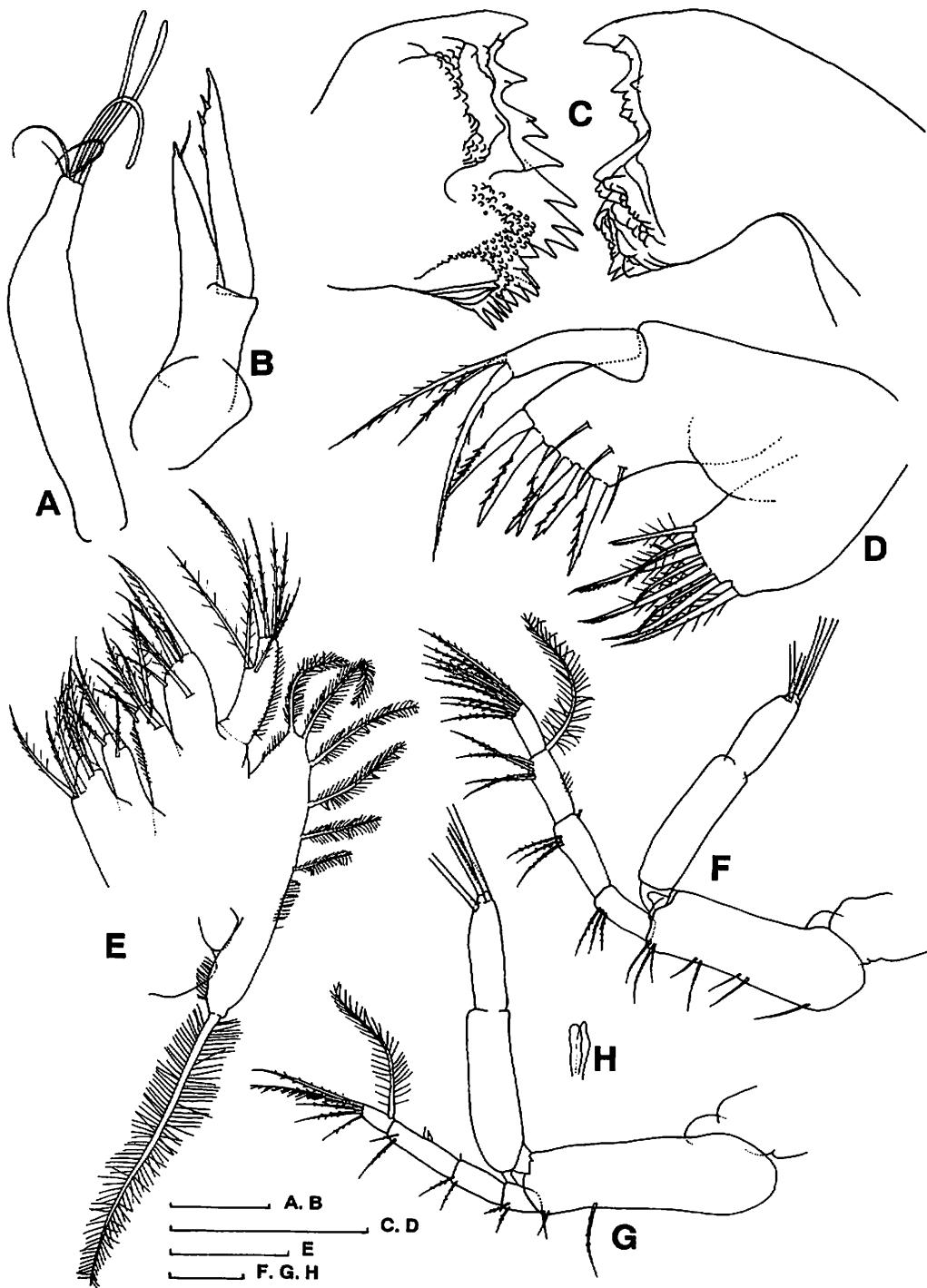


Fig. 4. *Pachycheles sculptus* (H. Milne Edwards, 1837), first zoea. A. Antennule. B. Antenna. C. Mandibles. D. Maxillule. E. Maxilla. F. First maxilliped. G. Second maxilliped. H. Third maxilliped. Scales=0.1 mm.

*Maxillule* (Fig. 4D).—Basal endite with 3 simple setae submarginally.

*Maxilla* (Fig. 4E).—Distal lobe of basal endite with 1 subterminal and 5 or 6 terminal setae.

*First maxilliped* (Fig. 4F).—Basis with 1+2+2+3 setae on ventral margin, endopod with third and fourth segments bearing 4 ventral and 9 distal setae, respectively.

*Second maxilliped* (Fig. 4G).—Basis with 1+2 setae, first segment of endopod with 2 ventral setae.

*Color in life*.—Rostral and posterior spine pale brown. Red chromatophores around mouthparts.

## Discussion

The general morphology of the adults of *Pachycheles garciaensis* and *P. sculptus* is very similar, but they can be distinguished from each other by the presence or absence of dense plumose setae on the ambulatory legs and male pleopods (Haig 1966; Nakasone & Miyake 1968). Regarding the morphological structures of the first zoea examined, *P. garciaensis* is also easily distinguishable from *P. sculptus* by the following characters: (1) the basal endite of the maxillule has 2 setae (3 setae in *P. sculptus*); and (2) the basis of the second maxilliped possesses a single ventral seta and the first endopod segment is naked (1+2 and 2 setae, respectively, in *P. sculptus*).

Konishi (1987) summarized the common morphological features of zoeae of seven *Pachycheles* species. However, as shown in Table 2, the present two species disagree with him regarding the following points: (1) the endopod of the maxillule has 3 setae (4 setae in the previously known species except for 3–5 setae in *P. pubescens*); (2) the endopod of the maxilla possesses 8 setae (9 setae in the others except for 7 or 9 setae in *P. natalensis* and 8 or 9 setae in *P. pubescens*); and (3) the coxa of the first maxilliped lacks ventral setae (2 setae in the others except for unexamined setae in *P. haigae*). Moreover, *P. garciaensis* and *P. sculptus* seem to possess a much longer rostral spine than those of their congeners (RSL/CL, 7.77–8.57). These morphological differences in the zoea may prove the validity of the genus *Pisosoma* Stimpson, which was established with the type species, *Porcellana pisum* H. Milne Edwards (= *Pachycheles sculptus*), and has been synonymized with *Pachycheles* since Haig (1960). However, as larval descriptions of the other species, including *Pachycheles pisoides* (Heller), *P. granti* Haig, and *P. johnsoni* Haig, which also fall into the generic category of *Pisosoma* based on the adult morphology, have not yet been made; it is necessary to wait upon further larval studies on these species and a detailed morphological examination of the adults in order

**Table 2.** Morphological differences in the first zoea between *Pachycheles* and *Neopisosoma*.

	<i>Pachycheles</i> (Konishi 1987)	<i>Pachycheles garciaensis</i> <i>P. sculptus</i> (present study)	<i>Neopisosoma</i> (Gore 1977; Werding & Müller 1990)
Maxillule: endopod	4 setae	3 setae	4 setae
Maxilla: endopod	9 setae	8 setae	8 or 9 setae
First maxilliped: coxa	2 setae	naked	naked



to reach a conclusion about the status of *Pisosoma*.

Gore (1977) and Werding & Müller (1990) described the larval development of *Neopisosoma angustifrons* (Benedict) and *N. neglectum* Werding. Judging from their descriptions, *Neopisosoma* zoea can be distinguished from *Pachycheles* zoea only by the absence of ventral setae on the coxa of the first maxilliped. However, as mentioned above, *Pachycheles garciaensis* and *P. sculptus* also lack the setae as in *Neopisosoma* species, and therefore, the two genera are not distinguishable from each other based on the zoeal morphology. According to Haig (1960) who originally separated the genera, the structure of the pterygostomial flap (epimera) in the adult stage is the principal distinction between them. The status of the two genera has also been discussed by Gore (1977), Werding (1986), and Werding & Müller (1990). Werding (1986) suggested that the degree of reduction of the posterior pieces of the pterygostomial flap is species-dependent rather than a genera-determining character. The present examination also finds no justification for separating *Neopisosoma* from *Pachycheles*.

### Acknowledgments

I would like to thank H. Misaki of the Kushimoto Marine Park, and A. Shigei and F. Sato of the Minami-Chita Beach Land Amusement Park, for providing laboratory facilities in the Yaeyama Marine Park Research Station during my stay there. I also express my appreciation to Dr. M. Murano of the Shin-Nippon Meteorological and Oceanographical Consultant Co., Ltd. and Dr. T. Ishimaru of the Tokyo University of Fisheries, for their encouragement during this study. The manuscript benefited from the comments of two anonymous reviewers.

### Literature Cited

- Gore, R. H. 1977. *Neopisosoma angustifrons* (Benedict, 1901): The complete larval development under laboratory conditions, with notes on larvae of the related genus *Pachycheles* (Decapoda Anomura Porcellanidae). *Crustaceana* 33: 284–300.
- Haig, J. 1960. The Porcellanidae (Crustacea Anomura) of the eastern Pacific. *Allan Hancock Pacific Exped.* 24: 1–440, pls. 1–41, text-figs. 1–12.
- Haig, J. 1966. A review of the Indo-west Pacific species of genus *Pachycheles* (Porcellanidae, Anomura). *Proc. Symp. Crustacea Part I*: 285–294.
- Konishi, K. 1987. The larval development of *Pachycheles stevensii* Stimpson, 1858 (Crustacea: Anomura: Porcellanidae) under laboratory conditions. *J. Crustacean Biol.* 7: 481–492.
- Kurata, H. 1964. Larvae of decapod Crustacea of Hokkaido. 7. Porcellanidae (Anomura). *Bull. Hokkaido Regional Fish. Res. Lab.* 29: 66–70. (In Japanese with English summary.)
- Miyake, S. 1982. *Japanese Crustacean Decapods and Stomatopods in Color, Vol. 1. Macrura, Anomura and Stomatopoda*. Hoikusha, Osaka, Japan, i–viii, 261 pp. (In Japanese.)
- Nakasone, Y. & S. Miyake 1968. On six species of *Pachycheles* (Anomura: Porcellanidae) from the West Pacific. *OHMU (Occ. Pap. Zool. Lab., Fac. Agric., Kyushu Univ.)* 1: 61–83, pls. 5, 6.
- Osawa, M. 1995. Larval development of four *Petrolisthes* species (Crustacea: Anomura: Porcellanidae) under laboratory conditions, with comments on the larvae of the genus. *Crustacean Res.* 24: 157–187.
- Shenoy, S. & K. N. Sankolli 1973. Larval development of a porcellanid crab *Pachycheles natalensis* (Krauss) (Decapoda, Anomura). *J. Mar. Biol. Ass. India.* 15: 545–555.
- Tirmizi, N. M. & M. Yaqoob 1979. Larval development of *Pachycheles tomentosus* Henderson (Anomura, Porcellanidae) with descriptive remarks on the adult from Karachi waters (northern Arabian Sea). *Pakistan J. Zool.* 11: 29–42.
- Werdning, B. 1986. Die gattung *Neopisosoma* Haig, 1960 im tropischen westatlantik, mit der beschreibung von *Neopisosoma neglectum* spec. nov. und *Neopisosoma orientale* spec. nov. (Crustacea: Anomura: Porcellanidae). *Zool. Mededel.* 60: 159–179.

- Werding, B. & H. G. Müller 1990. Larval development of *Neopisosoma neglectum* Werding, 1986 (Decapoda: Anomura: Porcellanidae) under laboratory conditions. *Helgoländ. Meeresunters.* **44**: 363–374.
- Yaqoob, M. 1979. Larval development of *Pachycheles natalensis* (Krauss, 1843) under laboratory conditions (Decapoda, Porcellanidae). *Biologia, Lahore* **25**: 23–34.