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Occurrence of mangrove pebble crab, *Philyra malefactrix* (Kemp, 1915) in Kali estuary, Karwar and its laboratory reared zoea and megalopa stages

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Original Article

Abstract

Philyra malefactrix (Kemp, 1915) of the family Leucosidae was recorded from the Kali estuary along with berried specimens. Berried female crab from the muddy, slushy substratum was collected and reared in the laboratory. The larvae were reared in 24 ppt saline water and the rearing water temperature ranged between 24 to 26 °C during the development period. The larvae passed through three zoeal and one megalopa stage. The larvae were compared with the other *Philyra* larvae reared in the laboratory.

Keywords: *Philyra malefactrix, zoeae, megalopa, larval development, Karwar coast, Kali estuary*

Introduction

Stanley Kemp (1915) described a small crab from Chilka in Odisha and assigned it to *Ebalia malefactrix.* The species was also found in Cochin backwaters by Gravely in 1914 and Ennur (Madras) by Annandale in 1915. "*Philyra malefactrix* (formerly *Ebalia malefactrix* or *Nursia malefactrix*) was first recorded from Singapore by Ow Yang (1963) from Pulau Senang. A lectotype specimen of this species was selected and figured by Rahayu and Ng (2003). *P. malefactrix* seems to prefer low saline water, occur in abundance and ovigerous females were caught during March, September and October (Kemp, 1915). The present species agree with Kemp's description. The paper describes the taxonomic features of the species and its laboratory-reared zoea and megalopa stages.

Material and methods

The material for the work was collected at Sadashivgad (Fig. 1) near the mouth of the Kali estuary. The study was conducted in 1972 at the PG Department of Marine Biology in Karwar, Karnataka University. In the subsequent years, the number of crabs noticed was less in number. Since it was known as *E. malefactrix* and further revised as *P. malefactrix*, the description got delayed. Description guidelines of Clark *et al.* (1998) have been generally followed for larval descriptions.

During the experiment, the temperature ranged from 24 to 26 °C and salinity was maintained at 24 ppt. The larvae were fed with freshly hatched *Artemia* nauplii. The location map provided is from the Open Street map. The author came across berried females of *P. malefactrix* during the crab survey of the Kali estuarine waters. The crab was collected by hand picking at 10 cm depth from the grey muddy substratum in 1972 and re-examined in 2015. The specimen was covered with grey mud. With the help of a digital vernier calliper, the measurements of adult crabs were recorded. The specimens measured 7.0 to 8.5 mm in carapace width. The mother crab was held in an aquarium until larvae hatched at ambient room temperature (24-26 °C). Hatching occurred at night. After hatching, the

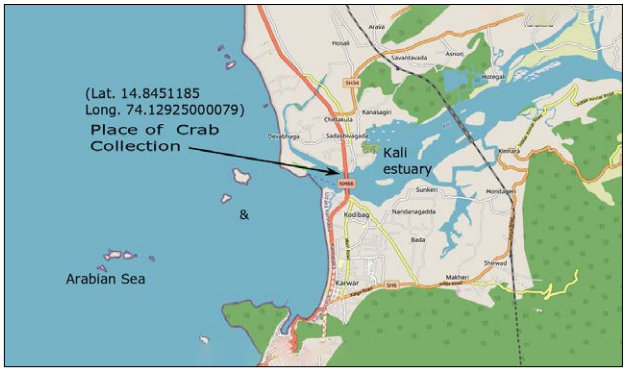

Fig. 1. Kali estuary, Karwar with collection sites. Source: Open Street Map

active, positively phototactic larvae were separated into 50-ml acrylic jars containing 45 ml of filtered seawater, (5 numbers/ jar). Some larvae were preserved in 5% formalin for further morphological studies. Newly hatched larvae were fed *ad libitum* freshly hatched *Artemia* nauplii. Seawater was changed, and specimens were inspected and fed daily. All rearing jars were washed in fresh water and air-dried before being reused with fresh seawater the following day. During rearing, salinity was 24 ppt. Larvae were reared in a natural day-night regime. A minimum of five specimens of each stage were dissected for morphological description. The larvae and their appendages were dissected under stereoscopic and compound light microscopes. Appendages were sketched with the help of Camera Lucida attached to the microscopes.

Results

The species is benthic; available in the brackish and marine environment, mainly in the Kali River mouth where salinity fluctuates highly and the substratum was slushy and muddy. The crabs were observed to pop out from the muddy substratum and crawl on the seashore. Innumerable specimens ranging from 7.0-8.5 mm in carapace width were available. The carapace of *P. malefactrix* (Fig. 2) is round and the ridges on the dorsal carapace surface meet. These ridges are covered with small and large granules. The first male pleopod is designated as G1. A distinctive G1 which has the distal part slender, sinuous and the tip bifurcated is visible as shown in Fig. 2. The carapace is polygonal in outline and as broad as, or a little broader than long. The postero-lateral borders are very long and gradually convergent posteriorly and the entire margin is elegantly beaded. The side walls of the hepatic region form a large independent anterolateral facet on either side of the carapace and the margin that defines the lower limit of this facet is beaded like the true anterolateral margin and, in dorsal view, the edge of the buccal cavern is visible. The lateral margin in large males is obtusely angled in two places and its junction with the postero-lateral margin is very prominent and sharply rectangular. The posterior margin is convex in female; in large males, it is tridentate owing to the enlargement of the tubercles in the centre and at the outer angles. The most conspicuous feature of the dorsal surface of the carapace is a prominent ridge that roughly takes the form of a "broad- arrow", which is much elevated above the general surface and covered with large close-set tubercles, The cornea of small eyes is exposed in dorsal view; the orbit is in open communication with the antennular fossae and there is a well-marked space between the edge of the floor of the orbit and the free edge of the buccal cavern. The antennae are distinct. The buccal cavern is a little broader than long. In the external maxillipeds the merus, which is pointed distally, is nearly as long as the ischium and the exopod does not reach so far as the merus of the endopod and is expanded with a convex external margin. The chelipeds are slightly longer than the carapace in the male and slightly shorter in the female. The merus is covered with vesiculous granules beneath and dorsally with granules arranged in parallel rows, a medial longitudinal area being left quite naked. The outer edges of the carpus and propodus are very finely granulated and numerous scattered granules are to be seen on the upper and inner surfaces of the carpus and palm. The palm is hardly one quarter longer than broad and is not longer than the fingers; near its proximal end on the inner surface, there is, in the adult male, a large coarse tubercle. The dactylus of the last pair of walking legs is considerably longer than the propodus. The margin of the thoracic sternum is festooned with small granules. The abdomen of the male consists of two pieces only, the penultimate portion bearing a large blunt tubercle at its distal end. The fused segments of the female abdomen are coarsely punctured and in the middle line near the distal end there is a small granular patch; the ultimate segment is about as broad as long. Live specimens were generally, rather thickly coated with fine mud. Mud removed specimens were found to be dull grey in colour, flecked with darker grey, the walking legs and the tubercular elevations of the carapace being reddish-brown (Kemp, 1915).

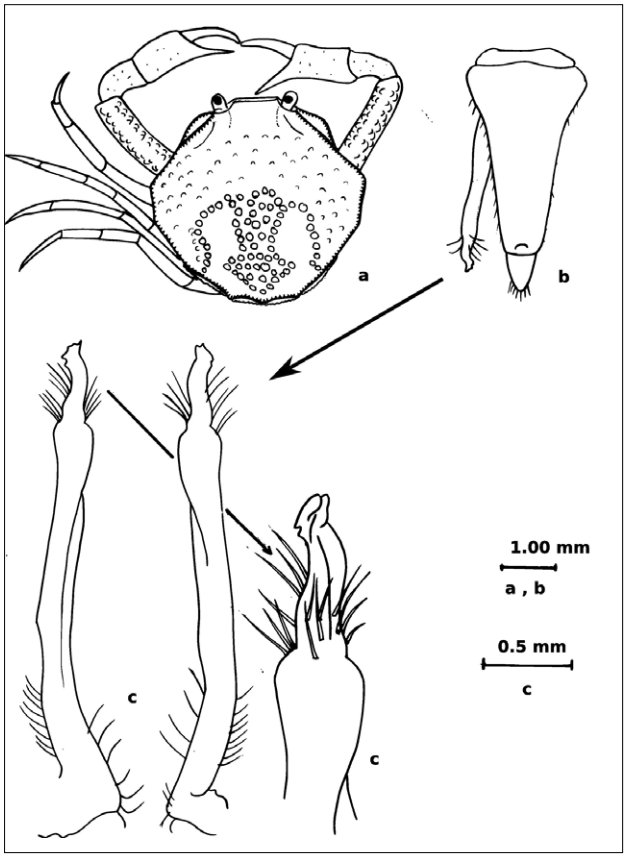

Fig. 2. *P. malefactrix* a. carapace, b. abdomen and c. G1 (first male pleopod)

This small crab is one of the common species of brachyuran

crabs in Karwar waters. In the present account, three zoeal stages and a megalopa of *P. malefactrix* have been described based on the larvae cultured in the laboratory. Many workers have described larvae either from plankton or only initial zoeal stages from laboratory hatching in the family Leucosiidae (Rajabai, 1960; Aikawa, 1929, 1937; Chhapgar, 1955; Hashmi, 1970; Ko, 1996, 2001; Lebour, 1928; Sankolli, 1961; Terada, 1984; Tufail and Hashmi, 1964; Rice, 1980; Wear and Fielder, 1985). Larval stages are known for ten species from Korean waters (Lee and Ko, 2017): *Ebaliinae stimpson*, 1871, *Arcania undecimspinosa* De Haan, 1841 by Terada (1984) and Quintana (1986); *Hiplyra platycheir* (De Haan, 1841) (*Philyra platychira*) by Ko (2000); *Myra fugax* (Fabricius, 1798) by Terada (1979); *Philyra kanekoi* Sakai, 1934 by Ko (2001), *Philyra syndactyla* Ortmann, 1892 by Terada (1979); *Pyrhila pisum* (De Haan, 1841) (*P. pisum*) by Aikawa (1929), Terada (1979) and Ko (1996); Leucosiinae Samouelle, 1819, *Euclosia obtusifrons* (De Haan, 1841) (*Leucosia obtusifrons*) and *Leucosia anatum* (Herbst, 1783) (*Leucosia longifrons*) by Terada (1984), First zoeas of Nur*sia rhomboidalis* (Miers, 1879) and *Pyrhila carinata* (Bell, 1855) by Lee and Ko (2017), *Lithadia rotundata* A. Milne Edwards, 1880 by Fransozo and Bertini (2002), Ghory and Siddiqui (2008) described larval stages of Leucosiidae collected from the Manora Channel, Pakistan, during 1993-1995. Also, the complete larval development of another genus *Ilia*, *Ilia nucleus* (Linnaeus, 1758) was described by Bartilotii *et al.* (2009). However, only two species in the genus *Philyra* of the family Leucosidae namely *P. globosa* (Krishnan and Kanuupandi, 1990) and *P. pltychira* (Ko, 2000), have been reared completely based on laboratory culture, right from hatching to megalopae or beyond, and the present account on *P. malefactrix* is also from hatching to megalopa stage and beyond, in the laboratory.

Description of larval stages

First Zoea: carapace length 0.75 mm; rostral spine length 0.14mm; abdomen length 0.61 mm. duration of the first zoeal stage 3-4 days. Dorsal and lateral carapace spines absent; rostral spine very small; eyes sessile (Fig. 3. a and b). Antennule (Fig. 3 c): uniramous, with 3 aesthetascs and 1 small smooth seta. Antenna (Fig. 3 d) uniramous, protopod pointed and slightly bulged at mid-level. Mandible (Fig, 3 e): without palp but with well-developed incisor and molar processes. Maxillule (Fig. 3 f): coxal endite with 6 plumodenticulate and basial with 4 terminal plumodenticulate plus one subterminal seta; endopod two-segmented, without seta on proximal, and with 4 terminal plumodenticulate setae on distal segment. Maxilla (Fig. 3 g): coxal endite with 5 plumodenticulate setae and basial with 8 plumodenticulate setae; endopod slightly bilobed, inner proximal lobe with 1 plumodenticulate and outer distal with 2 terminal plumodenticulate setae, microtrechia present on both inner and outer margins of endopod; scaphognathite with 3 marginal plumose setae, proximal end broad, and pointed posteriorly, with marginal microtrachia. First maxilliped (Fig 3 h): basis with eight setae arranged in one internal, three marginal and again 2+2 marginal setae. Endopod is five segmented with 2, 2, 1, 2 on proximal first four segments and the distal fifth segment with 4 terminal and 1 subterminal seta. Exopod is not 2-segmented with four natatory plumose setae. Second maxilliped (Fig. 3 i): basia with four setae and endopod of a single segment and with one terminal seta. Exopod is partially two-segmented and with 4 plumose natatory setae. Abdomen (Fig. 3 m) with five somites; first somite without dorsal setae while somites 2-5 with a pair of dorsal setae each, second and third somites each with a pair of dorsolateral expanded protuberances, the second somite with posteriorly placed protuberance while third somite protuberances fully cover the sides. Telson (Fig. 3 m): triangular; process formula 3+3; outer angles of the telson with 3 lateral teeth. Chromatophores: brownish chromatophores distributed as shown in Fig. 3 a. The distinguishing features of the First zoeae of some *Philyra* species are given in Table 1.

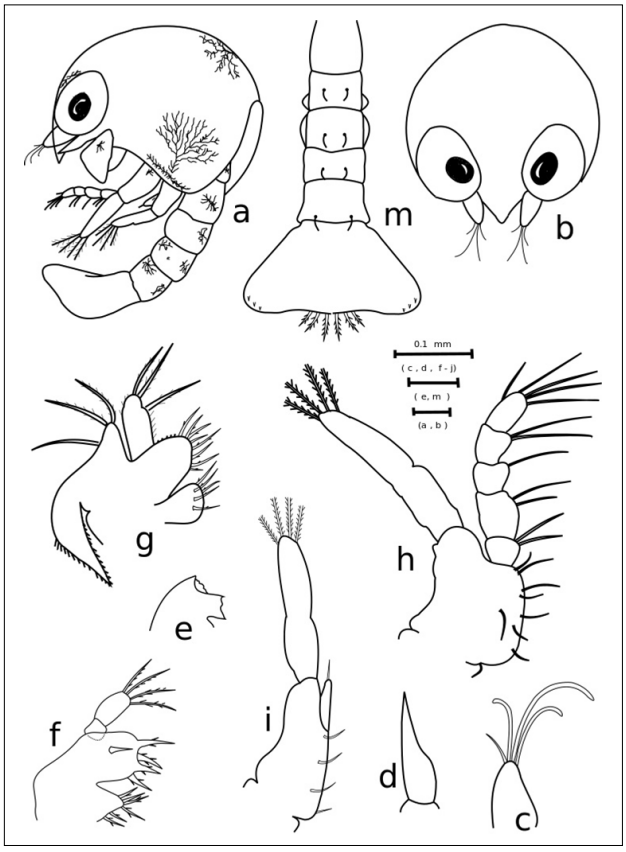

Fig. 3. First zoea of *P. malefactrix*, Kemp, 1915: a. carapace, b. front view of carapace, c. antennule, d. antenna, e. mandible, f. first maxilla, g. second maxilla, h. first maxilliped, i, second maxilliped and m. abdomen with telson

Table 1. Distinguishing features of first zoeae of some *Philyra* sp.

Feature	*P. malefactrix* (present account)	*P. globosa* (Krishnan and Kannupandi, 1990)	*P. pisum* (Aikawa,1929) and (Tereda, 1979)	*P. scabriuscua* (Rajabai, 1960)	*P. corallicola* (Sankolli, 1961)	*P. syndactyla* (Terada, 1979)	*P. platychira* (Ko, 2000)	*P. pisum* (Ko, 1996)	*P. kanehoi* (Ko, 2001)
Carapace spines	Rostral spine present	Rostral spine present	Rostral spine present	Dorsal and Rostral spine present	Dorsal, Rostral and lateral spines present	Dorsal and Rostral spine present	Rostral spine present	Rostral spine present	Rostral spine present
Anrtennle	3 Aesthetascs + 1 small seta	4 Aesthetascs	2 Aesthetascs + 2 setae	4 Aesthetascs	3 Aesthetascs	2 Aesthetascs +2 setae	4 Aesthetascs +1 seta	3 Aesthetascs +1 seta	3 Aesthetascs +1 seta
Maxillule : Coxa	6 setae	5 setae	6 setae	6 setae	5 setae	6 setae	5 setae	5 setae	6 setae
Basis	5 setae	4 setae	4 setae (5 setae)	5 setae	5 setae	5 setae	5 setae	5 setae	5 setae
Endopod	0, 4 setae	0, 4 setae	4 setae (0,4 setae)	0, 2 setae	3 setae	0,4 setae	4 setae	4 setae	0,4 setae
Maxilla: Basis	8 setae	5 setae	8 setae	8 setae	8 setae	8 setae	4+4 setae	8 setae	8 setae
First maxilliped									
Basis	8 setae	2,2,3,3setae	2,2,3,3setae (2,2,2,2, setae)	5 setae	No data	2,2,2,2 setae	2,2,2,2 setae	2,2,2,2 setae	8 setae
Endopod	2,2,1,2,5 setae	2,1,1,2,4 setae	2,2,1,2,4 seate(2,2,1,2,4+1 seate)	1,3,2,1,4 setae	2,2,2,2,4 setae	2,2,1,2, 4 +1 setae	2,2,1,2, 1 +4 setae	2,2,1,2, 1 +4 setae	2,2,1,2,5 setae
Second Maxilliped									
Basis	4 setae	1,1,1,1,setae	2,2,setae (1,1,1,1 setae)	3 setae	No data	1,1,1,1, setae	1,1,1,1, setae	1,1,1,1, setae	4 setae
Endopod	1 seta	1 seta	0,0,4 setae (3 setae)	2 setae	3 setae	3 setae	1+2 setae	2+1 setae	3(1+2) setae

Second zoea: carapace length of 0.76 mm; rostral spine length 0.13 mm, abdomen length 0.70 mm, duration of stage 3-4 days. The salient features of this stage are stalked eyes first abdominal somite with a single median dorsal seta (Fig. 4 a and b); 6 natatory setae on maxillipeds; pleopod buds visible. Antennule (Fig. 4 c); with 4 aesthetascs and a seta. Antenna and mandible (Fig. 4 d and e) no change. Maxillule (Fig. 4 f): two setae added on basial endite; a delicate plumose seta distally on outer margin (not shown in fig); except for these no other change. Maxilla (Fig. 4 g); scaphognathite now with 4 distal and 3 proximal plumose setae. First and second maxillipeds (Fig. 4 h and i): except for the increase in the number of natatory setae to 6, no other change. Pereiopod buds (Fig. 4 k1-5) are well developed. Abdomen (Fig. 4 m); a thick median dorsal seta appears on the first somite.

Third Zoea: rostral spine 0.11 mm length, abdominal length 0.8 mm, duration of stage 3-5 days. This stage is characterized by an antenna with endopod buds; pleopod buds are elongated. Antennule (Fig. 5 c): no change, with 4 aesthetascs. Antenna (Fig. 5 d): with endopod bud. Mandible (Fig. 5 e), Maxillule (Fig. 5 f) Maxilla (Fig. 5 g) and first and second maxillipeds (Fig. 5 h and i): No change, except for an increase in size and microtrichia on scaphognathite margin. Third maxilliped (Fig. 5 j): biramous, slightly elongated. Pereiopods (Fig. 5 k1-5); Elongated, showing slight segmentation. Abdomen (Fig. 5 m and Fig. 5 a); No change except for a slight increase in the length of pleopod buds.

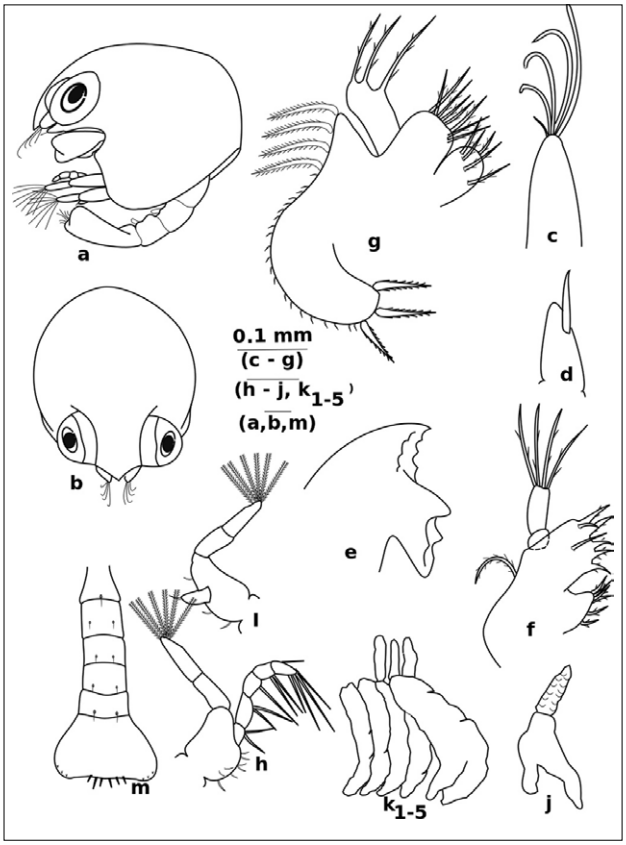

Fig. 4. Second zoea of *P. malefactrix* Kemp, 1915: a. carapace, b. front view of carapace, c. antennule, d. antenna, e. mandible, f. maxillule, g. maxilla, h. first maxilliped, i. second maxilliped, k1- 5, pereopod buds and m. abdomen with telson

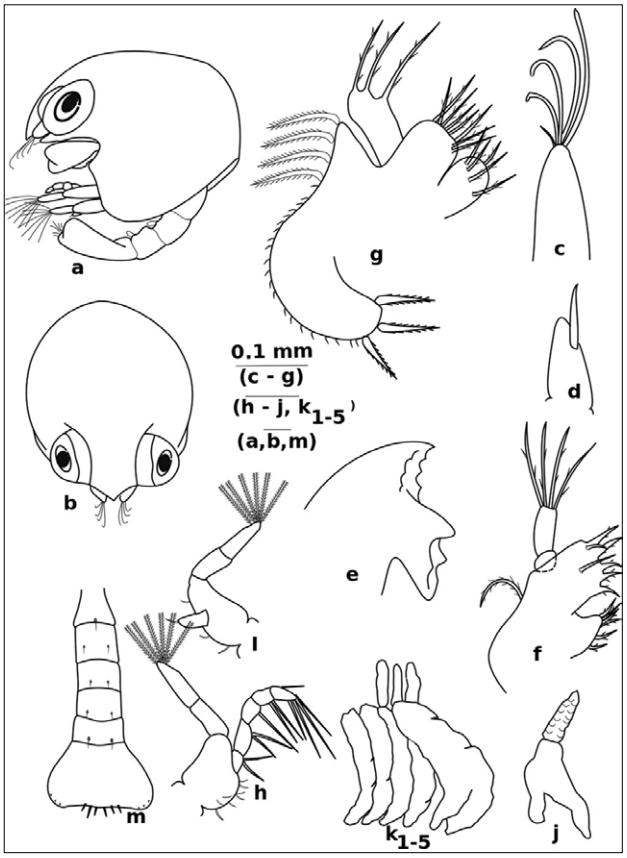

Fig. 5. Third zoea of *P. malefactrix* Kemp, 1915: a. carapace, b. front view of carapace, c. antennule, d. antenna, e. mandible, f.first maxilla, g. second maxilla, h. first maxilliped, i. second maxilliped, j. third maxilliped, k1-5. Pereopod telson buds and m. abdomen

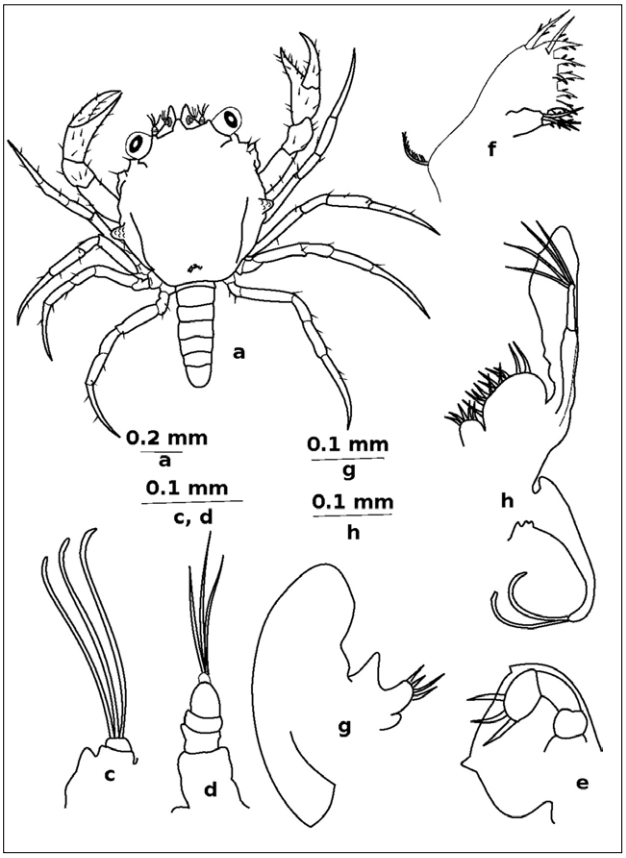

Fig. 6. Megalopa of *P. malefactrix* Kemp, 1915: a. carapace, c. antennule, d. antenna, e. mandible, f. first maxilla, g. second maxilla and h. first maxilliped

Megalopa: The carapace is 0.64 mm; carapace breadth (excluding epibranchial projections) is 0.55mm. Carapace (Fig. 6 a) smooth, with hepatic and epibranchial projections, three hepatic projections with one seta each, and epibranchial projections with minute tubercles; rostrum triangular, projecting forward, a gastric region without tubercles; a cardiac region with a small tubercle, an intestinal region with distinct projections. Antennule (Fig. 6 c): uniramous, two-segmented, the distal segment with 2 long and a small aesthetasc, no other setae present; basal segment with a single seta. Antenna (Fig 6 d); Peduncle two-segmented, without any setae or protuberances; flagellum two-segmented, the proximal segment bigger and the distal smaller, the distal segment with 3 long terminal setae. Mandible (Fig. 6 e): Masticatory process bluntly pointed; palp three-segmented, with 3 terminal spine-like setae on the distal segment. Maxillule (Fig. 6 f) Endopod of zoeal stages disappears. Coxal endite overlaps the basial with 3 plumodenticulate setae; basal endite with 9 stumpy plumodenticulate setae. Maxilla (Fig. 6 g): Both coxal and basial endites single-lobed; coxal endite devoid of setae whereas basal with 4 setae; endopod short, without any setae, scaphognathite long and devoid of setae along its border. First maxilliped (Fig. 6 h): Coxal endite small, with five setae; basal endite with 12 setae; endopod unsegmented, exceptionally broader at the distal one third, without any setae; exopod two segmented, the distal segment half of proximal and with 4 setae, epipod with two long setae. Second maxilliped (Fig. 7 i): Endopod five-segmented, with 0, 0, 0, 2 and 5 setae arranged distalwards; exopod two-segmented, the distal segment one-third the proximal and with 4 setae terminally, proximal segment without any setae. Third maxilliped (Fig. 7 j); Endopod five- segmented, the last three segments attached to outer angle of the meral segment, the first segment with 9 setae, second with 2+1, third and fourth with one seta each, fifth with 3 unequal thick setae terminally; exopod broad, unsegmented, reaching 1/3 the length of merus of endopod and with 4 setae in the lower half of outer border. Pereiopods (Fig 7 k1-5): First pereiopod chelate sparsely setose, fingers crossing each other; second to fifth pereiopods with dactylic longer than merii of respective legs, sparsely setose, no spines present on any of the legs. Abdomen (Fig. 7 a): with 5 somites, telson (Fig. 7 m) with rounded margin, without any setae. Pleopods: (Fig. 7 1-4): 4 pairs, second to fifth abdominal somites, first with 4, second

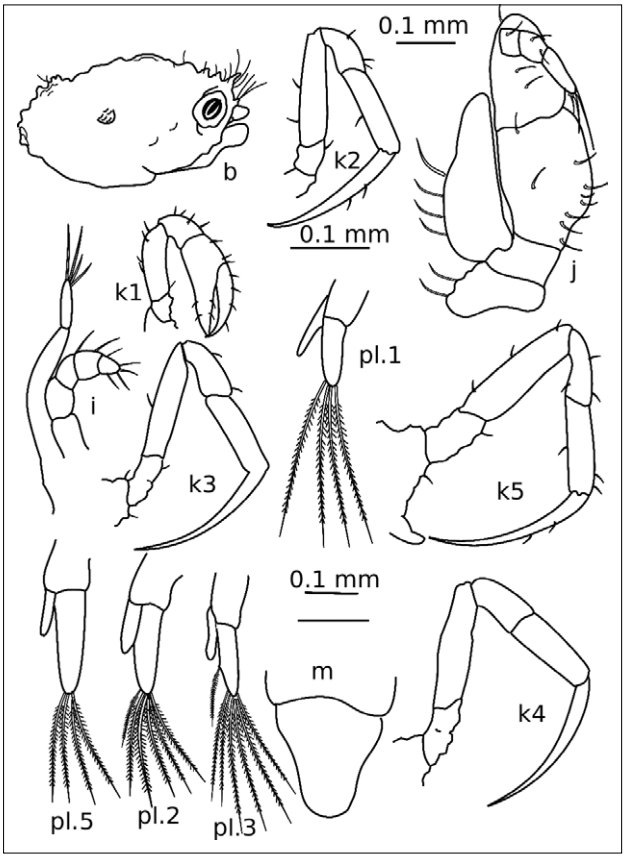

Fig. 7. Megalopa of *P. malefactrix* Kemp, 1915: b. side view of megalopa, i. second maxilliped, j. third maxilliped, k1-5 peropods, Pl, pleopods 1, 2, 3 & 4 and m. telson.

with 5+1, third with 6+1, fourth with 5 natatory setae; endopods without any hooks, uropods absent

Discussion

Very few laboratory-reared larvae attributable to *Philyra* have been described. The accounts of *P. platychira* and *P. pisum* by Ko (2000, 1996), *P. pisum* by Terada (1979), *P. globosa* by Krishnan and Kannupandi (1990) and *P. kanehoi* by Ko (2001) deal with laboratory-reared larvae of the genus *Philyra*. Hence the discussion in this account mainly concentrates on these species, though there are other accounts on *Philyra* larvae available by various authors collected and described from planktonic specimens. The present zoeae of *P. malefactrix* neither have lateral spines nor dorsal spines. In the present first stage zoea, the second and third abdominal segments have lateral protuberances whereas these are present only in the third segment in the larvae of *Ebala* sp. and in the second and third segment in the larvae *Ebalia longipedata* of Aikawa (1937). Lateral carapace spines are absent in *P. malefactrix* but present on posterio-lateral part of the carapace in *E. longipedata*. Thus, the larvae of the present species resemble those of *P. globosa, P. platychira, P. pisum, P. kanehoi* in the absence of carapace spines. The first zoeae of *P. malefactrix* (present account) resemble, except for *P. corralicola* (Sankolli, 1961), *P. syndactyla* (Terada, 1979) and *P. scabriuscula* (Rajabai, 1960), in the important character of not having lateral and dorsal carapace spines. The presence of the rostral spine is a common characteristic of *P. malefactrix* (present account), *P. globosa* (Krishnan and Kannupandi, 1990), *P. pisum* (Aikawa, 1929; Terada, 1979, *P. platychira* (Ko, 2000) and *P. kanehoi* (Ko, 2001). Among the reared species of *Philyra*, antennule of *P. malefactrix, P. pisum* and *P. kanehoi* have 3 aesthetascs plus a seta. Coxa of maxillule has 6 setae in both *P. malefactrix* and *P. kanehoi* but has 5 setae in *P. pisum* (Ko, 1996) whereas endopods of all these three species have 4 setae. The basis of maxilla in these three species has eight setae. Basis of the first maxilliped in *P. malefactrix, P. syndactyla, P. platychira, P. pisum* and *P. kanehol* has 8 setae each arranged in 2,2,2,2 pattern. Endopod of all these mentioned species has 2,2,1,2,5 setae except for *P. pisum* described by Ko (1996) which has 2,2,2,2,5 setae. The basis of the second maxilliped of all the species has 4 setae each except for *P. scabriuscula* and *P. corallicola* (no data). The endopod of the second maxilliped with only one seta agrees with *P. globus* but other species have differing numbers of setae and especially *P. pisum, P. platychira, P. syndactyla* and *P. kanehoi*.

Antennule is of usual form in *P. malefactrix*. Antenna in *P. malefactrix* is similar to other reared larvae. The very interesting difference is that the first maxilla in *P. malefactrix* has a two-segmented endopod whereas this is only of a single segment in *E. nux* and *E. longipedata*, and has 4 setae terminally in the present species and *E. longipedata* but 3 in *E. nux*. The endopod of the second maxilla is jointed in *P. malefactrix* and with 2 terminal and 1 lateral plumose setae and its border is finely setose. In the present species, scaphognathite has only 3 plumose setae whereas 4 each in the other two species of *Ebalia*, setation of endopod of the first maxilliped in *P. malefactrix* is 2, 2, 1, 2 and 5 whereas 2,1,1,2 & 4 in *E. nux*. Endopod of the second maxilliped with only one seta in the present species whereas one prominent seta plus 4-minute setae in *E. nux*. The endopods of first and second maxillipeds in *P. malefactrix* are attached to the basis at the distal one-third part. The segments in the first maxillipeds look stout, and the unsegmented endopod of the second maxilliped does not reach beyond the tip of the basis. This justifies the placement of *Ebalia malefactrix* in *Philyra* genus. The natatory setae are 4 in the first, 6 in the second and third zoeal stages in the present species, unlike in most of the other brachyuran genera, in the third stage, the arrangement of the endopod setae of the second maxilla is similar to that of *Viridiotheres gracilis* (former *Pinnothere gracilis*) (Kakati and Sankolli, 1975). The megalopa of *P. malefactrix* is dissimilar from the other brachyuran megalopae in most of the characters. It is characterised externally by the presence of epibranchial and

hepatic protuberances on the carapace. The dactylii of walking legs are longer than any other segment. Antennule and antenna are small appendages. The first maxilla has no endopod at all, though present in the earlier zoeal stages; moreover, the coxal endite slightly overlaps the basial.

The coxal endite, endopod and scaphognathite of second maxilla are devoid of setae. This type is not observed in many of the brachyuran zoeae. Endopods of first and exopod of second maxillipeds are unlike in other zoeae and are foliaceous in appearance, a striking feature of this megalopa is the absence of uropods. There are only four pairs of pleopods, the endopods of which are devoid of hooks. The zoeae of *P. kanekoi* Sakai, 1934 were obtained by laboratory rearing. Three zoeal stages were described and illustrated in detail by Ko (2001). Morphological comparisons by Ko with congeneric species revealed that zoeas of *P. kanekoi* were more similar to those of *P. pisum* and *P. platychira* than to other *Philyra* spp. But the present first zoea of *P. malefactrix* resembles *P. kanekoi* in all characters except for the endopod of the second maxilliped which has one seta instead of 3 in *P. kanekoi*. The present material could be distinguished from other Philyrinae species by having no dorsal carapace spine, a spinous tip of the antenna, and branching chromatophore in place of the dorsal carapace spine. Within the family Leucosiidae, the zoeas of *P. kanekoi, P. pisum* and *P. platychira* showed greatest affinities with *Leucosia sima* and *L. pubescens* (Leucosiinae), and the number of setae on the basipod of the first maxilliped could be a very useful character for identification between *Philyra* and *Leucosia* zoeas.

The complete larval development of *P. platychira* de Haan, 1841, from hatching to the megalopa stage, was obtained by laboratory rearing by Ko (2000). Three zoeal and one megalopa stage have been described and illustrated in detail. In the subfamily Philyrinae, it is unusual that the zoea has a lateral swollen protuberance on the carapace that in the third stage develops into a spine. The *Philyra* zoeae could be easily distinguished from the zoeae of *Arcania* and *Myra* by having no lateral carapace spine, 2, 1 seta on the endopod of the maxilla, and three small teeth on the posterolateral margin of the telson. In the family Leucosiidae, *Philyra* is as advanced as the leucosiines, whereas *Arcania* and *Myra* are the most ancestral group, based on the zoeal characteristics. Therefore, it is considered that the subfamily Philyrinae might be a significantly heterogeneous group (Ko, 2000). The megalopae of all these three species have characteristic features and can be easily distinguished. The characters are given below as they appear in respective publications.

Characters of megalopae of *P. platychira* by Ko (2000), *P. globosa* (Krishnan and Kannupandi (1990) and *P. malefactrix* (Present study): carapace of *P. malefactrix* (Fig. 8 a) is smooth, with hepatic and epibranchial projections, three hepatic projections with one seta each, and epibranchial projections with minute tubercles; rostrum triangular, projecting forward, a gastric region without tubercles; a cardiac region with a small tubercle, the intestinal region with distinct projections, but the carapace of *P. globosa* Krishnan and Kannupandi (1990) is laterally inflated, dorsal surface fringed with simple setae, with a long posterior mediodorsal carapace spine plus 2 short spines in the anterolateral (gastric) region; rostrum 3- horned; and the megalopa of *P. platychira* by Ko (2000) has a round shape with 2 anterolateral and 2 posterolateral gastric tubercles, and 1 long posteromedial spine. Antennule (Fig. 8 c) in *P. malfactrix* is uniramous, two-segmented, the distal segment with 2 long and 1 small aesthetasc, no other setae present; basial with a single seta, whereas in *P. globosa* antennule peduncle is 4-segmented, the ultimate segment with a disto-external distal and external plumose seta; endopod not developed; exopod 3- segmented, with 4 terminal aesthetascs, but antennule peduncle in *P. platychira* 3-segmented, with 1, 1, 1 seta respectively; endopod 2 segmented, with 2 terminal setae on the distal segment; exopod 3-segmented, with 0,3 aesthetascs and 1 short seta, and 4 terminal aesthetascs, respectively. Antenna peduncle (Fig. 8 d) in *P. malefactrix* is two-segmented, without any setae or protuberances; flagellum two-segmented, the proximal segment bigger and the distal smaller, the distal segment with 3 long terminal setae. The antenna peduncle of *P. globosa* is 4-segmented, all naked; flagellum 4-segmented with 2 terminal plumose setae on the ultimate segment. In *P. pltychira* antenna 5-segmented, the proximal segment with 1 short seta, segments II-IV without setae, and segment V with 3 terminal setae. Mandible (Fig. 8 e) of *P. malefactrix* has the masticatory process bluntly pointed; palp three-segmented, with 3 terminal spine-like setae on the distal segment whereas *P. globosa* devoid of palp and *P. platychira* endopod palp incompletely 3-segmented, distal segment with 4 marginal setae. In *P. malefactrix* endopod of maxillule (Fig. 8 f) of zoeal stages disappears. Coxal endite overlaps the basial with 3 setae; basial endite with 9 setae. In *P. globosa* maxillule coxa with 8 plumodenticulate setae; basis cuspidate with 5 + 4 plumodenticulate setae; endopod reduced to an unsegmented, unarmed bud. In *P. platychira* maxillule coxal endite with 7 setae; basial endite with 12 setae; endopod incompletely segmented with 1 short, subterminal plus 1 longer, terminal setae; exopod seta absent. The maxilla (Fig. 8 g) of *P. malefactrix* has both coxal and basal endites single-lobed; coxal endite devoid of setae whereas basal with 4 setae; endopod short, without any setae, scaphognathite long and devoid of setae along its border. In megalopa of *P. globosa* maxilla coxa absent; basis with 6 plumodenticulate setae; endopod unsegmented, naked; scaphognathite fringed with 35-37 densely plumose setae plus 5 simple setae on the

blade. Maxilla of *P. platychira* the coxal endite without seta; basial endite with 6 setae; endopod without seta; exopod margin with 33 plumose setae and 3 surface setae. The first maxilliped (Fig. 8 h) of the present species has small coxal endite, with 5 setae; basal endite with 12 setae; endopod unsegmented, exceptionally broader at the distal one-third, without any setae; exopod two-segmented, the distal segment half of proximal and with 4 setae, epipod with 2 long setae. In the first maxilliped of *P. globosa*, the coxa with 3 plumose and 3 plumodenticulate setae; basis broad, with 3 plumose and 8 plumodenticulate setae; endopod lamellar, unsegmented, glabrous; exopod 2-segmented, with 0,4 plumose setae; epipod with 2 plumodenticulate setae whereas in *P. platychira*, the first maxilliped epipod is with 1 long, simple seta; coxal endite with 5 setae; basial endite with 12 setae; endopod unsegmented, with 3 setae; exopod 2-segmented, proximal segment without seta; distal segment with 4 long, terminal plumose feeding setae. Thus megalopae of these three species have their unique features and can be identified easily.

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