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Larval Development of the Indian Grapsid Crab, *Metopograpsus latifrons* H. Milne Edwards *in vitro*

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Complete larval history of *M. latifrons* was studied in larvae spawned and reared in the laboratory. At 23-28°C temperature and salinity 27-30‰, 5 zoeal stages were observed followed by a megalopa stage. Morphological features of these larvae were compared with those of *M. messor*. Important characters of zoeal stages and megalopa were discussed.

The Karwar region, west coast of India, abounds in grapsid crabs especially of the genera *Sesarma* and *Metopograpsus*. Though Rajabai[1] has described the 1st zoea of *M. messor*, she could not obtain the later zoeal stages in the laboratory and thus, the complete larval development in the genus *Metopograpsus* remains unknown. Therefore, an attempt has been made to rear the crab, *M. latifrons*, in the laboratory and the present account deals with the complete larval development of the species.

Materials and Methods

An ovigerous female of *M. latifrons* with advanced stage of embryonic development, was collected from Sadashivagad area on the northern bank of the Kali estuary (lat. 14° 18′ N and long. 74° 97′ E) on 5 Sept. 1972. The crab was kept alive in an aquarium. The larvae hatched on the very day of the collection. The method of rearing the larvae is same as described[2]. Temperature and salinity of the seawater employed in the experiment ranged respectively from 23-28°C and 27-30‰.

Results

M. latifrons hatched as 1st zoea directly, without passing through a prezoeal stage. The larvae passed through 5 zoeal stages followed by a megalopa stage. Only 1 megalopa moulted to 1st crab stage in the present investigation.

First zoea—Rostral spine length (RSL) = 0.46 mm, dorsal spine length (DSL) = 0.53 mm, carapace length (CL) = 0.55 mm, abdomen length (ABL) = 0.82 mm and duration of the stage (DS) = 4-5 days.

Carapace (C) punctate with rostral and dorsal spines, lateral spines lacking, instead there are 2 rounded humps on the lateral sides (Figs 1 and 2), rostral spine with concave dorsal contour, medio-frontal tubercle present, ventral setae absent, eyes sessile. Abdomen of live zoea always tends to fold ventrally rendering the zoea ball-like. Antennule (A1, Fig. 3): Uniramous, small, conical, with 2 aesthetascs and a seta. Antenna (A2, Fig. 4): Only spinous process represented. Mandible (Md, Fig. 5): With well developed molar and incisor processes. First maxilla (Max 1, Fig. 6): Coxal and basal endites each with 5 setae, endopod 2-segmented, distal segment with 5 setae (2+2+1), proximal segment devoid of setae. Second maxilla (Max 2, Fig. 7): Coxal and basal endites bilobed, coxa with 4 and 3 setae on proximal and distal lobes respectively, basis with 4 setae each on its lobes, endopod bilobed, with 2 setae on each lobe, scaphognathite with 4 (3+1) marginal plumose setae, proximal tip pointed, plumose, like a broad seta. First maxilliped (Mxp 1, Fig. 8): Basis with 7 setae, endopod 5-segmented, with 1,2,1,2,5 (4+1) setae from proximal to distal segments, exopod unsegmented, with 4 natatory setae. Second maxilliped (Mxp 2, Fig. 9): Basis with 4 setae, endopod 3-segmented, segment 1 devoid of setae, segment 2 with 1 seta and segment 3 with 4 setae, exopod unsegmented with 4 natatory setae. Abdomen (Ab, Fig. 10): 5-segmented, segments increase in width posteriorly, 2nd segment with a collar and lateral protuberances, collar disappears in later zoeal stages, 3rd also with lateral protuberances, 5th segment with wing-like postero-lateral expansions, segments 2-5 with a pair of setae each. Telson (T, Fig. 10): Longer than wide, forked, with a median notch on posterior margin, narrows posteriorly, lateral margins wavy in appearance, telson process formula 3 +3. Chromatophores: Dorsal carapace spine posteriorly with brownish red chromatophore at base and 2/3rd distal part orange-red, between cardiac and gastric region a vertical brownish-red chromatophore runs, which continues on dorsal side of gut into 1st abdominal segment, a light orange-red chromatophore extends from ventral margin to midlateral point on carapace, eye stalks with brownish-red chromatophores posteriorly, brownish-red chromat-

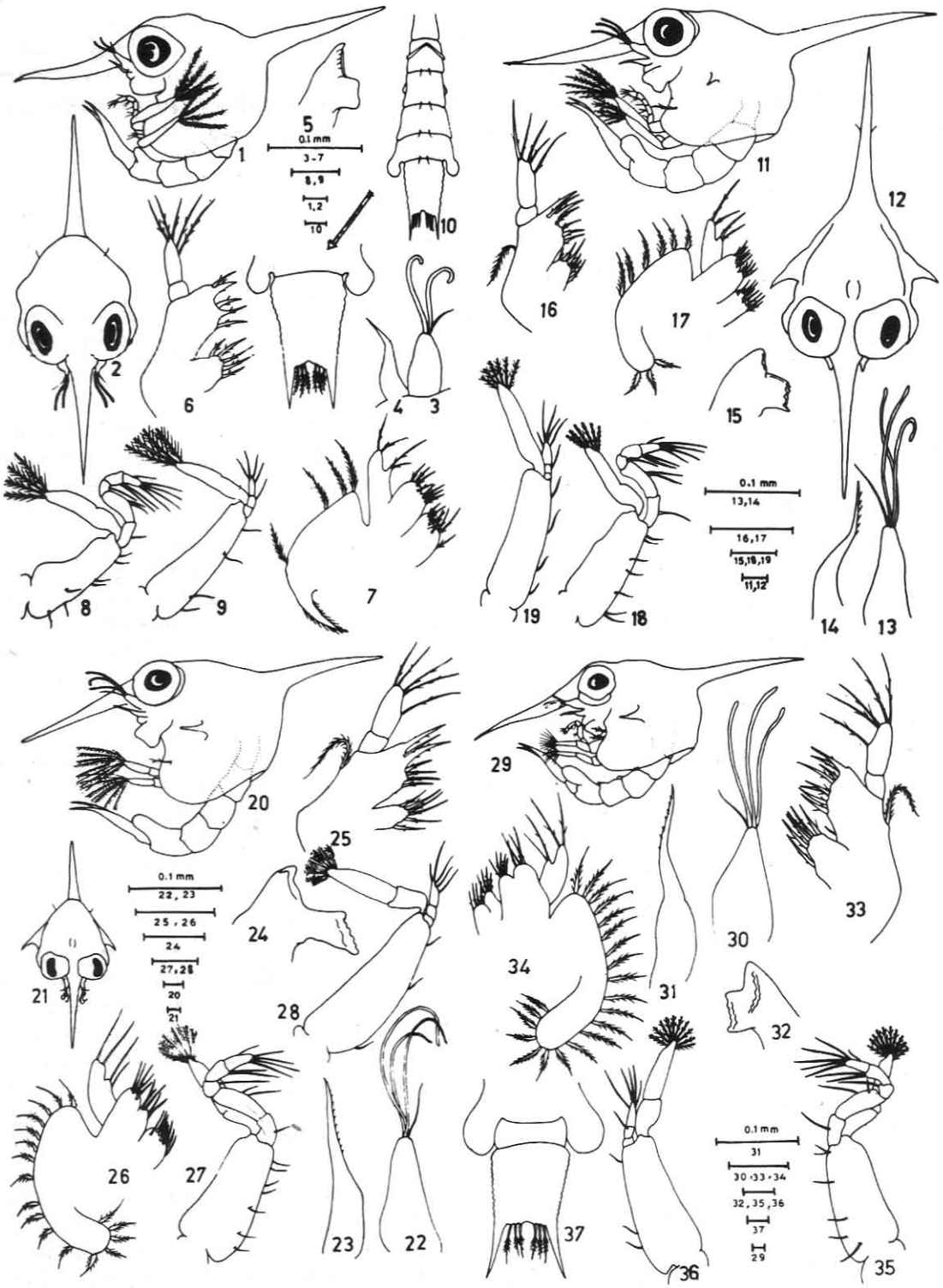


Fig. 1-10—First zoea [1, Lateral view of zoea; 2, front view of zoea; 3, antennule; 4, antenna; 5, mandible; 6, first maxilla; 7, second maxilla; 8, first maxilliped; 9, second maxilliped and 10, abdomen]. Figs 11-19—Second zoea—[11, Lateral view of zoea; 12, front view of zoea; 13, antennule; 14, antenna; 15, mandible; 16, first maxilla; 17, second maxilla; 18, first maxilliped and 19, second maxilliped]. Figs 20-28—Third zoea—[20, Lateral view of zoea; 21, front view of zoea; 22, antennule; 23, antenna; 24, mandible; 25, first maxilla; 26, second maxilla; 27, first maxilliped and 28, second maxilliped]. Figs 29-37—Fourth zoea—[29, Lateral view of zoea; 30, antennule; 31, antenna; 32, mandible; 33, first maxilla; 34, second maxilla; 35, first maxilliped; 36, second maxilliped and 37, posterior portion of abdomen with telson]

ophores present at base of antennules, on mandibles and postero-lateral sides of each abdominal segment. Fifth abdominal segment with brownish chromatophores on wing-like expansions. Reticulate light brown chromatophores present upto telson fork in telson.

Second zoea—RSL = 0.57 mm, DSL = 0.60 mm, LSL = 0.13 mm, CL = 0.66 mm, ABL = 0.95 mm and DS = 3-4 days.

C with a plumose seta just near ventral border, eyes stalked (Figs 11 and 12). A1 (Fig. 13): With 3 aesthetascs + a seta. A2 (Fig. 14): Only spinous process now with its spinules. Md (Fig. 15): Increased in size with well developed incisor tooth. Max 1 (Fig. 16): Coxal endite with 6 setae and basal endite with 7 setae, an outer marginal seta developed on distal portion. Max 2 (Fig. 17): Coxal endite with 4 setae on proximal and 4 setae on distal lobes, basal endite with 4 and 5 setae on proximal and distal lobes respectively, scaphognathite with 2 groups of setae, a distal group of 6 and a proximal of 3. Mxp 1 (Fig. 18): Exopod unsegmented, except for increase in number of natatory setae to 6 on exopod, no other change. Mxp 2 (Fig. 19): Distal segment of endopod with 5 setae, exopod unsegmented with 6 natatory setae.

Third zoea—RSL = 0.62 mm, DSL = 0.63 mm, LSL = 0.20 mm, CL = 0.83 mm, ABL = 1.25 mm and DS = 3-4 days.

C (Figs 20 and 21): Increased in size, with 1 plumose seta on its margin. A1 (Fig. 22): Thickened at base, with 3 aesthetascs and a seta. A2 (Fig. 23): Slightly thickened at base. Md (Fig. 24): Incisor process more elongated, with sharp cutting edge. Max 1 (Fig. 25): Increased in size. Max 2 (Fig. 26): Scaphognathite with 17 setae. Mxp 1 and Mxp 2 (Figs 27 and 28): Exopod 2-segmented and with 8 natatory setae. T: Slightly increased in length.

Fourth zoea—RSL = 1.01 mm, DSL = 1.06 mm, LSL = 0.28-0.30 mm, CL = 0.85 mm, ABL = 1.73 mm and DS = 3-4 days.

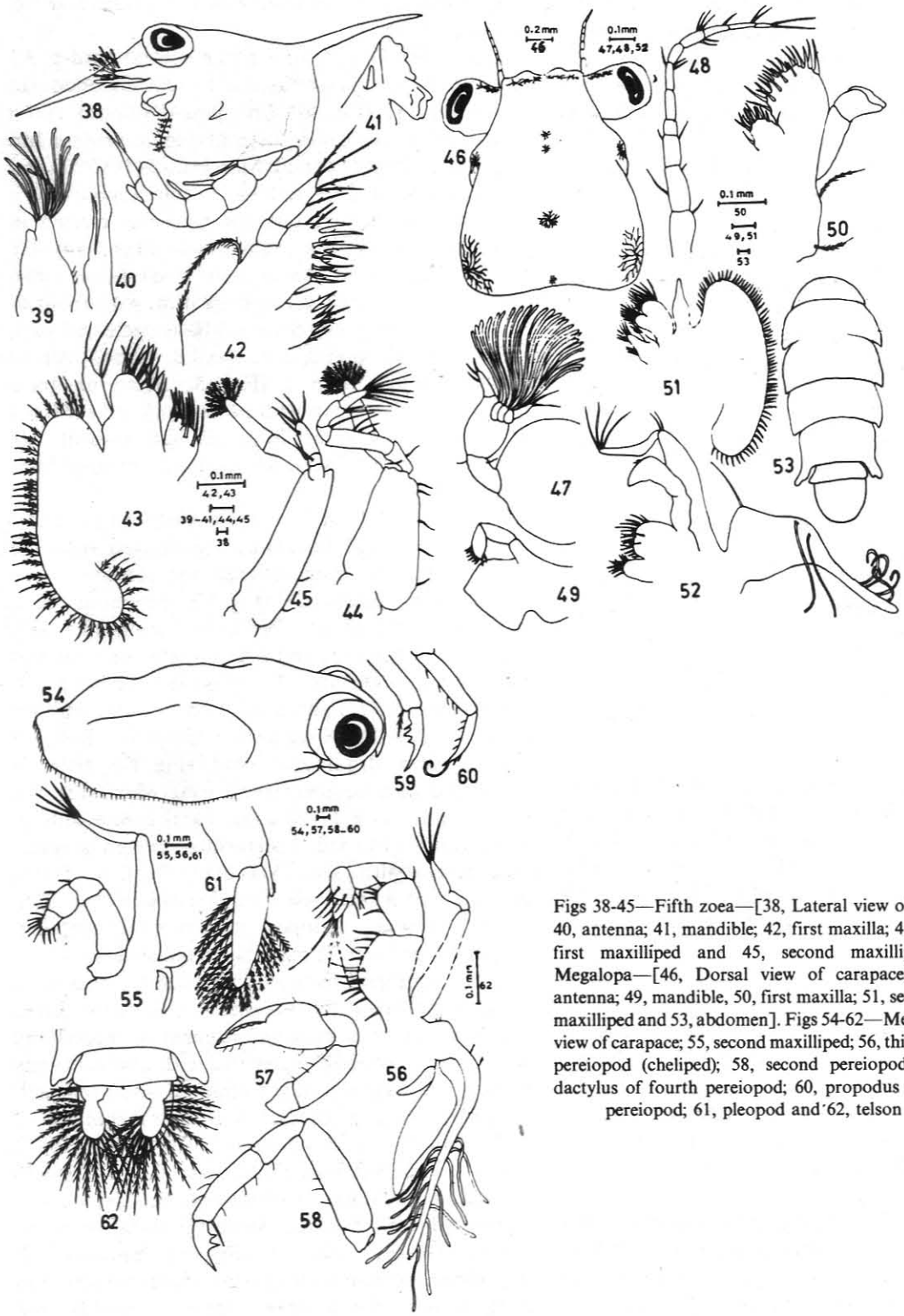
C with 2 long plumose hairs along front border (Fig. 29). A1 (Fig. 30): Base well thickened, aesthetascs more flattened. A2 (Fig. 31): Well swollen at base. Md (Fig. 32): Cutting edge strongly serrated. Max 1 (Fig. 33): Coxal endite with 6 and basal endite with 9 setae. Max 2 (Fig. 34): Scaphognathite now with 21 setae. Mxp 1 (Fig. 35): Distal segment of endopod with 6 setae, exopod with 10 natatory setae. Mxp 2 (Fig. 36): Natatory setae of distal segment of exopod increased to 10. Other appendages: Pereiopod and Mxp 3 buds appear, P1 chelate and Mxp 3 biramous. Ab (Figs 29 and 37): Sixth abdominal segment separated, 4 pairs of pleopod buds developed on 2nd to 5th segments.

Fifth zoea—RSL = 1.30 mm, DSL = 1.25 mm, LSL = 0.33 mm, CL = 1.60 mm, ABL = 2.13 mm and DS = 3-4 days.

C (Fig. 38): With 6 setae along ventral border. A1 (Fig. 39): With 11 aesthetascs and a seta, endopod bud developed. A2 (Fig. 40): Endopod developed as an elongated bud, extending beyond spinous process. Md (Fig. 41): With palp as bud. Max 1 (Fig. 42): Coxal and basal endites with 8-9 and 14-15 setae respectively, a proximal plumose seta added on outer margin in addition to earlier distal plumose seta. Max 2 (Fig. 43): Coxal endites with 5 setae each and basal endites with 6 and 8 setae respectively, scaphognathite with about 40 setae. Mxp 1 (Fig. 44): Setae on basis decreased to 5, setation on endopod 2, 2, 1, 2 and 8, exopod with 12 natatory setae. Mxp 2 (Fig. 45): Setae on basis increased to 2, exopod with 12 natatory setae. Mxp 3 and P1-5: As elongated buds, gill buds present. Ab: First segment with 7 setae on dorsal side, pleopod buds elongated.

Megalopa—C1 = 1.85 mm, Ca width = 1.55 mm.

C (Figs 46 and 54) broad and long, fringed with setae along its border, front deflexed and concave in the middle, eyes large. A1 (Fig. 47): Biramous, base swollen, devoid of seta, peduncle 2-segmented with about 24 aesthetascs, and 2 and 3 setae on proximal and distal segments. A2 (Fig. 48): Peduncle 3-segmented with 1,2 and 2 setae on 1st, 2nd and 3rd segments, flagellum 8-segmented with 0, 0, 3, 0, 5, 1, 2 and 2 setae distalwards. Md (Fig. 49): Palp 3-segmented, distal segment with 8 setae. Max 1 (Fig. 50): Coxal endite with 11-12 setae, basal endite with 20 setae, endopod broad, 2-segmented, devoid of setae, outer margin with 2 setae. Max 2 (Fig. 51): Coxal endite bilobed, with 9 and 3 setae, basal endite bilobed, with 10 and 11 setae, endopod without setae, scaphognathite fringed with 71 marginal plumose setae. Max 1 (Fig. 52): Protopod bilobed, with 10 and 17 marginal setae respectively on proximal and distal lobes, endopod as long as proximal segment of exopod and with 2 setae, exopod 2-segmented with 2 setae distally on proximal segment and 4 setae on distal segment, epipod flattened, triangular, with 1 proximal seta, 2 middle and 4 distal setobranch-like setae. Mxp 2 (Fig. 55): Endopod 5-segmented, with 0, 0, 1, 4 and 10 setae from proximal to distal segments, exopod 2-segmented with 5 apical setae on distal segment, epipod present. Mxp 3 (Fig. 56): Endopod 5-segmented, ischium with 14 setae, merus smaller than ischium and with 6 setae, carpus, propodus, and dactylus with 1, 8 and 5 setae respectively, exopod not large, 2-segmented, with 4 apical setae on distal segment, epipod long, ribbon-like, with 14 flattened setae on distal portion, 2 podobranchs present. P1-5 (Figs 57-60): First pair of pereiopods equal and chelate, with a few scattered setae, 2nd to 4th pereiopods



Figs 38-45—Fifth zoea—[38, Lateral view of zoea; 39, antennule; 40, antenna; 41, mandible; 42, first maxilla; 43, second maxilla; 44, first maxilliped and 45, second maxilliped]. Figs 46-53—Megalopa—[46, Dorsal view of carapace; 47, antennule; 48, antenna; 49, mandible, 50, first maxilla; 51, second maxilla; 52, first maxilliped and 53, abdomen]. Figs 54-62—Megalopa—[54, Lateral view of carapace; 55, second maxilliped; 56, third maxilliped; 57, first pereiopod (cheliped); 58, second pereiopod; 59, propodus and dactylus of fourth pereiopod; 60, propodus and dactylus of fifth pereiopod; 61, pleopod and 62, telson and uropods].

similar in structure, dactylus of each pereiopod with 2 or 3 strong, straight, blunt spines and corresponding propodus provided with a long bristle on distal inner part, 5th pereiopod with only one 'feeler' and 2 small outer spines on dactylus. Ab (Figs 53 and 62): Six-segmented, 2nd to 4th segments with postero-lateral spines and 5th segment with lobed expansions which extend up to 6th segment (Fig. 62), 4 pairs of biramous pleopods on 2nd to 5th segments (Fig. 61) and a pair of uropods on 6th segment (Fig. 62), exopods of pleopods with 21, 21, 22 and 18 plumose setae, endopod small, with 4 hooks on each, uropods uniramous with 2 setae

basally on peduncle and 16 terminal setae on ramus. T (Figs 53 and 62): Rounded posterior margin with 2 pairs of setae.

Chromatophores: All chromatophores of megalopa are dark-violet in colour. These are also seen in the parent crab. Chromatophores are stellate type and their distribution is as follows: Front of carapace, gastric, cardiac, branchial and intestinal regions of carapace, antero-dorsal side of eye stalks as illustrated, at the base of antennule and antenna, on mandible, dorsal side of abdomen, but segments of pereiopods are devoid of chromatophores.

Discussion

A noteworthy feature of *M. latifrons* is that the lateral carapace spines are absent only in the 1st stage zoea unlike in most of the other brachyuran 1st stage zoeae hitherto described. Though this character is also shared by the 1st stage zoea of *M. messor*, it is premature to generalise this character as of generic significance unless the detailed larval information of few more species of this genus is available. Though the lateral carapace spine is absent in the 1st stage zoea, it is nevertheless represented by a lateral hump in its place, which in subsequent zoeal stages develops into a typical lateral carapace spine. The absence of lateral carapace spine is a common feature of all zoeal stages of some species of the genera *Sesarma*[3,4], *Parasesarma*[5], *Metasesarma*[6], *Grapsus*[7], *Acmaeopleura*[8] and *Aratus*[9] in the family Grapsidae, whereas in the present species only the 1st stage zoea lacks the spine. However, aforesaid genera are devoid of any lateral carapace humps. The abdomen in *M. latifrons* and *M. messor* narrows anteriorly and progressively widens posteriorly from 1st to 5th segment. In addition to this, an indistinct collar is present on the 2nd abdominal segment of 1st stage zoea of *M. latifrons*, which disappears in later zoeal stages. But, surprisingly there is no mention of such a collar in the 1st stage zoea of *M. messor* by Rajabai[1]. The presence of this type of collar, characterisitc of zoeal stages, is also observed in the larvae of the genus *Pinnotheres* of the family Pinnotheridae, and moreover, the larvae of the genus *Pinnotheres* also lack lateral carapace spines, thus sharing the characters of *Metopograpsus* larvae. The larvae of some of the *Pinnotheres* possess an abdomen which is anteriorly narrowed like those of *M. latifrons* and *M. messor*. The significance of the presence of a collar and absence of lateral carapace spines in the genera *Metopograpsus* and *Pinnotheres* belonging to 2 different families of Brachyura is at present rather difficult and premature to interpret, except for the assumption that there might be some close relationship between the larvae of *M. latifrons* and those of *Pinnotheres*. Like many brachyuran larvae, *M. latifrons* and *M. messor* also have lateral protuberances on 2nd and 3rd abdominal segments. Larvae of *M. latifrons* and *M. messor* have a significant resemblance to those of *Dotilla sulcata*[10] and *D. blanfordi*[11] of the family Ocypodidae and those of the family Pinnotheridae except for the genus *Pinnotheres*[12–14] in having wing-like expansions on the 5th abdominal segment. Though the species of the genus *Dotilla* possess rounded wing-like expansions, they are not so pronounced as is the case of *Metopograpsus* larvae. In addition, in *Pachygrapsus crassipes*[15] of the family Grapsidae and in *Matuta lunaris*[16] of the family Calappidae, the 4th abdominal segment instead of the 5th one as in *Metopograpsus*, is expanded postero-laterally. These wing-like expansions of 5th abdominal segments of zoeal stages in *M. latifrons* persist as bilobed structures in megalopa stage as well.

The differences between the species *M. latifrons* and *M. messor*[1] are as follows: Basis of 1st maxilla is with 5 setae, setation of endopod of 1st maxilliped is 1, 2, 1, 2 and 5 in *M. latifrons* as against only 1 seta on the basis of 1st maxilla and 2, 1, 0, 3 and 5 setae on endopod of 1st maxilliped of *M. messor*.

The abdomen of megalopa in the present species is broader in the anterior segments except for the 1st one, showing a striking contrast in shape with that of preceding zoeal stages; the inter-orbital space is sufficiently broad, making it easier to assign the planktonic megalopa of this species to the family Grapsidae. However, a combination of the following specific characters of the megalopa stage of *M. latifrons* is important in distinguishing them from those of other brachyuran megalopae: the 2nd, 3rd and 4th pereiopods are similar to one another in that the dactylus of each is provided with 2 or 3 strong, straight and blunt spines; the 5th pereiopod has only 1 feeler instead of 3 feelers of most of other brachyuran megalopae, and, the bilobed expansions are present on the 5th abdominal segment representing the previous postero-lateral rounded wing-like expansions of the zoeal stages.

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