

Larval Development of Ghost Crab *Ocypode ceratophthalma* (Pallas) under Laboratory Conditions

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ABSTRACT

In the semi-terrestrial crab family Ocypodidae, the ghost crab *Ocypode ceratophthalma* (Pallas) represents the sandy shore ecosystem. Of the eleven species of the genus *Ocypode* recorded from Indo-West Pacific region (Serene, 1968), the ghost crab *O. ceratophthalma* was reared under laboratory conditions at Karwar. The larvae passed through 5 zoeal stages before reaching a megalopa stage. The temperature and salinity of the water during the experiment ranged from 23-26°C and 30-33 ppt. respectively. The complete metamorphosis took nearly 40 days before reaching first crab stage. Larval descriptions are given in the text. The larvae have a characteristic globose shape. Based on the presence of knobs on the abdominal segments, zoeae of the genus *Ocypode* can be grouped into two groups : one group having knobs on first and second abdominal segments and other group devoid of these knobs. In general, the megalopae of different species of *Ocypodidae* resemble each other in their gross morphology. Globosely shape, postero-lateral depressions for reception of fifth pair of walking legs, and lateral depressions where other ambulatory legs fit are common characters in these species.

Key Words: Larval development, Ghost crab, *Ocypode ceratophthalma*, laboratory culture, Zoeae and Megalopa,

INTRODUCTION

In the semi-terrestrial crab family Ocypodidae, larvae of the genus *Ocypode*, either from plankton or from laboratory hatchlings have been described in eight species viz., *O. albicans* (= *O. quadrata*); *O. gaudichaudii*; *O. occidentalis*; *O. platytarsis*; *O. cordimanus*; *O. aegypticus*; *O. ceratophthalma* and *O. stimpsoni*. Diaz and Costlow (1972) have given details on *O. albicans* (= *O. quadrata*); *O. gaudichaudii*; *O. occidentalis*; *O. platytarsis*; *O. cordimanus* while dealing with the larval account of their species *O. quadrata* from the Atlantic waters. In *O. aegypticus* only the first

zoea obtained in the laboratory has been described by Al-Kholy (1959) and as regards *O. ceratophthalma* Wellershaus (1971) described five zoeal stages and a megalopa, all stages being obtained from Cochin plankton, and he referred his material as possibly belonging to *O. ceratophthalma*. Terada (1979) described five zoeal stages of *O. stimpsoni*.

Further, of the eleven species of the genus *Ocypode* recorded from Indo-Pacific region (Serene, 1968), entire metamorphosis is not worked out in any of these species. The ghost crab *O. ceratophthalma*, one of these eleven

species, ranges throughout the tropical regions of Indo-Pacific, from Southern Japan, Hawaii to New South Wales of Australia, Red Sea, East and South Africa (Sakai, 1976).

The present account deals with the complete larval development of *O. ceratophthalma*, a common sandy shore crab of Karwar, along the west coast of India. The larvae pass through five zoeal stages before megalopa stage when reared in the laboratory, in about forty days.

MATERIAL AND METHODS

Ovigerous female was collected from the sandy beach within a distance of half a km. from the Kali river mouth. The crab was collected during dusk time soon after the sunset in the evening. Females with eggs in an advanced stage of embryonic development, generally make repeated trips towards water edge, indicating perhaps that their larvae were about to hatch. Such female, when caught, revealed that this was so and on transfer to aquaria with sea water just sufficient to submerge its belly, released the larvae. Thus the specimen released its larvae in the plastic container in which it was being transported to the laboratory. During the larval rearing the temperature and salinity of the water ranged from 23-26°C and 30-33 ppt., respectively. The zoeae were reared @5 numbers per bowl of 200 ml. capacity. Water was renewed every day and moults and dead larvae were removed. The larvae were dissected under binocular microscope with the help of entomological needles and drawings made with the help of camera lucida. Measurements of larvae were made with the help of stage and optical micrometers.

RESULTS AND DISCUSSION

Description of larval stages

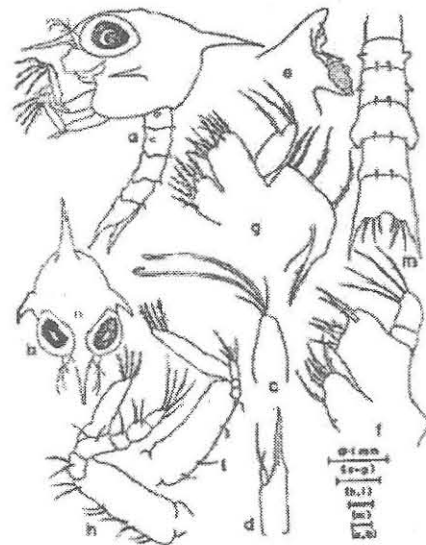
First Zoea

Rostral spine	=	0.30 mm
Dorsal spine	=	0.27 mm
Carapace length	=	0.72 mm
Lateral carapace spines	=	0.12 mm
Abdomen length	=	0.80 mm

Duration of the stage = 8-9 days

Carapace with a medio-frontal tubercle; rostral and dorsal spines more or less straight; lateral carapace spines short and are directed downwards; posterior border of carapace without hairs; eyes sessile. (Fig.1, a & b).

Fig.1: *First Zoea of Ocypode ceratophthalma (Pallas)*



a. Lateral view of first zoea; b. Anterior view of first zoea; c. Antennule; d. Antenna; e. Mandible; f. First maxilla; g. Second maxilla; h. First maxilliped; i. Second maxilliped; m. Abdomen and Telson

Antennule (Fig.1, c): Uniramous, with 2 long aesthetascs and 2 unequal setae.

Antenna (Fig.1, d): Exopod with 1 long and 1 small terminal setae; spinous process serrated

on both margins up to tip, almost 4 times longer than exopod. Mandible (Fig.1,e): Without palp but with well developed molar and incisor processes. First maxilla (Fig.1,f) : Coxal and basal endites with 5 setae each; palp 2-segmented with no seta on proximal and 4 setae on distal segments. Second maxilla (Fig.1, g): Both bilobed coxal and basal endites with 4 and 3, 5 and 4 setae respectively; palp with two lobes, proximal lobe with 1 and distal with 2 setae; scaphognathite with 4 marginal plumose setae and its proximal end produced into a broad plumose seta-like extension. First maxilliped (Fig.1, h): Basipod with 8 setae; endopod 5-segmented with 2, 2, 1, 2 and 5 setae arranged distalwards; exopod un-segmented, with 4 natatory setae. Second maxilliped (Fig.1,i): Basipod with 4 setae; endopod 3-segmented with 0,0 and 4 setae distalwards; exopod similar to that of first maxilliped. Abdomen (Fig.1, m): Five-segmented, first segment without dorsal setae; segments 2-5 each with a pair of dorsal setae; second segment with a pair of anteriorly directed and third segment with a pair of posteriorly directed dorso-lateral protuberances; fourth segment expanded laterally in its distal posterior region. Telson (Fig.1, m): Widely forked as in figure; process formula inside the fork is 3+3, proximal portion of cornua on each side slightly bulged.

Second Zoea

Rostral spine	= 0.32 mm
Dorsal spine	= 0.26 mm
Carapace length	= 1.35 mm
Lateral carapace spines	= 0.15 mm
Abdomen length	= 1.10 mm

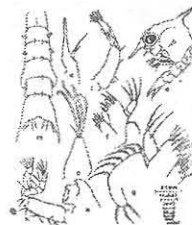
Duration of the stage = 5-8 days

The salient features are : Eye stalked; exopod of maxillipeds with 6 natatory setae; a

setae on carapace, first abdominal segment with a single medio-dorsal setae (Fig.2, a & b).

Antennule (Fig.2,c): Number of aesthetascs increased to 4 but that of setae decreased to 1. Antenna and Mandible (Fig. 2, d & e): No change. First maxilla (Fig.2,f) : Two more setae added on basal endite; a plumose seta appeared distally on outer margin. Second maxilla (Fig.2, g): Scaphognathite now with 6 (distal group)+ 3 (proximal group) setae. First maxilliped (Fig.2,h): Exopod seate now increased to 6 natatory setae. Second maxilliped (Fig.2,i):Distal segment of endopod with 5 setae; exopod with 6 natatory setae. Abdomen (Fig.2, m): Five-segmented, first segment with a single dorsal seta; postero-lateral angles of fourth segment increased in length. Telson (Fig.2, m): Widely forked ; process formula inside the fork is 3+3.

Fig.2. Second Zoea of Ocypode



a. Lateral view of second zoea; b. Anterior view of second zoea c. antennule; d. antenna; e. Mandible; f. First maxilla; g. Second maxilla; h. First maxilliped; i. Second maxilliped; m. Abdomen & Telson

Third Zoea

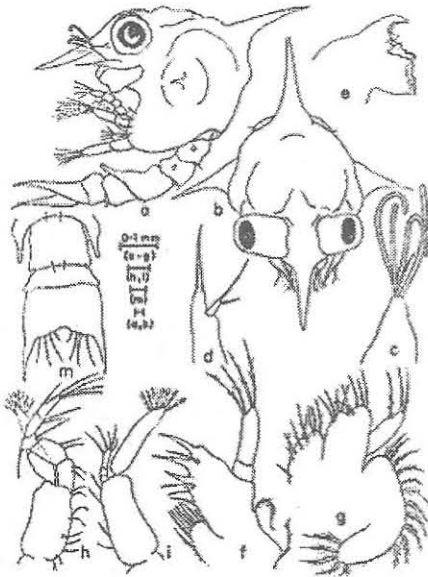
Rostral spine	= 0.40 mm
Dorsal spine	= 0.46 mm
Carapace length	= 1.40 mm
Lateral carapace spines	= 0.24 mm
Abdomen length	= 1.40 mm

Duration of the stage = 6-8 days

The salient features are : Ventral border of carapace with 4 plumose setae; carapace showing bulges as illustrated (Fig. 3, a & b)

including the medio-dorsal tubercle; maxillipeds with 8 natatory setae; postero-lateral angles of fourth abdominal segment more elongated; sixth abdominal segment separated from telson; telson process formula 4+4.

Fig.3: Third Zoea of *Ocypode ceratophthalma* (Pallas)



a. Lateral view of third zoea; b. Anterior view of third zoea; c. Antennule; d. Antenna; e. Mandible; f. First maxilla; g. Second maxilla; h. First maxilliped; i. Second maxilliped; m. Abdomen & Telson

Antennule, Antenna and Mandible (**Fig.3, c, d & e**): No change, except for increase in size. First maxilla (**Fig.3, f**): Coxal and basa endite setae increased to 7 and 8 respectively; a proximal seta added on outer margin. Second maxilla (**Fig.3, g**): Setae on proximal lobe of coxal endite increased to 6; scaphognathite with distal group of 11 setae and proximal group of 5, interspace with fine hairs. First and second maxillipeds (**Fig.3, h & i**): Exopod with 8 natatory setae, but it is 2-segmented in first maxilliped and unsegmented in second maxilliped. Third segment of endopod of first maxilliped is now

with 2 setae. Abdomen (**Fig.3, m**): Six - segmented, fourth segment now with more elongated postero-lateral corners, sixth segment separated from telson. Telson (**Fig.3, m**): Process formula inside the fork is 4+4.

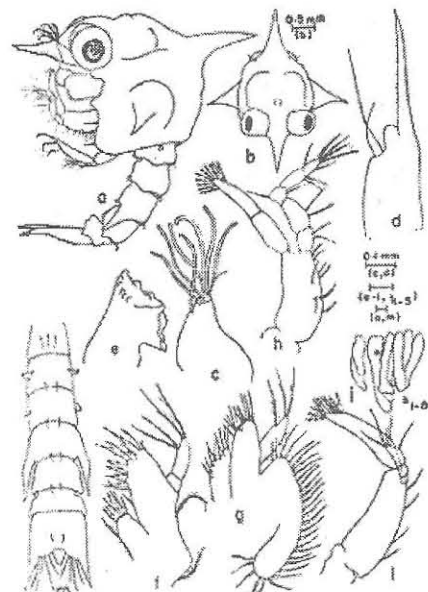
Fourth Zoea

Rostral spine	= 0.56 mm
Dorsal spine	= 0.56 mm
Carapace length	= 1.50 mm
Lateral carapace spines	= 0.44 mm
Abdomen length	= 2.00 mm

Duration of the stage = 7-9 days

The salient features are : Endopod of antenna developed; maxillipeds with 10 natatory setae; 4 pairs of pleopod buds developed; first abdominal segment with 3 dorsal setae; telson process formula 5+5.

Fig.4: Fourth Zoea of *Ocypode ceratophthalma* (Pallas)



a. Lateral view of fourth zoea; b. Anterior view of fourth zoea; c. Antennule; d. Antenna; e. Mandible; f. First maxilla; g. Second maxilla; h. First maxilliped; i. Second maxilliped; j. Third maxilliped; k 1-5. Pereiopod buds; m. Abdomen and Telson

Antennule (**Fig.4, c**): With 7 aesthetascs in 2 tiers and a small seta. Antenna (**Fig.4,d**): Endopod developed as a small bud. Mandible(**Fig.4,e**): No change, except for increase in size. First maxilla (**Fig.4,f**) : Coxal endite with 8 and basal endite with 11 setae; distal segment of palp slightly bilobed, each lobe with 2 setae. Second maxilla (**Fig.4, g**): Coxal endite with 6+4 setae on its lobe, basal with 6+6 or 7+7 setae; scaphognathite now fully fringed with about 25-30 marginal setae. First and second maxillipeds (**Fig.4,h & i**): Except for increase in number of natatory setae to 10 on exopods of first and second and 6 on distal segment of endopod of first maxilliped, no other change. Other appendages (**Fig.4, j, k 1-5**): Third maxilliped developed as a biramous bud; all 5 pairs of pereiopods as buds. Abdomen (**Fig.4, m**): Six-segmented, first segment with 3 dorsal setae; postero-lateral angles of fourth segment longer than the length of fifth segment; no setae on sixth segment. Four pairs of small pleopod buds on second to fifth segments. Telson (**Fig.4, m**): With 2 dorsal setae; process formula is 5+5.

Fifth Zoea

Rostral spine	=	0.9 mm
Dorsal spine	=	0.9 mm
Carapace length	=	2.30 mm
Lateral carapace spines	=	0.77 mm
Abdomen length	=	3.30 mm

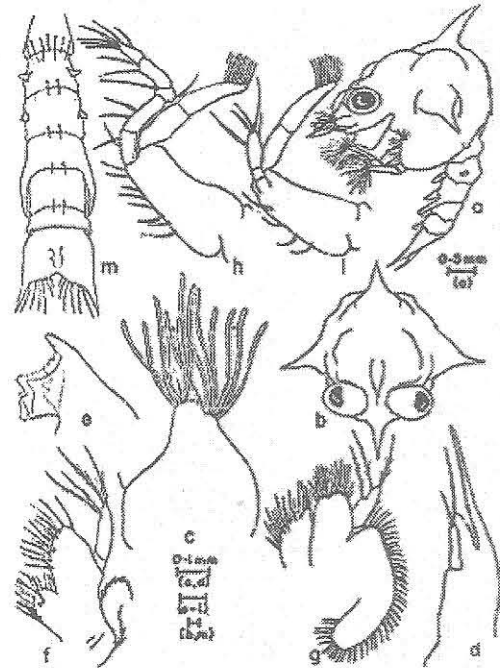
Duration of the stage = 8 days

The salient features are: maxillipeds with 12 natatory setae; first abdominal segment with 7 dorsal setae; dorsal surface of telson with 4 setae and telson process formula 6+6.

Antennule (**Fig.5, c**): With 13 aesthetascs arranged in 3 tiers; a minute seta situated basal on peduncle. Antenna (**Fig.4,d**): Except for

increase in length of endopod which is now longer than exopod, no other change. First maxilla (**Fig.5,f**) : Setae on coxal and basal endites increased to 16 each. Second maxilla (**Fig.5, g**): Setae on coxal and basal endites

Fig.5: Fifth Zoea of *Ocypode ceratophthalma* (Pallas)



a. Lateral view of fifth zoea; b. Anterior view of fifth zoea; c. Antennule; d. Antenna; f. First maxilla; g. Second maxilla; h. First maxilliped; i. Second maxilliped; m. Abdomen and Telson

increased to 17 and 18 respectively; scaphognathite with 42-46 marginal setae. First and Second maxillipeds (**Fig.5,h & i**): Natatory setae increased to 12 and exopod of second maxillipeds two-segmented. Other appendages: Third maxilliped and pereiopod buds increased in length, and first pereiopod showing chelate nature. Abdomen (**Fig.5, m**): First segment with 7 dorsal setae; postero-lateral lobes of fourth segment almost reaching to sixth abdominal segment. Telson (**Fig.5, m**): Dorsal setae with

2 pairs of setae; process formula 6+6.

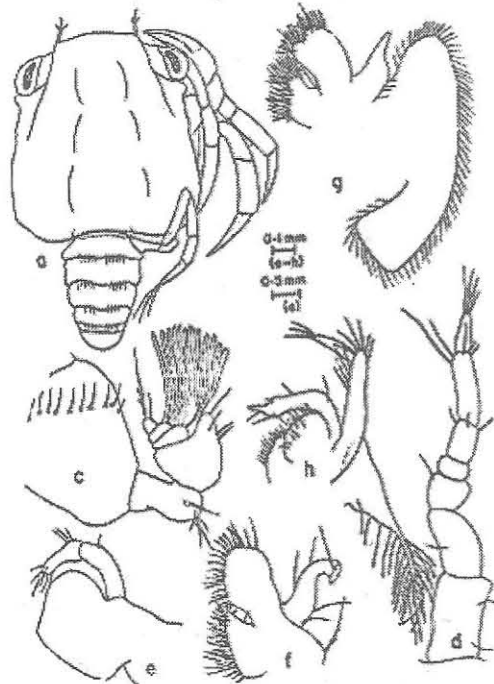
Megalopa

Carapace length = 2.6 mm
Carapace breadth = 2.5 mm
Abdomen length = 2.65 mm

Duration of the stage = 13-14 days

Carapace globular, with faint depressions and prominences (Fig.6, a); rostrum deflexed ventrally and is visible in lateral view only; transverse orbital projection distinct; carapace with depressions laterally for the reception of pereopods; eyes stalked, directed rather posteriorly, no ophthalmic stylets (cerii) of adult are developed in this stage.

Fig.6: Megalopa of *Ocypode ceratophthalma* (Pallas) Dorsal view



a. Dorsal view of megalopa; c. Antennule; d. Antenna; e. Mandible; f. First maxilla; g. Second maxilla; h. First maxilliped

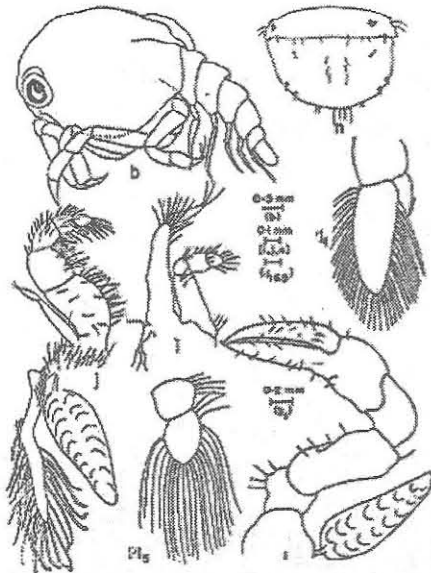
Antennule (Fig. 6, c): Peduncle with 3 segments, basal being large and globose with 10, 5 and 3=1 setae distal wards; flagellum of

three-segments, with 13 aesthetascs in 3 tiers and 1 plumose seta and one non-plumose seta on its distal segment; inner flagellum separated by a small protuberance. Antenna (Fig.6,d) : Peduncle three-segmented, with 2,1 and 1 seate arranged distalwards; flagellum four-segmented with setation 0, 3, 5 and 4 numbers. Mandible (Fig. 6, e): Masticatory process slightly pointed, palp two-segmented, with a seta on proximal and 3+6 setae on distal segment. First maxilla (Fig.6, f): Coxal and basal endites setose with about 30 and 24 setae respectively; palp now like that of adult but with 5 setae; one outer seta of zoeal stages continues. Second maxilla (Fig.6,g) : Coxal endite with 32 and basal with 12-14 setae; palp with 3-4 basal setae on its outer margin; scaphognathite fully fringed with about 65 or more setae. First maxilliped (Fig. 6,h) : Coxal endite with 10 and basal with 20 setae; palp with 5 setae; exopod two-segmented and with 10 seate on proximal segment and 3 on distal; epipod triangular, tapering, with about 18-20 setobranch-like setae. Second maxilliped (Fig. 7,i): Endopod four-segmented, with 6, 3, 7 and 6 setae distalwards; exopod two-segmented with 10 setae on proximal and 3 on distal segments; epipod very small carrying 4 setobranch-like setae.

Third maxilliped (Fig.7, j): Endopod large, five-segmented, with about 24,13, 15, 14 and 8 setae distalwards; exopod two-segmented, reaching half the length of meral segment of endopod and with a single seta on proximal segment and 2 on distal; epipod with about 30 or more setobranch-like setae on its ribbon-like portion; a podobranch present. Pereiopods : First pair chelate (Fig.7, k1); with a podobranch; second and third pairs also with 1 podobranch each; second to fifth similar, except for "feelers" on dactylus of last pair (Fig. 6,a and 7,b).

Abdomen (**Fig. 6,a**): Six-segmented; setose in nature. Pleopods (**Fig. 7,a and I1 & I5**) : four

Fig. 7: Megalopa of *Ocypode ceratophthalma* (Pallas) Lateral view



b. Lateral view of megalopa; i. Second maxilliped; j. Third maxilliped; k. Pereopod I; l & m. Pleopods 1 and 5; n. Telson

pairs of pleopods on second to fifth abdominal segments, a pair of uropods on sixth segment; exopod with 40, 30, 33-34 and 28 setae respectively on first to fourth pleopods while uropod (**Fig. 7, I5**) with only 22 on its distal and 5 on proximal segments; endopods of pleopods with 8, 8, 8 and 4 hooks respectively. Telson (**Fig. 7, n**): Semicircular in outline, with 4 median plumose setae posteriorly besides 2 minute and 2 thick spine-like setae (not shown in fig.) on each side laterally along the margin; on dorsal surface; 3 pairs of setae in middle line and one on each side.

DISCUSSION

In the present species, prezoal stage was not found though in *Ocypode gaudichaudii*

(Crane, 1940) and in *O. platytarsis* (Rajabai, 1951) presence of a prezoal stage has been reported. A prezoal stage was also present in some of the hatchlings of *O. quadrata*, but never moulted to next stage (Diaz and Costlow, 1972).

The larvae of *O. ceratophthalma*, like those of *O. quadrata*, have a characteristic globose shape, showing distinctive depression-protrusion pattern of the carapace, and this pattern is obvious throughout the larval development except in the first zoeal stage when only frontal and dorsal protruberances are present in *O. ceratophthalma*. The surface of the abdominal segments in *O. ceratophthalma* are not clearly rugose, like those of *O. quadrata*, during development. Diaz and Costlow (1972) have described the lateral knobs in the first and second abdominal segments in their description of the first zoea and have also shown these on the second and third segments, as per **Fig. 2**. In *O. platytarsis*, the fourth and fifth abdominal segments bear a pair of knobs each, directed anteriorly and posteriorly, respectively. Thus based on the presence of knobs on the abdominal segments, larvae of the genus *Ocypode* can be grouped into two separate groups; one group having knobs on first and second abdominal segments like those in *O. ceratophthalma* and *O. quadrata* or on fourth and fifth abdominal segments like those of *O. platytarsis*, and the second group devoid of these knobs. The larvae of the other hitherto known crabs of *Ocypode* fall into the latter group.

Diaz and Costlow (1972) gave a detailed table of comparison of the first zoeal stages of *O. platytarsis* (Rajabai, 1951) and *O. gaudichaudii* (Crane, 1940) with the first stage of their species *O. quadrata*. Hence comparison is made herewith only between the

first zoeae of present species *O. ceratophthalma* and of *O. quadrata*. The first zoeae in both the species agree in almost all respects except that there are two knob-like projections, one frontal and one dorsal, on the carapace in the present species *O. ceratophthalma*, but only frontal knob in *O. quadrata*. Diaz and Costlow (1972) stress the importance of the frontal projection as a provisional distinctive character for *O. quadrata*.

It is interesting to note that both species have same number of zoeal stages, i.e. five, before moulting to megalopa stage. Besides, *O. quadrata* is the only species in the genus in which entire metamorphosis is worked out. A comparison of subsequent stages made between these two species, reveals that they mainly differ in respect of setation on first abdominal segment and Telson process formula as under. In zoea second, third, fourth and fifth in the present species *O. ceratophthalma*, telson process formula is 3+3, 4+4, 5+5 and 6+6

respectively, whereas in *O. quadrata*, the corresponding stages have , 4+4, 5+5, 6+6 and 7+7 respectively. As regards abdominal setation, first two stages in both the species, have a single seta each while in the subsequent stages, the number of setae is 1, 3 and 7 respectively in *O. ceratophthalma*, whereas, 3,6,13 in *O. quadrata*.

In general, the megalopae of *O. ceratophthalma*, *O. quadrata*, *O. gaudichaudii*; *O. occidentalis*; *O. cordimana* and *O. platytarsis* resemble each other in their gross morphology. The globose shape, postero-lateral depressions for reception of the fifth pair of legs, and lateral depressions where other ambulatory legs fit in, are common characters in these species. *O. ceratophthalma* showed 22 setae on the exopod of the last pair of pleopods, whereas *O. quadrata*, *O. gaudichaudii*, *O. occidentalis* and *O. platytarsis* have 26, 22, 22 and 32 respectively. The megalopae of *O. quadrata*

Species	<i>O. ceratophthalma</i> (Karwar material, reared) Present work	<i>Ocypode ceratophthalma</i> Cochin plankton material (Wellershaus, 1971)
Zoeal stages		
Carapace	Medio-frontal tubercle present	Medio-frontal tubercle absent
Abdomen	First abdominal segment devoid of setae in first zoea Quadrangular, with short forks	First abdominal segment with a mid-dorsal plumose seta Triangular, with long forks
Telson		
Megalopa		
Carapace	Longer than broad, larger eyes are placed laterally	Broader than long, smaller eyes are placed mid-dorsally
Uropods	Well developed	Absent
Telson	Broadly rounded, with only few setae on posterior margin and a group of setae dorsally	Narrower, with distinct tubercle-like protruberances and a patch of rugae-like structure

differ from that of *O.ceratophthalma* in the following characters: antenna seven-segmented in the present species but ten-segmented in *O.quadrata*; setation of pleopods on second to fifth abdominal segments in the present species is 40,30,33-34 and 28 respectively whereas in *O.quadrata*, it is 46,44,38 and 33; also, the last (sixth) pleopod or uropod setae are 5 on basal and 22 on distal segments in *O.ceratophthalma* but there are only 6 and 26 setae respectively in *O.quadrata*.

In the light of the present studies on larvae of *Ocypode ceratophthalma* reared in the laboratory, the larvae described by Wellershaus (1971) from Cochin plankton and referred to as *O.ceratophthalma*, seem to belong to some other species of crab and not to *O.ceratophthalma* proper. The differences between the present material and that reported by Wellershaus (1971) are quite distinct.

The prolonged duration of the last zoeal stage, like those of *O.quadrata* (Diaz and Costlow, 1972), points to the lack of optimal requirements for rearing of these *Ocypode* larvae. The delay in moulting of megalopae of *Ocypode* appears to be common for the genus.

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