Article

Morpho-taxonomic study of some planktonic caught megalopal stages collected from northern Arabian Sea

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Abstract

Present study deal with the identification of planktonic caught megalopal stages of different crab species. Zooplankton samples were collected from Clifton and Manora Channel (Karachi, Pakistan). The stages are described, illustrated and compared with available literature.

Keywords planktonic caught; morpho-taxonomic study; megalopal stages.

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1 Introduction

Brachyurans are the true crabs, comprising the largest group of crustaceans, found in all types of habitats (Al-Khafaji, 2017; Varadharajan et al., 2013). Most crabs cannot swim, except portunids which have become powerful swimmers, due to the adaptation of the last pair of legs into broad flattened paddles. Crabs show marked sexual dimorphism. Many species of crabs are commercially consumed throughout the world.

Early life cycle of brachyuran crabs has a planktonic dispersal stage consisting of a variable number of zoeal larvae followed by the molt to the megalopal stage. Most brachyurans have zoeal stages and a megalopa in their development, some have a megalopa but no zoeas and some have neither zoeas nor a megalopa (Williamson and Rice, 1996). Variations in developmental stages and morphology of zoeas and megalopae were described in brachyuran crabs and allocated to the effects of the salinity, temperature, availability, and food quality (Shirley et al., 1987; Montú et al., 1990; Spivak et al., 1994; Dĭaz et al., 1995; Pestana and Ostrensky, 1995; Cuesta et al., 2002; Gimenez et al., 2004; Zeng et al., 2004).

2 Materials and Methods

2.1 Collection sites and collection technique for obtaining plankton samples

Zooplankton samples were collected from Clifton (Lat. 24°47’42”N Long. 66°59’06”E) and Manora Channel (Lat. 24°48’N Long. 66°59’E). The collections for planktonic specimens were made using Bongo net of 300

µ mesh size with horizontally attached flow meter in a tow time of 10 minutes. The depths of samples were 15'-20'.

2.2 Microscopic observations

The samples were preserved in 5% buffered formalin. Zooplankton were sorted under microscope Ogawa Seiki (4 x 10 magnifications) and transferred to 70% alcohol. Lactic acid was used for clearance of larvae while Rose Bengal was used for staining of larvae. Temporary slides of each stage were made by using glycerin plus 5 % formalin (3: 1).

Measurement of each stage was made with the aid of micrometer. The total length (TL) was determined from the tip of the rostrum to the mid posterior border of the carapace. Measurements are in millimeters (mm).

Identification of these megalopae was made up to possible taxon level by comparison with available literature. The preserved megalopae were deposited in the Marine Reference Collection and resource centre, University of Karachi.

2.3 Summary of materials examined

Table 1 is the summary of materials examined.

Table 1 Summary of materials examined.

Family/ Species	Size of megalopae	No. of megalopae	Locality
Leucosiidae *Philyra* sp.	1.99mm	1	Manora Channel
Portunidae *Charybdis* sp.	3.53mm - 4.64mm	3	Manora Channel
Pilumnidae *Pilumnopeus convexus*	2.77mm - 3.18 mm	2	Clifton
Dotillidae *Dotilla blanfordi*	2.47mm-2.25mm	3	Clifton

3 Results

3.1 Key to the genera

1A- Endopod of peleopod with 2 hooks----------**2**

1B- Endopod of peleopod with more than 2 hooks----------**3**

2A- Antennal peduncle 2-segmented ---------- **LEUCOSIIDAE**

2B- Antennal peduncle 4-segmented ---------- **PILUMINIDAE**

3A- Fourth pereiopod with a pairs of large cornua developed posteriolaterally on sternal plate near coxa---------- **PORTUNIDAE**

3B- Fourth pereiopod without cornua ---------- **DOTILLIDAE**

3.2 Systematics of megalopae

Subphylum Crustacea Brunnich, 1772
Class Malacostraca Latreille, 1802
Order Decapoda Latreille, 1802
Infraorder Brachyura Latreille, 1802
Section Eubrachyura de Saint Laurent, 1980
Subsection Heterotremata Guinot, 1977
Superfamily Leucosioidea Samoulle, 1819
Family Leucosiidae Samoulle, 1819
Genus *Philyra* Leach, 1815
***Philyra* sp.**
Superfamily Portunoidea Rafinesque, 1815
Family Portunidae Rafinesque, 1815
Genus *Charybdis* de Haan, 1833
***Charybdis* sp.**
Superfamily Pilumnoidea Samouelle, 1819
Family Pilumnidae Samouelle, 1819
Genus *Pilumnopeus* A.Milne Edwards, 1863
***Pilumnopeus convexus* (Maccagno, 1936)**
Subsection Thoracotremata Guinot, 1977
Superfamily Ocypodoidea Rafinesque, 1815
Family Dotillidae Stimpson, 1858
Genus *Dotilla* de Haan, 1835
***Dotilla blanfordi* Alcock, 1900**

4 Description of Megalopae

4.1 Leucosiidae Samoulle, 1819

***Philyra* sp.** (Fig. 1 - Q)

Diagnostic Features

Carapace (Figs. 1A, B). - Carapace oblong; rostral spine long, with rounded tip; dorsal surface with 1 pair of large anteriodorsal spines and a single posteriodorsal spine, with few setae; eyes stalked and prominent.

Antennule (Fig. 1C). - Peduncle 3-segmented with 2,1,1 very small setae; endopod unsegmented with 1 small terminal seta; exopod 3-segmented, segments 1 and 2 with 2 and 3 subterminal aesthetascs, respectively and segment 3 with 1 terminal seta.

Antenna (Fig. 1D).- 2-segmented peduncle without setae; 4-segmented flagellum; ultimate segment with 3 terminal plumodenticulate setae.

Mandible (Fig. 1E). - Well developed, palp broken.

Maxillule (Fig.1F). - Coxal endite with 7 plumodenticulate setae; basial endite with 5 cuspidate and 8 plumodenticulate setae; endopod unsegmented and very much reduced, without setae.

Maxilla (Fig. 1G). - Coxal and basial endites uniramous, coxal endite with 2 plumodenticulate setae and basial endite with 5 plumodenticulate setae, respectively; endopod simple; exopod (scaphognathite) with 41 setae.

Maxilliped I (Fig. 1H). - Epipod with 2 long setae; coxal endite with 3 plumodenticulate setae and basial endite with 12 plumodenticulate setae; endopod with 1 seta; exopod 2-segmented, distal segment with 4 terminal plumose natatory setae.

Maxilliped II (Fig. 1I). - Epipod and coxa broken; basis with 1 tiny plumodenticulate seta; endopod 5-

segmented; ischium and merus without setae, carpus with 1 seta; propodus with 3 plumodenticulate setae and dactylus with 5 cuspidate and 2 plumodenticulate setae; exopod 2-segmented, distal segment with 4 terminal plumose natatory setae.

Maxilliped III (Fig. 1J). - Epipod and coxa broken; basis with 5 plumodenticulate setae; ischium broad and with 8 plumodenticulate setae; merus with 3 plumodenticulate setae; carpus and propodus each with 1 plumodenticulate seta; dactylus with 3 terminal plumodenticulate setae; exopod broad unsegmented, with 3 plumodenticulate setae laterally.

Pereiopods I-V (Figs. 1K- O). - Developed and sparsely covered with setae; pereiopod I chelate; ischium of pereiopod II with a single prominent blunt spine.

Abdomen (Fig. 1Q). - Five somites with simple posteriolateral angle; somites 2-5 each with pair of biramous pleopods; pleopod 4 (Fig. 1P) endopod unsegmented with 2 subterminal hooks on medial internal margin; exopod unsegmented; pleopods 1-4 with 6 – 7 long marginal plumose natatory setae; posteriodorsal setae on somite 1-5 not visible.

Telson (Fig. 1Q). - Broader than long, simple and smooth, setae not seen.

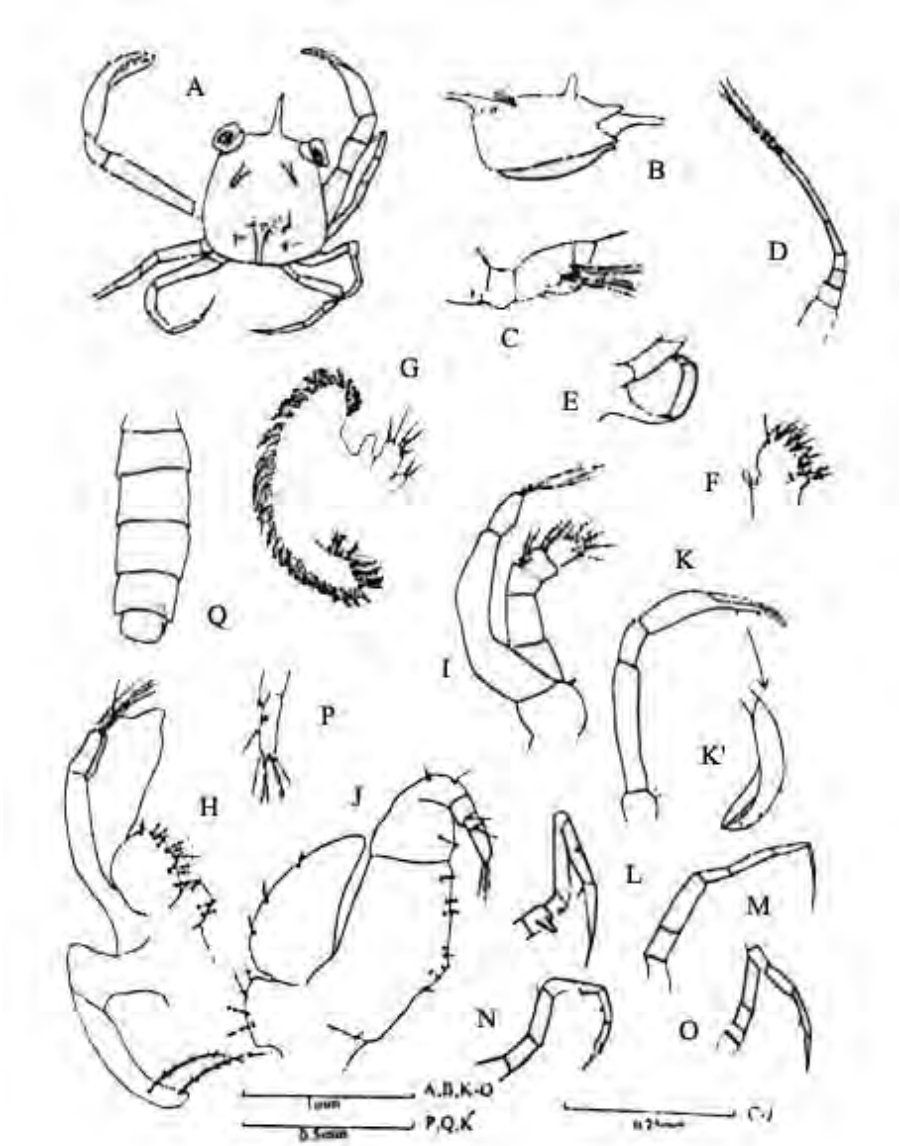

Fig. 1 *Philyra* sp. Megalopa: A, entire, dorsal view; B, lateral view of carapace; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H - J, maxillipeds I - III; K-O, pereiopods I -V; K', dactylus of chela, enlarged; P, pleopod IV; Q, abdomen with telson, dorsal view.

4.2 Portunoidea Rafinesque, 1815

***Charybdis* sp.** (Fig. 2A- S)

Diagnostic Features

Carapace (Fig. 2A). - Carapace smooth; narrowing anteriorly; rostrum long bearing few small spinules on either sides of distolateral margin; posteriolateral margin on either side bears variable number of setules; eyes stalked and prominent.

Antennule (Fig. 2B). - Peduncle 3-segmented with 4,3,2, small setae, respectively; endopod 1-segmented with four terminal plumodenticulate setae; exopod 5-segmented; segments 2,3,4 with 5,5,7 (3 subterminal + 4 terminal) aesthetascs and segments 3, 4 and 5 with 1,1,2 (1 subterminal + 1 terminal) setae, respectively.

Antenna (Fig. 2C). - 4-segmented peduncle with 0,2,1,0 setae; 7 segmented flagellum with 2,3,0,3,1,4,8 (4 subterminal + 4 terminal) setae, respectively.

Mandible (Fig. 2D). - Palp 2-segmented, proximal segment with 1 plumodenticulate seta and distal segment fringed with setae.

Maxillule (Fig. 2E). - Coxal endite with 14 (5 subterminal + 9 terminal) plumodenticulate setae; basial endite with 9 cuspidate and 14 plumodenticulate setae; endopod 2-segmented, proximal segment with 5 and distal segment with 2 plumodenticulate setae; exopod with 1 seta.

Maxilla (Fig. 2F). - Coxal endite bilobed with 9+5 plumodenticulate setae; basial endite bilobed with 9+11 plumodenticulate setae, respectively; endopod simple; exopod (scaphognathite) margin with 69 (6 subterminal + 63 terminal) plumose setae.

Maxilliped I (Fig. 2G). - Epipod with 21 long plumodenticulate setae; coxal endite with 16 plumodenticulate setae; basial endite with 35 plumodenticulate setae; endopod scapula shaped, unsegmented with 1 subterminal plumodenticulate seta and 5 simple terminal setae; exopod 2-segmented, proximal segment with 3 plumodenticulate setae; distal segment with 5 terminal plumose feeding setae.

Maxilliped II (Fig. 2H). - Epipod broken; prodobranch gill present; coxa with 1 small seta, basis with 2 small setae; endopod 5-segmented; ischium with 1 plumodenticulate seta; merus with 5 plumodenticulate setae; carpus with 2 plumodenticulate setae; propodus with1 cuspidate and 7 plumodenticulate setae; dactylus with 10 plumodenticulate setae; exopod 2- segmented, proximal segment with 1 seta and distal segment with 5 plumodenticulate feeding setae.

Maxilliped (Fig. 2I). - Epipod with 23 long plumodenticulate setae and arthrobranch gill; protopod with 4 plumodenticulate setae; ischium with 23 plumodenticulate setae; merus with 15 plumodenticulate setae; carpus with 12 plumodenticulate setae; prododus with 13 plumodenticulate setae; dactylus with 3 cuspidate setae; exopod 2-segmented, distal segment with 2 subterminal and 5 terminal plumose raptatory setae.

Pereiopods I-V (Figs. 2J-N). - Ischii of I and II pereiopods with a singlespine ventromedially; a pair of large cornua present posteriolaterally on sternal plate near to coxa of fourth pereiopod;

significantly dactylus of fifth pereiopod with 7 long subterminal and 10 minute setae.

Abdomen (Fig. 2A). - Six somites present; somites 2,3,6 with slightly developed posterioleteral angle and 1-3 lateral setae present on somites 2 and 3; posteriolateral angle of somite 5 with well developed rounded tips and posterior margin with 11 setae; somite 6 with 7 setae on posterior margin.

Pleopods (Fig. 2O-R). - biramous present on abdominal somites 2-5; endopod unsegmented with 3-4 subterminal hooks on the internal margin; exopod partially segmented and each exopod with 22, 21, 19, 18 long marginal plumose natatory setae from I - IV pleopods respectively; uropods (Fig. 228S) present on somite 6 with 13 long marginal plumose natatory setae.

Telson (Fig. 2A). - With 2 pairs of mediodorsal setae.

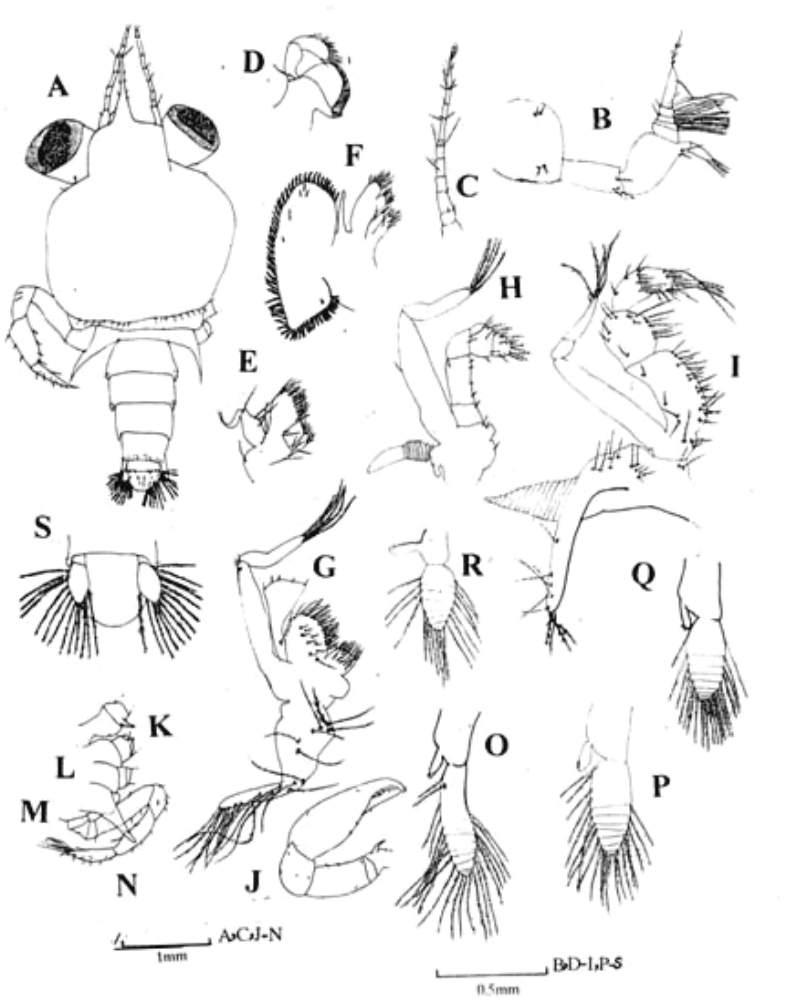

Fig. 2 *Charybdis* sp. Megalopa: A, entire, dorsal view; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G- I, maxillipeds I- III; J, pereiopod I (chela), K-M, pereiopods II-IV (coxa - ischium); N, pereiopod V; O-R, pleopods I-IV; S, telson with uropods, dorsal view.

4.3 Pilumnidae Samouelle, 1819

Pilumnopeus convexus **(Figs. 3A - 4L)**

Diagnostic Features

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

Antenna (Fig. 3C). - Uniramous with 4-segmented peduncle, segment 1 produced distolateraly 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. 3D). - Masticatory processes adult like; palp 2-segmented; 1 plumodenticulate seta present on proximal end; distal segment with few plumodenticulate setae.

Maxillule (Fig. 3E). - Coxal endite with 6 plumodenticulate setae, basial endite with 4 cuspidate setae and 10 plumodenticulate setae; endopod with 8 (2+2+4) plumodenticulate setae; exopod with 1 plumose seta.

Maxilla (Fig. 3F). - Coxal and basial 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. 4A). - 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. 4B). - 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. 4C). - 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. 4D - H).- Developed and sparsely covered with cuspidate and plumodenticulate setae.

Abdomen (Fig. 3A). - Six somites with rounded posteriolateral angle and bear 2 pairs of setae on posteriolateral angle of somites 2-5.

Peleopod (Figs. 4I - 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. 3G). - 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.

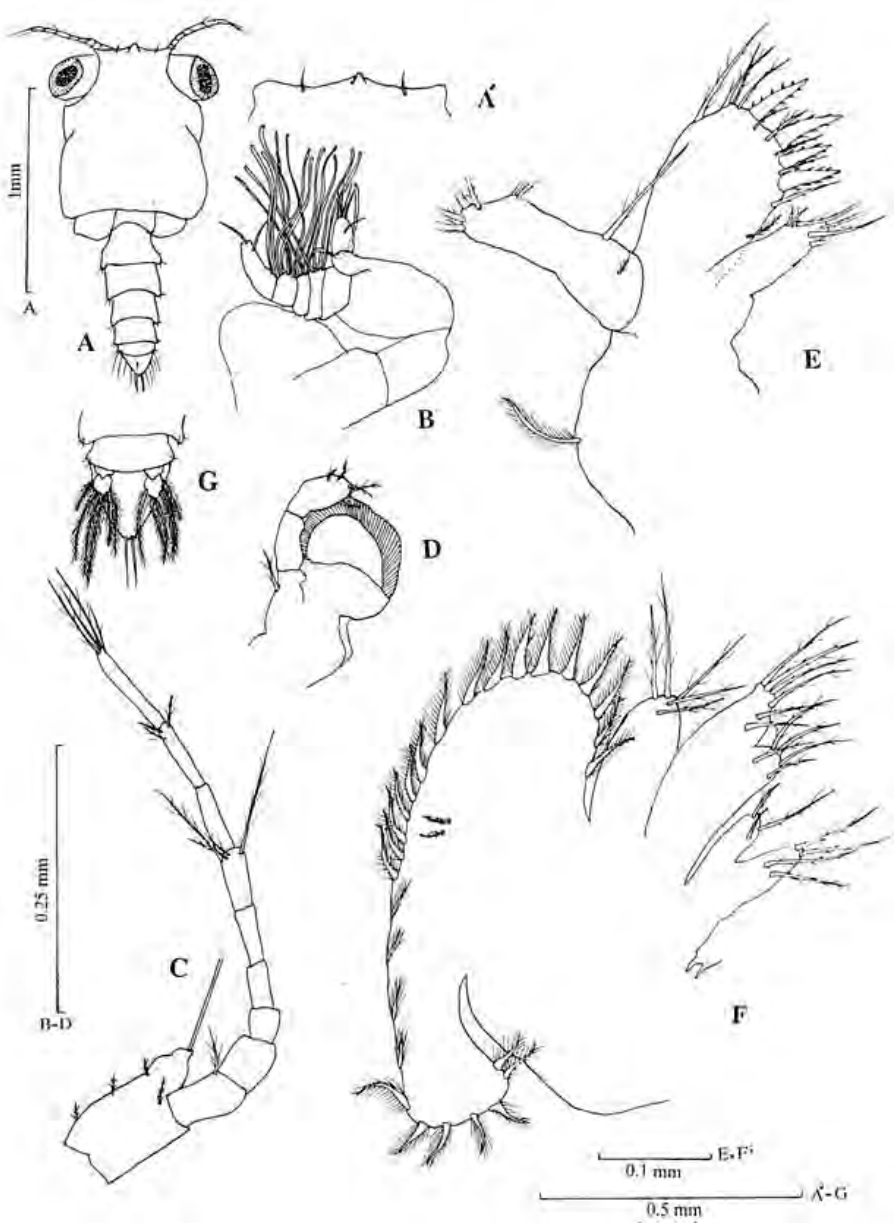

Fig. 3 *Pilumnopeus convexus* (Maccagno, 1936). Megalopa. A, entire, dorsal view; A' frontal view of carapace; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, telson with uropod, ventral view.

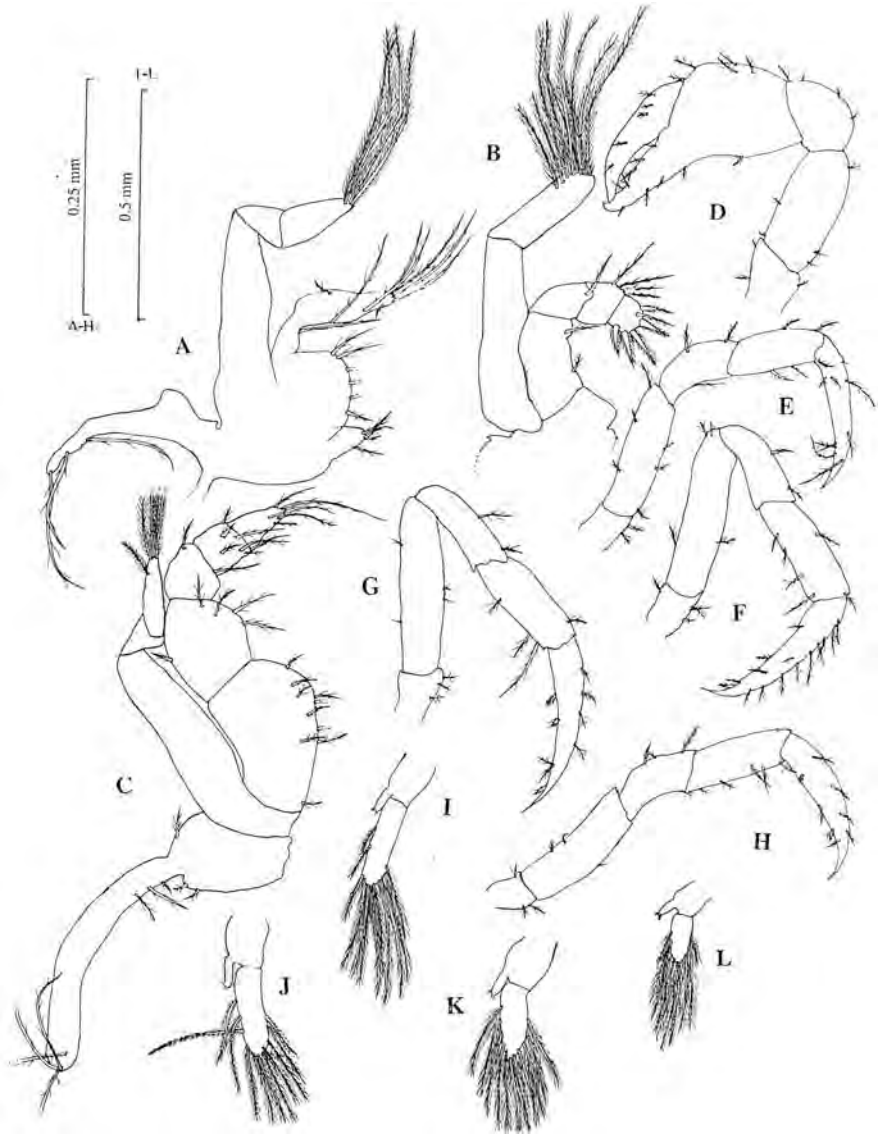

Fig. 4 *Pilumnopeus convexus* (Maccagno,1936). Megalopa. A - C, maxillipeds I – III; D-H, pereiopods I-V; I-L, peleopods I - IV.

4.4 Dotillidae Stimpson, 1858

***Dotilla blanfordi* Alcock, 1900** (Fig. 5A - U)

Diagnostic Features

Carapace (Figs. 5A,B). - Carapace broad; frontal border of the carapace with four lobes; dorsal surface with 2 pairs of tubercles and few setae; rostrum short knob like directed ventrally; posterior margin bear variable number of setules; eyes stalked and prominent.

Antennule (Fig. 5C). - Peduncle 3-segmented with 3,1,3 setae, respectively; endopod absent; exopod 2-segmented, segment 1 ,2 with 2,3 aesthetascs and 1, 2 setae, respectively.

Antenna (Fig. 5D). - 3-segmented peduncle, segment 3 with 1 seta; 4-segmented flagellum, distal segment with 3 setae.

Mandible (Fig. 5E). - Palp 3-segmented with 1,1,29 setae, respectively.

Maxillule (Fig. 5F). - Epipod with 2 setae; coxal endite with several plumodenticulate setae; basial endite with 17 cuspidate and 20 plumodenticulate setae; endopd 2-segmented, distal segment with 1 terminal plumodenticulate seta.

Maxilla (Fig. 5G). - Coxal endite bilobed with 16+7 plumodenticulate setae; basial endite bilobed with 14+36 plumodenticulate setae, respectively; endopod simple; exopod (scaphognathite) margin with several plumose setae.

Maxilliped I (Fig. 5H). - Epipod with 10 long plumodenticulate setae; coxa with 14 plumodenticulate setae; basis with several plumodenticulate setae; endopod unsegmented with 3 plumodenticulate subterminal setae; exopod 3-segmented, proximal segment with 2 plumodenticulate setae, distal segment with 2 setae (broken).

Maxilliped II (Fig. 5I). - Epipod broken; coxa naked; basis with 2 plumodenticulate setae; endopod 5-segmented, ischium with 4 plumodenticulate setae, merus with 2 plumodenticulate setae, dactylus with 19 plumodenticulate setae; exopod 2-segmented, proximal segment with 1 plumodenticulate seta and distal segment with 2 setae (broken).

Maxilliped III (Fig. 5J). - Epipod and coxa broken; basis with 7 plumodenticulate setae; endopod 5-segmented, ischium with 16 plumodenticulate setae, merus with 29 plumodenticulate setae, carpus with 20 plumodenticulate setae, propodus with 4 plumodenticulate setae, dactylus with 4 plumodenticulate setae; exopod 3-segmented, proximal segments with 1,1 plumodenticulate setae, respectively and distal segment with 2 terminal plumose raptatory setae.

Pereiopods I-V (Figs. 5K-O). - Pereiopods I-V developed and sparsely covered with plumodenticulate setae.

Abdomen (Fig. 5T). - Five somites present; somites 1-5 slightly developed posteriolateral angles; somites 2-5 each with 1 pair of lateral setae; somite 6 with 1 pair of medial setae; somites 2-5 each with 1 pair of biramous pleopod (Figs. 5P-S); endopod unsegmented with 2-4 subterminal hooks on the medial margin; exopod unsegmented, pleopods 1-4 with 18,18,18,16 long marginal plumose natatory setae, respectively; uropods (Fig. 5U) present on somite 6 with 1 long marginal plumose natatory seta.

Telson (Fig. 5U). - Two pairs of lateral setae present on posterior margin and with 1 pair of medial setae.

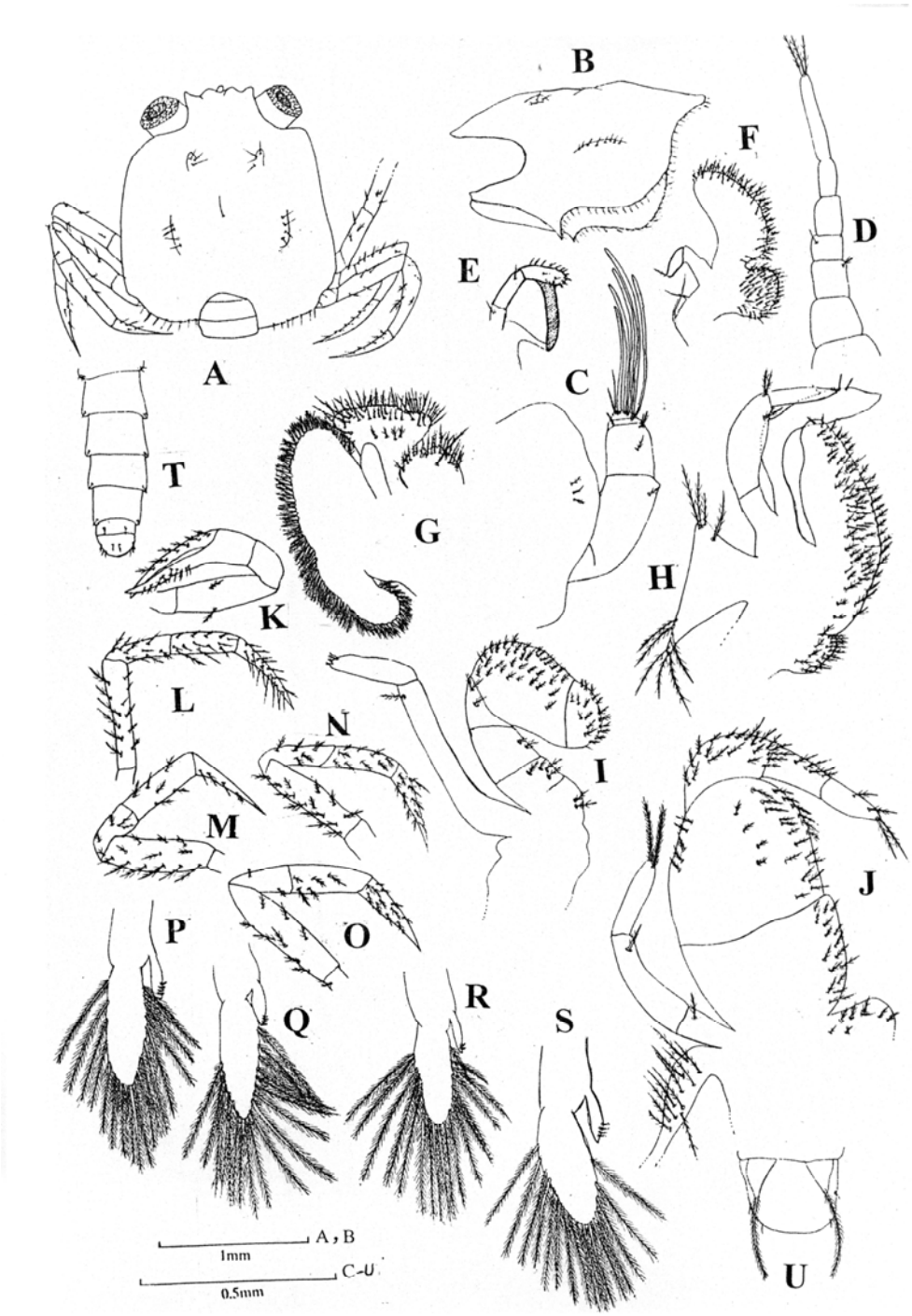

Fig. 5 *Dotilla blanfordi* Alcock, 1900. Megalopa A, entire, dorsal view; B, lateral view of carapace C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H-J, maxillipeds I-III; K-O, pereiopods I-V; P-S, pleopods I - IV; T, telson with uropods, U, abdomen, dorsal view.

5 Discussion

The identification of megalopae from plankton is very difficult even with the grouping of characters, morphologically they are so versatile that the accurate identification is only possible to obtain from the known parents. However efforts are being made to identify them with the help of previous knowledge or by the

comparison with laboratory reared larvae.

5.1 *Philyra* sp.

The single megalopa shows the typical characters of leucosid crab given by Quintana (1986) i.e., smooth carapace, rudimentary rostrum, the armature of outer flagellum of antennule and that of the sternum. The present work describes perhaps the 17th megalopa in Leucosidae.

The megalopa is near to those of *Hiplyra sagittal* and *Philyra syndactyla* using Quintanas' key (1986). When compared with six previously studied megalopae of subfamily Philyrinae, few setal differences in the exopod (scaphognathite) of maxilla; coxal, basial and epipodal setae of maxilliped I; and the number of setae on the propodus and dactylus of maxilliped II are seen as shown in Table 2. Quintana (1986) stated that leucosid megalopae could be divided into three subfamilies (Ebaliinae, Philyrinae and Leucosiinae) according to the segmentation and armature of the antennular outer flagellum. The present megalopa has 3 segmented antennular outer flagellum with 5 aesthetascs.

The present megalopa not attributed to *P.syndactyla* although it has been reported from Tamil Nado, India, but mostly has been reported from Pacific. It is therefore possible that this megalopa and that described by Amir (1989) belongs to one of the Philyrinae described from here except *P.corallicola*.

Table 2 Comparison between planktonic megalopa of *Philyra* sp. (present study) and other leucosiid genera.

Characters	***Philyra* sp.(present study)**	***P.corallicola* Hashmi (1970)**	***P. syndactyla* Quintana, (1986)**	***Hiplyra sagitta* Quintana (1986) (=*P. platychira*)**	***Pyrhila pisum* Ko (1996) (=*Philyra pisum)***	***Lyphira perplexa* Krishnan & Kannupandi (1990) *(as P.globosa)***	***Philyra.*sp. Amir, 1989 (unpublished)**
Carapace spines	present	absent	present	present	present	present	present
Mandibular palp: distal segment	broken	1 seta	4 setae	5 setae	4 setae	palp absent	5 setae
Maxillule: coxal endite setae	7 setae	7 setae	7 setae	7 setae	5 setae	8 setae	7 setae
basial endite setae	13setae	11 setae	13 setae	13 setae	9 setae	9 setae	14 setae
Maxilla: Basial endite setae	5 setae	14-16 setae	5 setae	5 setae	7 setae	6 setae	5 setae
scaphognathite setae	14 setae	30-35 setae	33 setae	35-36 setae	no mention	35-37 setae	32 setae
Maxilliped I setae: epipod	2 setae	stout plumose posterior process	3 setae	3-4 setae	no mention	2 setae	broken
coxa	3 setae	5 setae	5 setae	6 setae	3 setae	3 setae	5 setae
basis	12 setae	10 setae	10 setae	14 setae	13 setae	11 setae	13 setae
Maxilliped II: endopod: ischium	setae absent	setae absent	no mention	setae absent	no mention	no mention	setae absent

merus	setae absent	setae absent	setae absent	setae absent	setae absent	setae absent	setae absent
carpus	1 seta	setae absent	1 seta	1 seta	setae absent	setae absent	1 seta
propodus	3 setae	3 setae	2 setae	3 setae	1 setae	2 setae	3 setae
dactylus	7 setae	5 setae	5 setae	5 setae	5 setae	9 setae	5 setae
Maxilliped III:exopod setae	3 setae	2 setae	3 setae	4 setae	3 setae	3 setae	5 setae

5.2 *Charybdis* sp.

The identification of megalopa is difficult because generally there is a lack of adequate descriptions and their usual scarce presence in planktonic samples prevent their assignment to known zoeal series and secondly during laboratory rearing experiments, the phase is rarely reached due to high zoeal mortality.

Table 3 Comparison between planktonic caught megalopa of *Charybdis* sp. (present study) and megalopae of *C. feriatus* and *C. japonica.*

Characters	***Charybdis* sp. present study**	***C. feriatus* Fielder *et al* (1984)**	***C. japonica* Yatsuzuka & Sakai (1984)**
Antennule: peduncle	4,3,2 setae	6,5,3 setae	4,5,3 setae
endopod	4 setae	4 setae	6 setae
exopod aesthetasc + setae	17 + 4	-	18 + 15
Maxilliped I: epipod	21 setae	21 setae	15 setae
coxa	16 setae	-	14 setae
basis	35 setae	-	31 setae
exopod	3,5 setae	2,5 setae	3,5 setae
Maxilliped II: protopod	3 setae	1 seta	3 setae
endopod	1,5,2,8,10 setae	2,3,2,8,10 setae	2,5,1,9,12 setae
exopod	1,5 setae	1,6 setae	1,4 setae
Telson: medial setae	2 pairs	2 pairs	no mention
posterior marginal setae	setae absent	3 setae	setae absent

5.3 *Pilumnopeus convexus*

Several differences among *Pilumnopeus* zoeae for example the number of setae of carapace, antennular exopod (including the aesthetascs), maxillular and maxillar coxal and basial endite, scaphognathite, distal segment of the endopod of first maxilliped, abdominal proximal somite and telson and the timing of appearance of some structures in the larval sequence like the bud of antennular and antennal endopod, the

epipod of maxilla, the mandibular palp, the buds of third maxilliped, pereiopods and pleopods and the sixth abdominal somite were observed by Spivak and Rodriguez (2002). The abbreviated development can account for the observed early appearance of these structures in *P. vespertilio* and *P. kempi* (Lim and Tan, 1981; Siddiqui and Tirmizi, 1992).

Table 4 Comparison between planktonic caught megalopa of *Pilumnopeus convexus* (present study) and megalopae of *P. granulates, B. eucratoides* and *Heteropanope glabra.*

Characters	***P. convexus*** **present study**	***P. granulatus*** **Ko (1997)**	***B. eucratoides*** **Lim *et al* (1986) (as *P. eucratoides)***	***H. glabra*** **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 terminal setae	2-segmented, 4 setae	2-segmented, 7 setae	2-segmented, 4 setae	2-segmented, 6 setae
Maxilliped II:	2-segmented	Incompletely 3-segmented	2-segmented	2-segmented
Exopod 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)

5.4 *Dotilla blanfordi*

The morphological characters of planktonic megalopa of *Dotilla blanfordi* Alcock, 1900, present study is compared with the megalopa of *Dotilla blanfordi* studied by Raja Bai (1960). There is only single difference between the shape of posterolateral angles and observed similarity with laboratory (MRC, unpublished) reared megalopa, which is given in Table 5.

Table 5 Comparison between planktonic caught and laboratory reared megalopae of *Dotilla blanfordi*

Characters	***D.blanfordi*** **present study**	***D. blanfordi*** **Lab. reared (MRC, unpublished)**	***D. blanfordi*** **Raja Bai (1960)**
Telson: posteriolateral angles	rounded	Rounded	pointed

Megalopae have been reported from the Manora Channel by Tirmizi and Siddiqui (1993) and from Clifton by Kazmi and Naushaba (2004).

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