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Redescription of the complete developmental stages of *Pilumnopus convexus* (Maccagno, 1936) (described as *Pilumnus* sp.) (Crustacea: Decapoda: Brachyura: Pilumnidae)

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Abstract

The present paper is based on the result of laboratory rearing of *Pilumnopus convexus* from the 1st zoeal to megalopa stage earlier described as *Pilumnus* sp. But as *Pilumnopus convexus* this will be the ever first report of the larvae of *Pilumnopus convexus*. The ovigerous female was collected from P.N.S. Himalya, Karachi (Long 66°58'42"E, Lat 24°47'30"N) on 11 nov, 1985 and maintained in the wet laboratory of MRC, recently reexamined and identified as *Pilumnopus convexus*. Larvae were hatched, at room temperature 18-29°C in filtered seawater of a salinity of 36 ppt and pH 7.9.

All the larval stages of *Pilumnopus convexus* are described along with their illustrations, taken from earlier description as *Pilumnus* sp and compared with the available descriptions of congeneric species of *Pilumnopus* and allied genera.

Keywords: decapoda, pilumnidae, *Pilumnopus convexus*, larval development, Pakistan

Introduction

The genus *Pilumnopus* is a tropical genus, inhabiting coastal waters from the intertidal interstices of rocks on beaches. Included in the genus *Pilumnopus* are 10 well organized species (Davie and Türkay, 2009; Ng *et al.*, 2008) [8-10, 24] 24 except *Pilumnopus convexus* (Maccagno, 1936) [13, 14] which is taxonomically problematic.

So far zoeal stages of 3 species of the genus - *P. serratifrons* (as *H. serratifrons*), *P. makianus*, and *P. granulatus* are described the world over (Ko, 1997; Lim *et al.*, 1986; Greenwood and Fielder, 1984; Lee, 1993 [17, 19, 15].

The present larvae of *P. convexus* are the first ever obtained in the laboratory. No such information was present in any part of the world. The larvae are compared with those of congeneric species.

Materials and Methods

During routine collection trips we have collected one ovigerous female of *Pilumnopus convexus* from P.N.S. Himalya, Karachi (Long 66°58'42"E, Lat 24°47'30"N). Ovigerous female was kept in the laboratory in unfiltered seawater with a salinity of 36‰, pH 7.9 and room temperature was 18-29 °C and water temperature 16 – 27 °C until hatching occurred. Newly hatched larvae were segregated and placed ten larvae per beaker (500 ml) containing filtered seawater of same salinity and temperature. Each beaker was examined daily to fill with freshly filtered seawater. *Artemia* nauplii were offered as food. Temporary slides were made by using glycerin plus 5% formalin (3:1). The illustrations were made with the help of Olympus BH2 microscope (1.25X4, 10, 20 and 40 magnifications) with Nomarski Differential Interference Contrast (D/C) and camera lucida attachment.

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Results



Plate 1: *Pilumnopus convexus* (Maccagno, 1936) female

Table 1: Time of the first appearance and measurements of each larval stage of *Pilumnopus convexus* (Maccagno, 1936).

Stage	Days elapsed after hatching	Carapace length CL \pm SD (mm)	Abdomenal length AL \pm SD (mm)	Total Length TL \pm SD (mm)
Zoea I	5	0.54 \pm 0.56	0.53 \pm 0.60	1.07 \pm 1.16
Zoea II	3	0.52 \pm 0.85	0.62 \pm 0.85	1.14 \pm 1.70
Zoea III	4	1.01 \pm 1.05	0.89 \pm 0.86	1.90 \pm 1.91
Zoea IV	3	1.50 \pm 1.51	0.97 \pm 1.00	2.47 \pm 2.51
Megalopa	3	0.87 \pm 0.99	-	1.62 \pm 1.99

Larval description

Zoea I (Fig. 1 - J)

Carapace (Figs. 1A, B).- posterior half pubescent; dorsal spine long backwardly curved; rostral and lateral spines small and downwardly curved; posterior margin bears variable number of setules; eyes sessile.

Antennule (Fig. 1C).- Uniramous with 3 terminal aesthetascs and 2 setae.

Antenna (Fig. 1D).- Protopod and exopod approximately equal in length, each tapers apically; protopod with rows of spinules on either margins of distal half and exopod with 2 spines on distolateral margin, from where a row of spinules starts on distomesial margin.

Mandible (Fig. 1E).- Incisor and molar processes well developed.

Maxillule (Fig. 1F). - Coxal endite with 6 terminal plumodenticulate setae; basal endite with 3 cuspidate setae and 2 plumodenticulate setae; endopod 2-segmented with 1, 4+2 plumodenticulate setae, respectively.

Maxilla (Fig. 1G).- Coxal endite, basal endite and endopod bilobed with 3+3, 4+5 and 3+5 plumodenticulate setae,

respectively; scaphognathite with 4 marginal plumose setae; posterior process tapering and fringed with fine setae.

Maxilliped I (Fig. 1H).- Coxa naked; basis with 10 plumodenticulate setae on medial margin; endopod 5-segmented with 3,2,1,2,6 (2 subterminal + 4 terminal) plumodenticulate setae, respectively; exopod 2-segmented with 4 terminal plumose natatory setae.

Maxilliped II (Fig. 1I).- Coxa naked; basis with 4 plumodenticulate setae on medial margin; endopod 3-segmented with 1,1,6, (3 subterminal + 3 terminal) plumodenticulate setae, respectively; exopod 2-segmented with 4 terminal plumose natatory setae.

Abdomen (Fig. 1J).- Five somites; somite 2 with 1 pair of dorsolateral processes directed anteriorly; somite 3 with 1 pair of dorsolateral processes directed posteriorly; somites 3-5 with well-developed posterolateral angle; somites 1-5 with a pair of posteriodorsal setae.

Telson (Fig. 1J).- Bifurcated, each half of the furca bearing 1 large lateral spine; 1 small dorsal spine; 1 small lateral seta; inner border of each furca covered with fine setae; posterior margin of the telson with 3 pairs of spinulate setae.

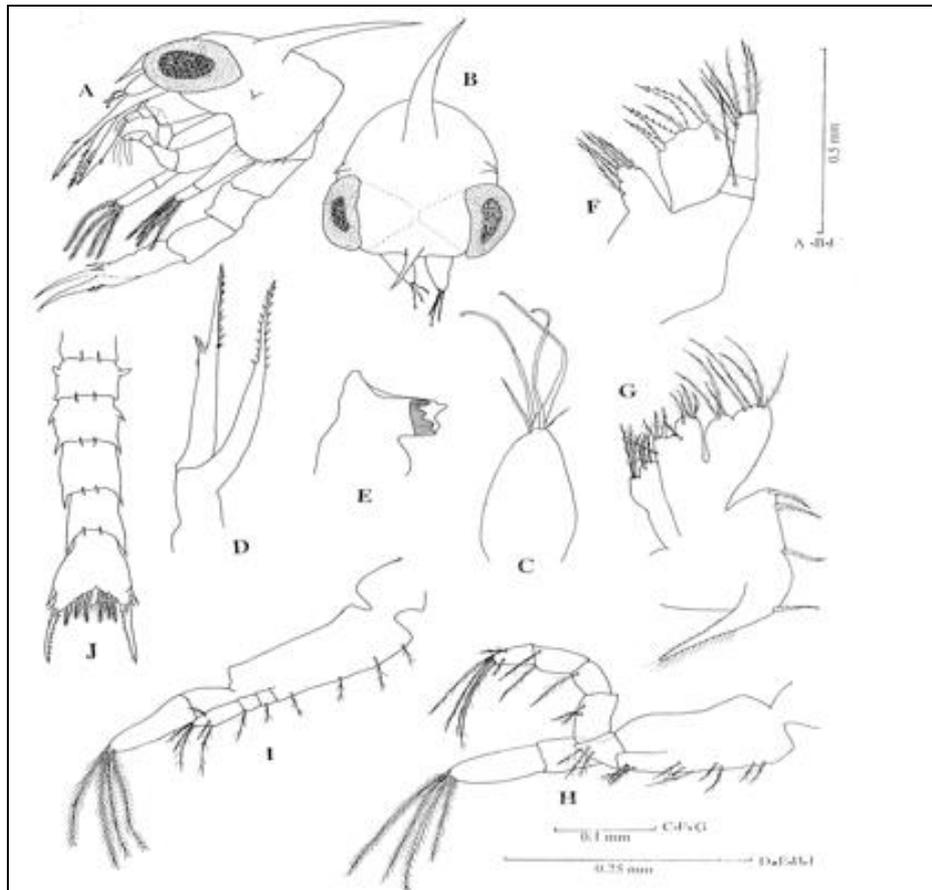


Fig 1: *Pilumnopus convexus* (Maccagno, 1936). Zoea I. A, entire, lateral view; B, dorsofrontal view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, I, maxillipeds I, II; J, abdomen with telson, dorsal view

Zoea II (Fig. 2A - J)

Carapace (Figs. 2A, B).- posterior half pubescent; dorsal spine long backwardly curved; rostral and lateral spines small and downwardly curved; posterior margins bear variable number of setules; eyes stalked.

Antennule (Fig. 2C).- Biramous; endopod bud present; exopod with 5 terminal aesthetascs and 1 small seta.

Antenna (Fig. 2D).- Protopod and exopod approximately equal in length, each tapers apically; protopod with rows of spinules on either margins of distal half and exopod with 2 spines on distolateral margin, from where a row of spinules starts on distomesial margin; endopod bud present approximately one fifth length of exopod.

Mandible (Fig. 2E).- Mandibular palp present.

Maxillule (Fig. 2F). - Coxal endite with 7 plumodenticulate setae; basal endite with 5 cuspidate setae and 3 plumodenticulate setae; endopod 2-segmented with 1, 4+2 plumodenticulate setae, respectively; exopod with 1 plumose seta.

Maxilla (Fig. 2G).- Coxal and basal endite bilobed with 4+4 and 6+4 plumodenticulate setae, respectively; endopod bilobed with 3+3, 4+5 and 3+5 plumodenticulate setae,

respectively; exopod (scaphognathite) with 8 marginal plumose setae; posterior process broadened.

Maxilliped I (Fig. 2H).- Coxa naked; ; basis with 10 plumodenticulate setae on medial margin; endopod 5-segmented with 3,2,1,2,5 (1 subterminal + 4 terminal) plumodenticulate setae, respectively; exopod with 6 terminal plumose natatory setae.

Maxilliped II (Fig. 2I).- Coxa naked; basis with 4 plumodenticulate setae on medial margin; endopod 3-segmented with 1,1,6, (3 subterminal + 3 terminal) plumodenticulate setae, respectively; exopod with 6 terminal plumose natatory setae.

Abdomen (Fig. 2J).- Now with six somites; somite 2 with 1 pair of dorsolateral processes directed anteriorly; somite 3 with 1 pair of dorsolateral processes directed posteriorly; somites 3-5 with well-developed posteriolateral angle; somites 1-5 with a pair of posteriodorsal setae; somites 6 without setae.

Telson (Fig. 2J).- Bifurcated, each half of the furca bearing 1 large lateral spine; 1 small dorsal spine; 1 small lateral seta; inner border of each furca covered with fine setae; posterior margin of the telson with 3 pairs of spinulate setae.

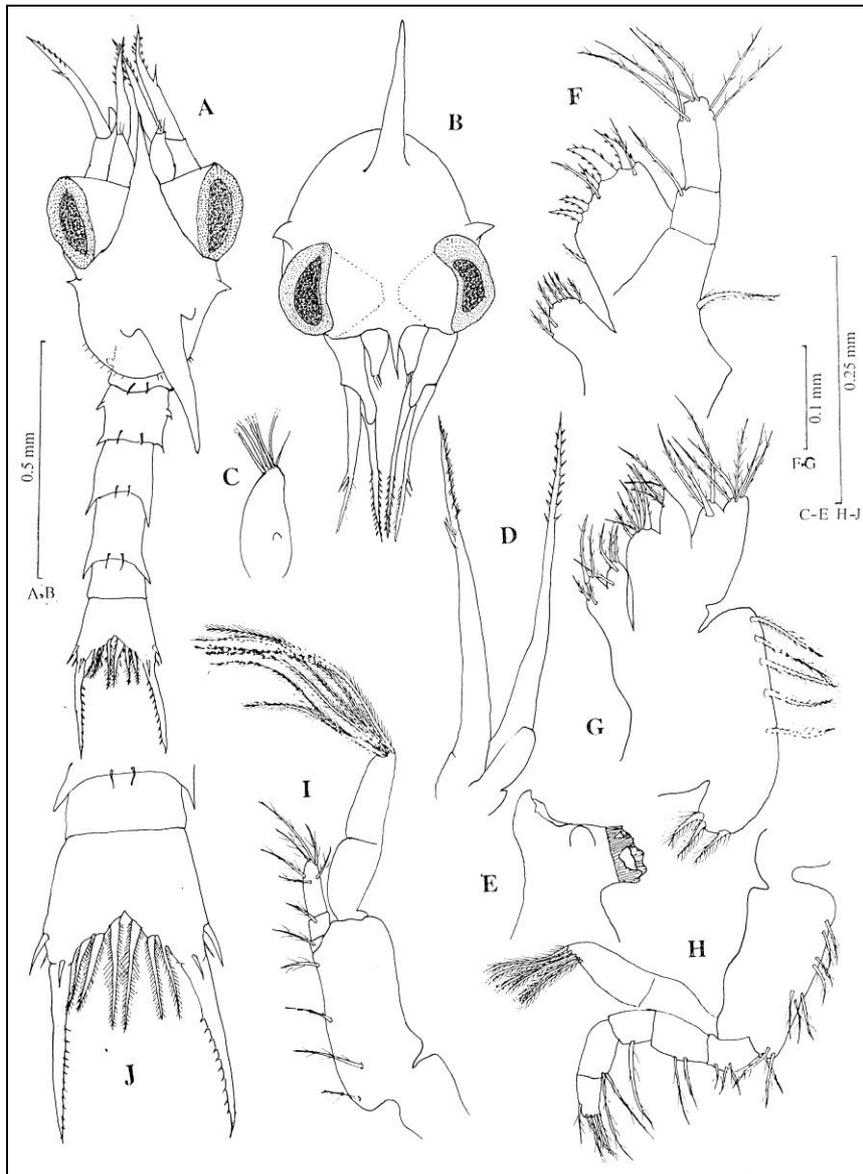


Fig 2: *Pilumnopus convexus* (Maccagno, 1936). Zoea II. A, entire, dorsal view; B, dorsofrontal view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, I, maxillipeds I, II; J, telson

Zoea III (Fig. 3A - P)

Carapace (Figs. 3A, B).- posterior half pubescent; dorsal spine long backwardly curved; rostral and lateral spines small and downwardly curved; posterior margins bear variable number of setules; eyes stalked.

Antennule (Fig. 3C).- Biramous; endopod bud present; exopod with 5 terminal aesthetascs and 1 small seta.

Antenna (Fig. 3D).- Endopod bud is one third of length exopod.

Mandible (Fig. 3E).- Mandibular palp present.

Maxillule (Fig. 3F). - Coxal endite with 7 plumodenticulate setae; basal endite with 5 cuspidate setae and 4 plumodenticulate setae; endopod 2-segmented with 1, 4+2 plumodenticulate setae, respectively; exopod with 1 plumose seta.

Maxilla (Fig. 3G).- Coxal and basal endite bilobed with 4+4 and 5+5 plumodenticulate setae, respectively; endopod bilobed with 3+3, 4+5 and 3+5 plumodenticulate setae, respectively; scaphognathite with 17 marginal setae.

Maxilliped I (Fig. 3H).- Coxa naked; basis with 10 plumodenticulate setae on medial margin; endopod 5-segmented 3,2,1,2,6 (2 subterminal + 4 terminal)

plumodenticulate setae, respectively; exopod with 8 terminal plumose natatory setae.

Maxilliped II (Fig. 3I).- Coxa naked; basis with 4 plumodenticulate setae on medial margin; endopod 3-segmented with 1,1,6, (3 subterminal + 3 terminal) plumodenticulate setae, respectively; exopod with 8 terminal plumose natatory setae.

Maxilliped III (Fig. 3J).- Biramous; rudimentary.

Pereiopods I-V (Figs. 3K - O).- Rudimentary.

Abdomen (Fig. 3P).- Six somites; somite 2 with 1 pair of dorsolateral processes directed anteriorly; somite 3 with 1 pair of dorsolateral processes directed posteriorly; somites 3-5 with well-developed posterolateral angle; somites 1-5 with a pair of posteriodorsal setae; somites 6 without setae.

Peleopod (Fig. 3A).- Uniramous buds, rudimentary, developed on abdominal somites 2-6.

Telson (Fig. 3P).- Bifurcated, each half of the furca bearing 1 large lateral spine; 1 small dorsal spine; 1 small lateral seta; inner border of each furca covered with fine setae; posterior margin of the telson with 3 pairs of spinulate setae.

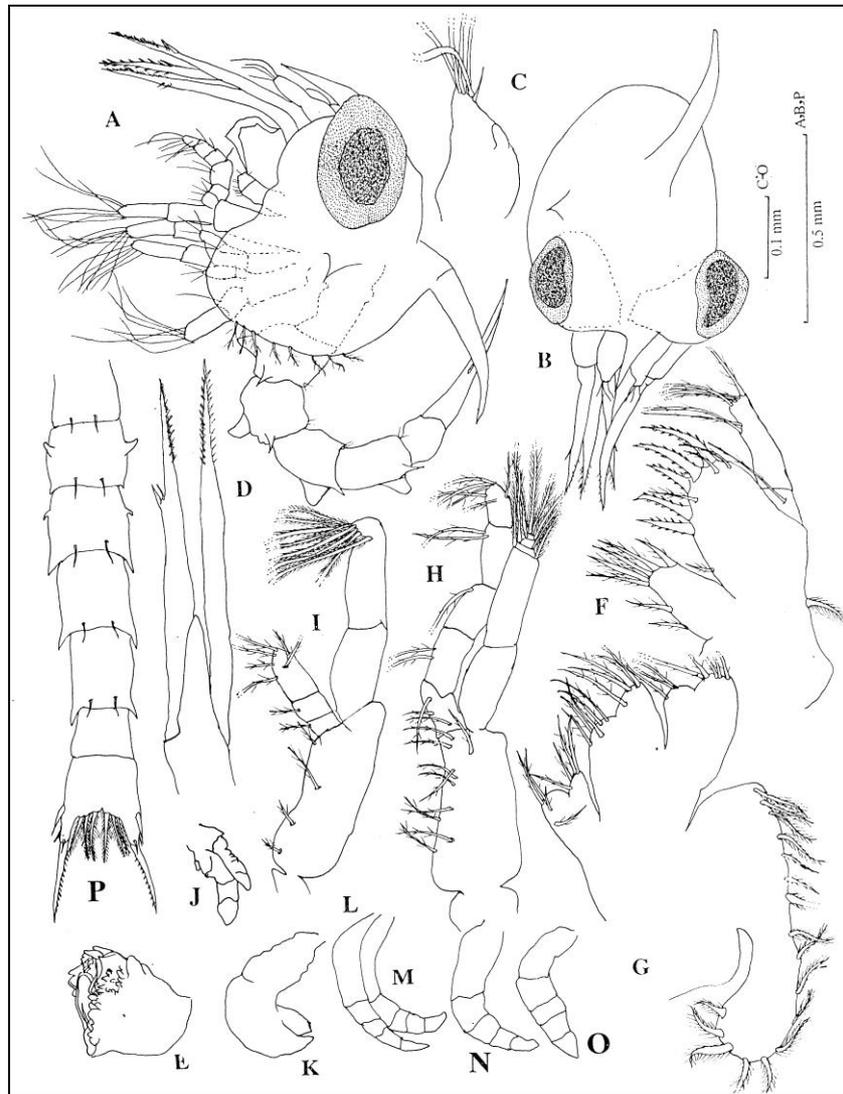


Fig 3: *Pilumnopus convexus* (Maccagno, 1936). Zoea III. A, entire, dorsal view; B, dorsofrontal view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H - J, maxillipeds I - III; K - O, pereiopods I - V; P, abdomen with telson, dorsal view

Zoea IV (Fig. 4A - P)

Carapace (Figs. 4A, B).- posterior half pubescent; dorsal spine long backwardly curved; rostral and lateral spines small and downwardly curved; posterior margins bear variable number of setules; eyes stalked.

Antennule (Fig. 4C).- Biramous; endopod bud present; exopod with 5 terminal aesthetascs and 1 small seta.

Antenna (Fig. 4D).- Endopod less than half length of exopod.

Mandible (Fig. 4E).- Mandibular palp more developed.

Maxillule (Fig. 4 F).- Coxal endite with 7 plumodenticulate setae; basal endite with 5 cuspidate setae and 4 plumodenticulate setae; endopod 2-segmented with 1, 4+2 plumodenticulate setae, respectively; exopod with 1 plumose seta.

Maxilla (Fig. 4G).- Coxal and basal endite bilobed with 4+4 and 6+6 plumodenticulate setae, respectively; endopod 2-segmented with 1, 4+2 plumodenticulate setae, respectively; scaphognathite with 21 marginal setae.

Maxilliped I (Fig. 4H).- Coxa naked; basis with 10 plumodenticulate setae on medial margin; endopod 5-

segmented 3,2,1,2,6 (2 subterminal + 4 terminal) plumodenticulate setae, respectively; exopod with 10 terminal plumose natatory setae.

Maxilliped II (Fig. 4I).- Coxa naked; basis with 4 plumodenticulate setae on medial margin; endopod 3-segmented with 1,1,6, (3 subterminal + 3 terminal) plumodenticulate setae, respectively; exopod with 9 terminal plumose natatory setae.

Maxilliped III (Fig. 4J).- Increase in size otherwise no change.

Pereiopods I-V (Figs. 4K - O).- More developed buds.

Abdomen (Fig. 4P).- Six somites; somite 2 with 1 pair of dorsolateral processes directed anteriorly; somite 3 with 1 pair of dorsolateral processes directed posteriorly; somites 3-5 with well- developed posterolateral angle; somites 1-5 with a pair of posteriodorsal setae; somite 6 without setae.

Peleopod (Fig. 4A).- Biramous buds on abdominal somites 2-5 and somite 6 with uniramous bud.

Telson (Fig. 4P).- Posterior margin with 3 pairs of spinulate setae and 1 small seta centrally.

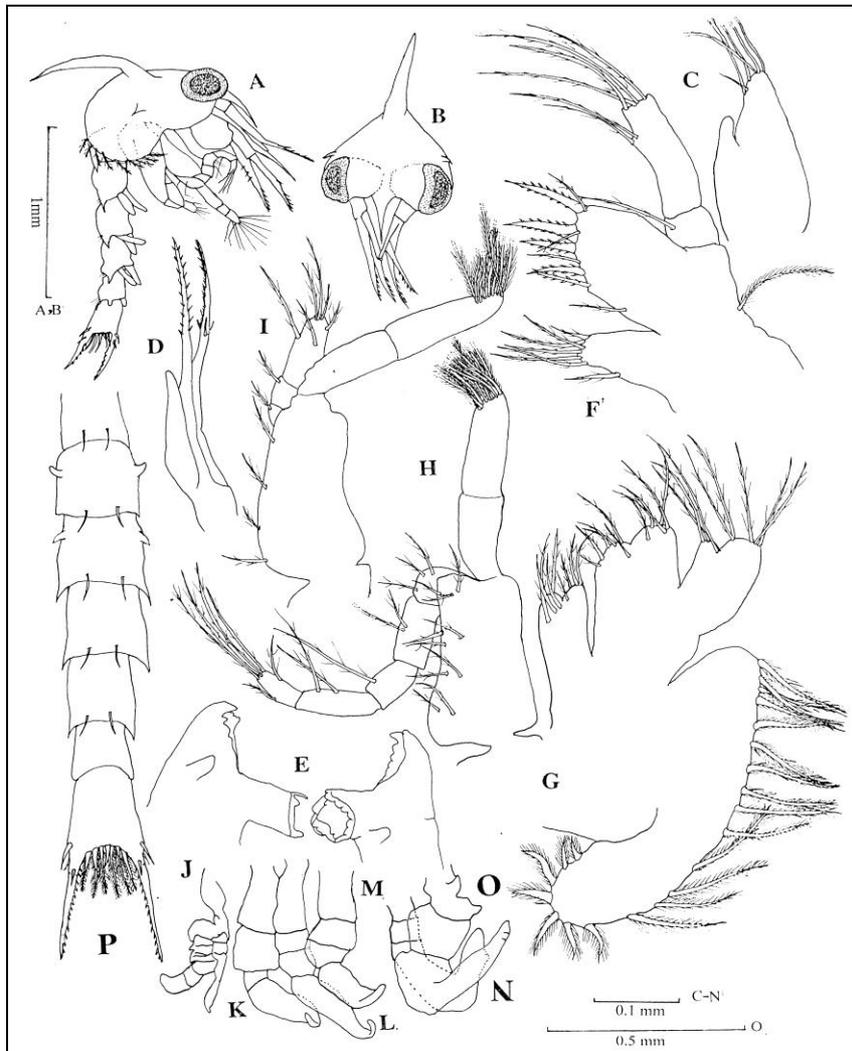


Fig 4: *Pilumnopus convexus* (Maccagno, 1936). Zoea IV. A, entire, lateral view; B, dorsofrontal view; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H- J, maxillipeds I - III; K- O, pereiopods I-V; P, abdomen with telson, dorsal view

Megalopa (Figs. 5A - 6L)

Carapace (Fig. 5A).- broader than long; rostrum short and knob like; one pair of small seta present on either sides of rostrum; eyes stalked and prominent.

Antennule (Fig. 5B).- Biramous; 3 segmented peduncle without setation; endopod with 1 subterminal and 4 terminal setae; exopod with 15 aesthetascs and 2 setae.

Antenna (Fig. 5C).- Uniramous with 4-segmented peduncle, segment 1 produced distolaterally with 4 lateral plumodenticulate setae and 1 terminal long seta; segment 2 bears 1 plumodenticulate seta; flagellum 6-segmented with 0,0,3+1,0,2+1,4 plumodenticulate setae, respectively.

Mandible (Fig. 5D).- Masticatory processes adult like; palp 2-segmented; 1 plumodenticulate seta present on proximal end; distal segment with few plumodenticulate setae.

Maxillule (Fig. 5E).- Coxal endite with 6 plumodenticulate setae, basal endite with 4 cuspidate setae and 10 plumodenticulate setae; endopod with 8 (2+2+4) plumodenticulate setae; exopod with 1 plumose seta.

Maxilla (Fig. 5F).- Coxal and basal endite bilobed with 4+3 and 5+6 plumodenticulate setae, respectively; endopod with 5 plumodenticulate setae; exopod (scaphognathite) with 27-29 marginal and 2 submarginal plumose setae.

Maxilliped I (Fig. 6A).- Coxal endite with 4 plumodenticulate setae; epipod and basis with 3 and 6 plumodenticulate setae, respectively; endopod with 9 plumodenticulate setae and

exopod with 4 terminal plumose natatory setae.

Maxilliped II (Fig. 6B).- Coxal endite broken; basis naked; endopod with 2,1,4 plumodenticulate setae, segments 1-3 respectively, segment 4 with 1 plumodenticulate and 5 cuspidate setae; exopod with 10 terminal plumose natatory setae.

Maxilliped III (Fig. 6C).- Adult like ; coax and basis reduced; epipod with 7 plumodenticulate setae; endopod 5-segmented, proximal two segments broad and sparsely setose, few long plumodenticulate setae progressing distally on segments 3-5; exopod 2-segmented, with 4 terminal and 1 subterminal natatory plumose setae.

Pereiopods I-V (Figs. 6D - H).- Developed and sparsely covered with cuspidate and plumodenticulate setae.

Abdomen (Fig. 5A).- Six somites with rounded posteriolateral angle and bear 2 pairs of setae on posteriolateral angle of somites 2-5.

Peleopod (Figs. 6I - L).- Peleopods biramous developed on abdominal somites 2-5; exopod of peleopod 1-4 with 12,11,11, and 10 plumose setae, respectively; endopod of each peleopod with 2 hooks distally.

Telson (Fig. 5G).- Telson triangular with a simple seta on the dorsal surface and 1 pair of long seta on mid posterior margin; distal segment of uropod terminally with 6 natatory plumose setae.

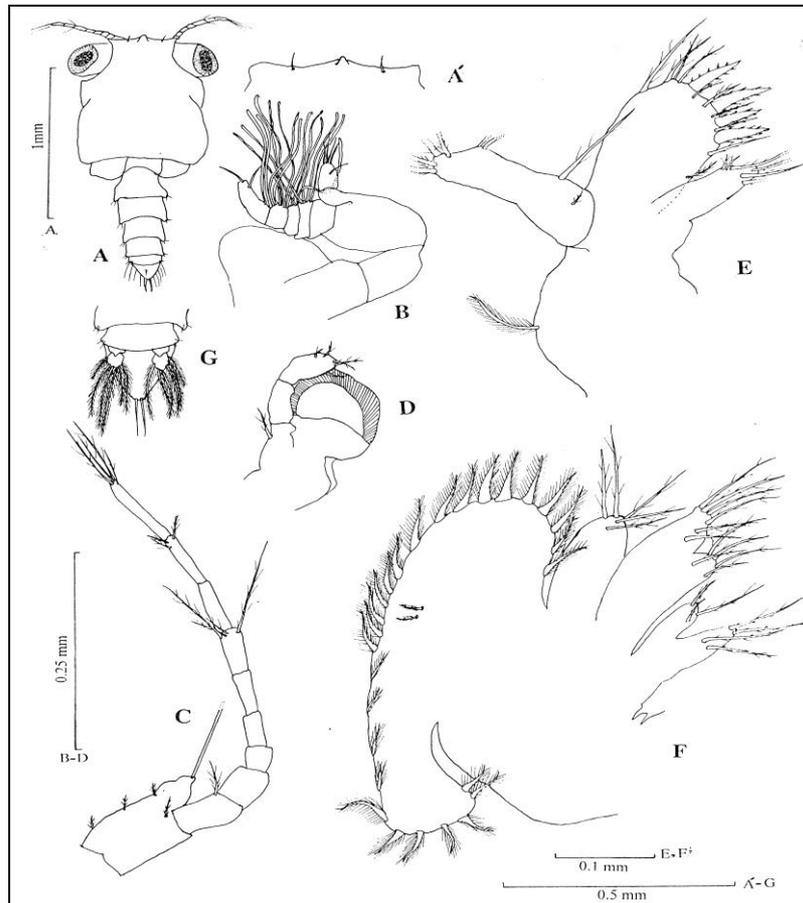


Fig 5: *Pilumnopeus convexus* (Maccagno, 1936). Megalopa. A, entire, dorsal view; A' frontal view of carapace; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, telson with uropod, ventral view

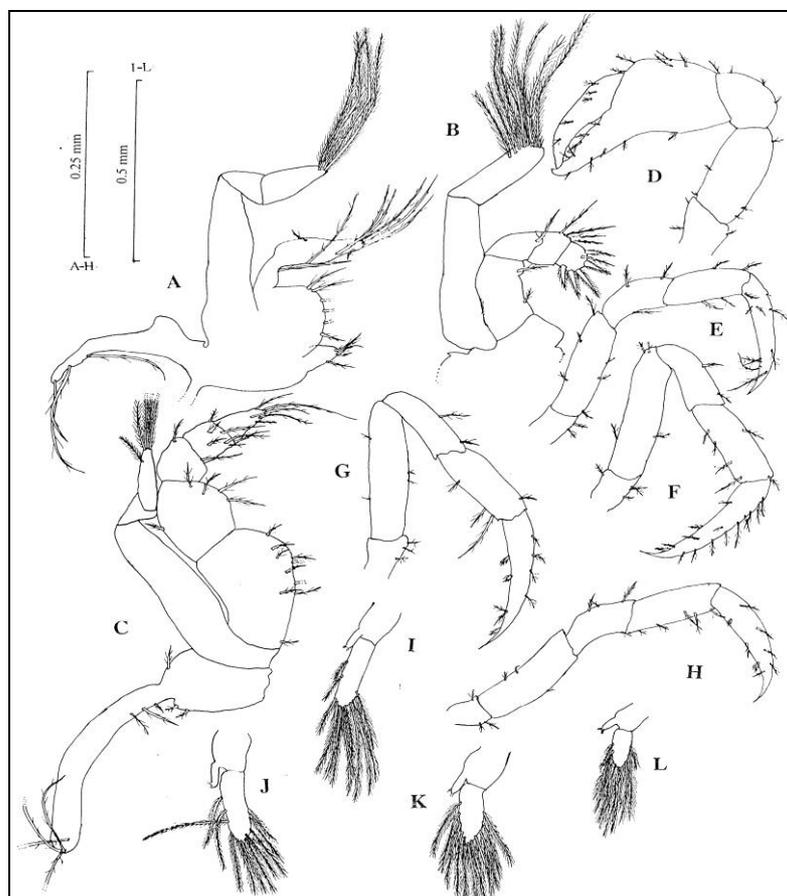


Fig 6: *Pilumnopeus convexus* (Maccagno, 1936). Megalopa. A - C, maxillipeds I - III; D-H, pereiopods I-V; I-L, pleopods I - IV

Discussion

The family Pilumnidae consists of many taxonomically problematic genera. The status of the present genus *Pilumnopus* has long been the subject of debate. Taxonomy of *Pilumnopus convexus* was discussed by Maccagno, 1936; Ward, 1942; Davie, 1989; Cooper, 1997; Ghani and Davie, 2000; Apel, 2001; Ghory *et al.*, 2013; Naderloo, 2017; Gosavi *et al.*, 2017 and Al-Khafaji, 2017.

The present larval study of *Pilumnopus convexus* is the first report of the larvae of *P. convexus*, no such information is present in any part of the world, although the same larvae were described by Ghory and Siddiqui, in 2000 under *Pilumnus* with a conclusion that those larvae were “definitely a different species may be new or new record from Pakistan”. Then Ghani and Davie (2000) reported it from Pakistan. The female utilized in Ghory and Siddiqui, 2000 was reexamined and identified as *Pilumnopus convexus*. The purpose of this study is to redescribe the complete larval development of *P. convexus* from laboratory reared material and to compare with available descriptions of the laboratory reared larvae of congeneric species and allied genera (*Benthopanope eucratoides*, *Heteropanope glabra*, *Pilumnopus granulatus* and *Pilumnopus serratifrons*).

P. convexus has four zoeal stages before reaching megalopa. The morphology of *P. convexus* has few characters which resemble to the *B. eucratoides*, *P. granulatus* and *P. serratifrons*. As given in table 2 the first zoea of *P. convexus* resembles with *P. serratifrons* in having the long and curved carapace dorsal spine, rostral spine and lateral spines are small and pointed and its maxilla coxal endite with 3+3 setae and telson has 3+3 posterior marginal setae. In case of second and third zoeal stages resemble *P. granulatus* in having the same length of antennal endopodal bud, endopodal setae of

maxilliped I and basal endite setae of maxilla (Table 2), but *P. granulatus* has long and straight carapace dorsal spine while it is long and curved in *P. convexus*. In megalopal stage *P. convexus* again having a little resemblance with *P. granulatus* through the number of endopodal terminal setae of antennule and endopodal setae of maxilliped I (Table 2). However *P. convexus* and *B. eucratoides* also have little resemblance with exopod setae of maxilliped I and II whereas *B. eucratoides* and *P. convexus*. *B. eucratoides* has no lateral spine and carapace rostral spine is long and pointed but shares *Heteropanope* a pair of lateral processes on third abdominal somite.

Conclusion

Obtaining the larval development from an ovigerous female in the laboratory has one distinct advantage, the species can be subsequently positively identified (Clark, 2009). The identification of the adult Pilumnid species, specially their females, is very difficult but the investigation on larval morphology and development may help to solve this issue. According to Lim *et al.*, 1984 crab zoeae are considered to be useful in Brachyuran taxonomy.

Although a small number of species have been investigated on larvae basis of the following closely allied genera there do appear larval characters which separate *Pilumnopus* from the close genera *Heteropanope* and *Benthopanope*. Now with the present availability of larval characteristics which is an addition to larval information of the group may help in a properly validated conclusion and will aid in elucidating the generic placement. There is a necessary need for taxonomic revision of *Pilumnopus* together with its allied genera *Benthopanope* and *Heteropanope* in the region.

Table 2: Comparison between laboratory reared zoeae of *Pilumnopus convexus* (present study), *Benthopanope eucratoides*, *P. granulatus*, *Pilumnopus serratifrons* and *Heteropanope glabra*.

Zoea I:

Characters	<i>P. convexus</i> present study	<i>P. granulatus</i> Ko (1997)	<i>P. serratifrons</i> Greenwood & Fielder (1984)	<i>P. serratifrons</i> Wear (1968)(as <i>H. (P.)</i> <i>serratifrons</i>)	<i>B. eucratoides</i> Lim <i>et al</i> (1986) (as <i>P. eucratoides</i>)	<i>Heteropanope</i> <i>glabra</i> Lim <i>et al</i> (1984)
Zoeal stages	4-5	4	3	1	3	4
Carapace spines: Dorsal	long & curved	long & straight	long & straight	long & curved	long & curved	long & straight
rostral spine	small & pointed	small & pointed	small & pointed	small & pointed	long & pointed	long & pointed
lateral spine	small & pointed	small & pointed	small & pointed	small & pointed	absent	Long with rounded tips
Antennule: aesthetascs + seta	3 aesthetascs+ 2 setae	3 aesthetascs+ 3 setae	3 aesthetascs+ 3 setae	4 aesthetascs	2 aesthetascs + 2 setae	4 aesthetascs+ 2 setae
Maxillule: setae: coxal endite	6 setae	7 setae	7 setae	5 setae	7 setae	6 setae
basial endite	3+2 setae	5 setae	5 setae	4 setae	5 setae	5 setae
Maxilla: setae: coxal endite	3+3 setae	10 setae		3 + 3 setae	5+4 setae	6+4 setae
basial endite	4+5 setae	9 setae	4+5 setae	3 + 4 setae	4+4 setae	5+4 setae
Maxilliped I: Endopod	14(3,2,1,1+1,2+4) setae	13 (3,2,1,2,1+4) setae	13(3,2,1,2,1+4) setae	11 (2,2,1,2,4) setae	14(3,2,1,2,1+5) setae	13(3,2,1,2,5) setae
Telson: posterior margin	3+3 setae	3+3 setae	3+3 setae	3+3 setae	3+1+3 setae	3+3 setae

Zoea II:

Characters	<i>P. convexus</i> present study	<i>P. granulatus</i> Ko (1997)	<i>P. serratifrons</i> Greenwood & Fielder (1984)	<i>B. eucratoides</i> Lim et al (1986) (as <i>P. eucratoides</i>)	<i>Heteropanope glabra</i> Lim et al (1984)
Antennule: aesthetascs + seta	5aesthetascs +1 seta	3 aesthetascs + 3 setae	5 aesthetascs	2 aesthetascs +2 setae	4 aesthetascs + 1 seta
Antenna: endopodal bud length to exopod	one fifth	one fifth	not mentioned	one third	one fifth
Maxillule: basal endite	5+3+1 setae	8 setae	8 setae	6+2+1 setae	8 + 1 setae
Maxilla: Setae coxal endite	4+4 setae	6+4 setae	4+5 setae	5+4 setae	5+4 setae
basial endite	6+4 setae	5+5 setae	5+5 setae	4+4 setae	3+2 setae
Exopod (scaphognathit) marginal setae	8 setae	11 setae	11 setae	10 setae	11 setae
Maxilliped I: Endopod	13(3,2,1,2,5) setae	13(3,2,1,2,1+4) setae	13(3,2,1,2,1+4) setae	14(3,2,1,2,1+5)	13(3,2,1,2,1+4) setae

Zoea III:

Characters	<i>P. convexus</i> present study	<i>P. granulatus</i> Ko (1997)	<i>P. serratifrons</i> Greenwood & Fielder (1984)	<i>B. eucratoides</i> Lim et al (1986) (as <i>P. eucratoides</i>)	<i>Heteropanope glabra</i> Lim et al (1984)
Antennule: aesthetascs + seta	5+1 setae	4+1 setae	11+1 seta	3+2 setae	4+1 setae
Antenna: endopodal bud length to exopod	one third	one third	not mentioned	half length	half length
Maxillule: setae: basal endite	5+4+1 setae	9 setae	9 setae	9+1 setae	9+1 setae
Maxilla: Setae coxal endite	4+4 setae	6+4 setae	4+5 setae	5+4 setae	6+4 setae
basial endite	5+5 setae	5+5 setae	6+7 setae	5+6 setae	6+6 setae
Exopod (Scaphognathit) marginal setae	17 setae	20 setae	22 setae	14 setae	20 setae

Zoea IV:

Characters	<i>P. convexus</i> present study	<i>P. granulatus</i> Ko (1997)	<i>Heteropanope glabra</i> Lim et al (1984)
Antennule: aesthetascs + seta	5+1 setae	9+1 setae	6+2 setae
Antenna: endopodal bud length to exopod	less than half	more than half	three fifth
Maxilla: Setae coxal endite	4+4 setae	6+4 setae	6+4 setae
Exopod (Scaphognathit) marginal setae	21 setae	28 setae	27 setae

Megalop:

Characters	<i>P. convexus</i> present study	<i>P. granulatus</i> Ko (1997)	<i>B. eucratoides</i> Lim et al (1986) (as <i>P. eucratoides</i>)	<i>Heteropanope glabra</i> Lim et al (1984)
Rostrum shape	short, blunt	short, pointed	short	short consist of three lobes
Antennule: Endopod terminal setae	4 setae	4 setae	3 setae	5 setae
sub-terminal setae	1 seta	2 setae	3 setae	1 seta
outer flagellum	5-segmented	4-segmented	4-segmented	4-segmented
Aesthetascs	15	12	9	12
Setae	2 setae	4 setae	3 setae	4 setae
Mandibular palp: setae on distal segment	5 setae	8 setae	6 setae	6 setae
Maxillule: setae: coxal endite	6 setae	15 setae	8 setae	13 setae
basial endite	14 setae	20 setae	16 setae	18 setae
Endopod	no segmented, 8(2+2+4) setae	no segmented, 6 (2+2+2) setae	no segmented, 4(2+2) setae	2-segmented, 1+ 1 setae
Maxilla: setae: coxal endite	4+3 setae	8+6 setae	6+2 setae	9(4,5)+ 4 (2+2) setae
basial endite	5+6 setae	6+9 setae	4+8 setae	5+8 setae
Endopod	5 setae	4 setae	1 seta	5 setae
Maxilliped I: setae: epipod	3 setae	8 setae	5 setae	7 setae
Basis	6 setae	9 setae	10 setae	12 setae
Endopod	9 setae	9 setae	2 setae	4 setae
Exopod	2-segmented, 4 setae	2-segmented, 7 setae	2-segmented, 4 setae	2-segmented, 6 setae
Maxilliped II:	2-segmented	Incompletely 3-	2-segmented	2-segmented

Exopod		segmented		
terminal setae	10 setae	5 setae	5 setae	4 setae
endopod setae	13(2,1,4,6) setae	14 (2,1,4,7) setae	13 (2, 1, 4, 6.) setae	15 (2,1,5,7) setae
Maxilliped III: terminal setae	5 setae	5 setae	6 setae	6 setae
endopod setae	29(10,4+1,2,7,5) setae	46 (15,8,7,10,6)	36 (12,9,4,6,5) setae	46(15,10,6,10,5)

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