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ON THE EGGS AND EARLY LARVAL STAGES OF *PINNOTHERES GRACILIS* BURGER AND *PINNOTHERES MODIOLICOLUS* BURGER*

A. NOBLE

Central Marine Fisheries Research Institute, Cochin, India.

ABSTRACT.

The eggs, pre-zoea and first zoea of *Pinnotheres gracilis* Burger and *P. modiolicolus* Burger are described. Although they resemble each other in many respects there are certain differences which would help in their identification. In the possession of the characteristic trilobed telson, and the rostral and lateral spines on the carapace, the larvae of the two species agree. However, the antenna is absent in the former and present in the latter. Attention is also drawn here to the highly variable nature of some of the morphological characters during development in the genus *Pinnotheres*.

INTRODUCTION.

OF the large number of species of *Pinnotheres* Latreile, development of *P. pisum* and *P. ostreum* only have been worked out more or less completely and descriptions of one or more developmental stages of a few others are also available. A review of these works is given by Silas and Alagarswami (1967). From Indian waters two stages of a species of *Pinnotheres* have been described by Menon (1937) and a zoeal stage of *P. ridgewayi* by Prasad and Tampi (1957).

In order to study the larval life-history of *P. gracilis* and *P. modiolicolus*, recently reported from the west coast of India (George and Noble, 1968), attempts were made to rear them in the laboratory. Berried females of these crabs were removed from their hosts and reared in sea-water aquaria. On several occasions the larvae hatched out successfully but failed to undergo further development after the first zoea stage. A short account of their eggs and larvae is given in this report.

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DESCRIPTIONS.

Pinnotheres gracilis Burger

Egg :

Spherical, orange in colour and 0.28 mm in diameter in early stage. When organogenesis is almost complete it is 0.30 mm in size (Fig. 1 a) and colour changes to black.

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Pre-zoea (Fig. 1 b):

Length 0.7 mm. Remains mostly passive at the bottom, but occasionally shows wriggling and writhing movements. Lateral spines small, discernible only on careful examination under embryonic membrane held close to body, apex directed upwards; rostral spine not visible until dissected out of embryonic membrane in which it is kept bent beneath thorax, covering mouth and often wrinkled; abdomen with 4 somites; telson normally kept curled below body, sudden deflexion of which brings about jerking movement in larvae, whereas wriggling is effected by movement of appendages; eyes small, sessile and black; several stellate chromatophores present at different places; setae in appendages 1/3 to 3/4 embedded inside.

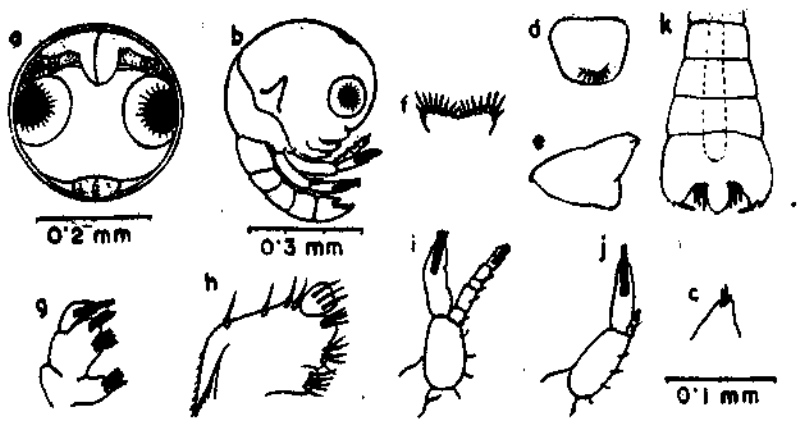

Fig. 1. *Pinnotheres gracilis*. a. egg, b. pre-zoea, c. antennule, d. labrum, e. mandible, f. labium, g. first maxilla, h. second maxilla, i. first maxilliped, j. second maxilliped, and k. telson Figures a to k have the same magnification as a and d to h as c.

Antennule (A_1) is visible as a small conical palp which carries 3 aesthetes apically, of which one is minute, others not as long as papilla (Fig. 1 c). *Antenna* (A_2) absent. *Labrum* (Lbr) a fleshy fold with a projection bearing a few strong bristle-like hairs on ventral side (Fig. 1 d). *Mandible* (Md), upper edge beak-like, lower edge rounded and rough surfaced; palp absent (Fig. 1 e). *Labium* (Lbi) flat and notched at its outer margin in middle where ventral projection of labrum dovetails when mouth is closed; either side of notch covered with strong spiny hairs (Fig. 1 f). *First maxilla* (Mx_1) with 4 strong hirsute setae in coxopodite; 7 in batches of 4 proximal and 3 distal on basipodite, of which 2 in first and 1 in second are strong and hirsute; endopodite longer than broad, ending with 4 setae at its tip clustered together as a bundle (Fig. 1 g). *Second maxilla* (Mx_2) has 5 and 9 setae respectively in coxopodite and basipodite; setae on basipodite in 2 batches of 5 and 4; 3 apical setae in endopodite; scaphognathite long, tapers distally to a point, carries 4 flagelliform setae with deeply set bases (Fig. 1 h). *First maxilliped* ($Mxpd_1$), coxopodite with 1 and basipodite with 4 setae on inner margin; exopodite unsegmented, slightly curved, with tips of 4 setae visible at apex; endopodite five-segmented, first and third segments are smaller, a seta each on first 3 segments, 2 in fourth and 4 terminal and a minute subterminal one on outer margin of fifth (Fig. 1 i). *Second maxilliped* ($Mxpd_2$) devoid of seta in coxopodite; has 4 setae in basipodite; exopodite unsegmented, with 4 setae clubed together; endopodite small, two-jointed, with 1 seta in first and 4 setae in second segment (Fig. 1 j). *Third maxilliped* ($Mxpd_3$) rudimentary

(Fig. 1 b). *Telson* (Tel) flat and trilobed ; outer margins of lateral lobes crenulated posteriorly ; a long sturdy spine at tip directed inwards towards distal end of dome-shaped median lobe and a very short one just before it outside ; in between median and lateral lobes, are 3 setae on either side, decreasing in length from innermost, none reaching tip of median lobe (Fig. 1 k).

The pre-zoea is quite short-lived and the moult to first zoea takes place within a period of few hours.

First zoea (Fig. 2 a, b) :

Rises to the surface, swims actively and is phototropic. Length 0.8 mm ; lateral spines straighten, point outwards and backwards ; rostral spine half the length of carapace, longer than lateral spines, and stands out sturdy and strong ; dorsal spine absent ; in appendages, full length of all setae are visible outside ; abdomen has 4 somites and it gets wider towards telson ; bigger and clearer stellate chromatophores present.

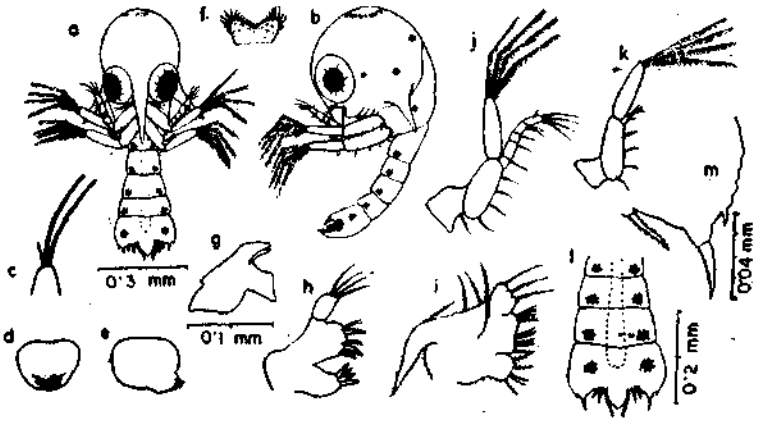

Fig. 2. *Pinnotheres gracilis*. a. first zoea (front view), b. same (side view), c. antennule, d. labrum (ventral view), e. same (side view), f. labium, g. mandible, h. first maxilla, i. second maxilla, j. first maxilliped, k. second maxilliped, l. Telson and m. telson-enlarged lateral lobe. Magnification of figure b same as a and j and k as l. Figures c to i are under the same magnification.

Short aesthetes in A_1 (Fig. 2 c) as long as conical palp, longer ones are more than 3 times its length. A_2 absent. Ventral protuberance in Lbr (Fig. 2 d) thickly covered with strong spiny hairs (Fig. 2 e). Md (Fig. 2 g) has no palp ; upper margin projects into 2 beaks placed side by side ; lower margin differentiated into cutting edge standing inwards and downwards. Lbi (Fig. 2 f) covered more densely with bristle-like hairs. No change in number of setae in Mx_1 (Fig. 2 h) ; hirsute setae on basipodite appear median in position and others which are slender and simple form pairs slightly above ; setae in endopodite longer than segment. Mx_2 (Fig. 2 i) has same number of setae, 3 setae on coxopodite and 1 on proximal set of basipodite single and median in position, and rest form pairs ; distal set of setae on basipodite arises as a tuft from it ; setae in endopodite are narrow and much longer than it and are mounted on small elevations separated each other by notches ; setae in scaphognathite almost twice as long as they were in pre-zoea stage and look more

slender and fine ; all setae have fine hairs on them ; margin of protopodite and endopodite are also finely hairy ; scaphognathite and its setae have very fine hairs on them. All setae in $Mxpd_1$ (Fig. 2 j) are longer, those on exopodite very long and natatory. No change in the number of setae in $Mxpd_2$ (Fig. 2 k), but all are longer and those on exopodite have become natatory. $Mxpd_3$ rudimentary. In Tel (Fig. 2 l), median lobe is longer than lateral ones ; terminal spines on lateral lobes are straight, pointing right out; crenulations on sides distinct (Fig. 2 m) ; setae on telson are longer, inner most being longest reaches far beyond tip of median lobe; all setae have fine hairs on them.

Pinnotheres modiolicolus Burger

Egg :

Globular, measuring 0.48 mm in early stage, and after organogenesis 0.5 mm in diameter (Fig. 3 a) ; egg orange in colour at beginning and turns black with development.

Pre-zoea (Fig. 3 b) :

Length 1.10 mm. Resembles the pre-zoea of *P. gracilis* in many respects but differs from it in the following salient features. Spines on carapace are well developed ; rostral spine measures two-third length of carapace and lateral ones are slightly smaller ; latter though folded against the carapace, have their tips directed upwards in newly hatched larvae and soon straighten and attain a position which is downwards and forwards.

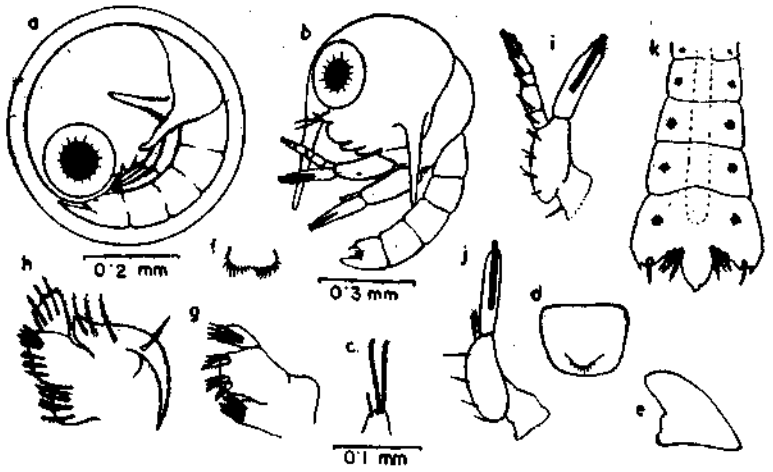

Fig. 3. *Pinnotheres modiolicolus*. a. egg, b. pre-zoea, c. antennule, d. labrum, e. mandible. f. labium, g. first maxilla, h. second maxilla, i. first maxilliped, j. second maxilliped, and k. telson. Magnifications of a and i to k are same and those of c to h same.

In A_1 (Fig. 3 c), all 3 aesthetes are longer, shortest as same and others 2.5 times more of length of papilla. Lbr (Fig. 3 d), Md (Fig. 3 e) and Lbi (Fig. 3 f) same as in *P. gracilis*. Basipodite of Mx_1 (Fig. 3 g) with 2 setae in proximal and 1 in distal set, all median in position, strong and hirsute ; remaining being slender, plain and in pairs. Similarly 3 setae in coxopodite of Mx_2 (Fig. 3 h) and 1 in proximal set of its basipodite appear to be single, rest forming pairs ; free exposed ends of all these

setae covered sparsely with fine hairs ; margins, especially of scaphognathite and endopodite have hairs finer than those found on setae. Basipodite of $Mxpd_1$ (Fig. 3 i) carries 7 setae, one single proximal and 6 in 3 pairs ; all segments in endopodite carry setae, only their tips being seen out. $Mxpd_2$ (Fig. 3 j) same as in *P. gracilis*. Middle lobe of Tel (Fig. 3 k) much longer than lateral ones ; outer margins of lateral lobes only faintly crenulated ; setae covered with fine hairs.

First zoea (Figs. 4 a, b) :

The pre-zoea passes on to this stage quicker than in *P. gracilis*. Length 1.25 mm. Except for size, it looks quite similar to first zoea of *P. gracilis* ; lateral spines directed outwards and backwards ; setae on appendages fully visible outside ; long aesthetes in A_1 (Fig. 4 c) have become much longer and measures 4.5 times length of small one. A_2 (Fig. 4 d) present as a minute conical papilla carrying a short seta at its apex (unlike in *P. gracilis* and *P. ridgewayi*) ; compared to A_1, it is much smaller in size (Fig. 4 e). Lbr (Fig. 4 f) and Lbi (Fig. 4 h) have more hairs than in pre-zoea stage. Incisors and molar formed in Md (Fig. 4 g). A cluster of very short hairs appears on

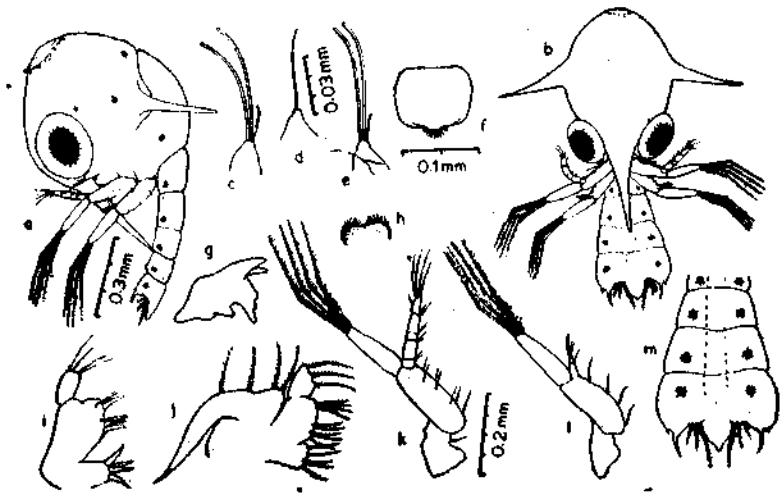

Fig. 4. *Pinnotheres modiolicolus* a. first zoea (side view), b. same (front view), c. antennule, d. antenna, e. antennule and antenna combined, f. labrum, g. mandible, h. labium, i. first maxilla j. second maxilla, k. first maxilliped, l. second maxilliped and m. telson. Figures a and b are of the same magnifications. Similarly c and e to j are under one magnification and k, l and m under another.

basipodite of Mx_1 (Fig. 4 i) along lower margin just before first set of setae. Setae in endopodite of Mx_2 (Fig. 4 j) as in *P. gracilis* arise from small elevations separated each other by small notches ; setae and margins of the appendage, especially of scaphognathite and endopodite covered with more fine hairs. Setae in exopodite of $Mxpd_1$ (Fig. 4 k), as in *P. gracilis*, are very long and natatory ; all segments in endopodite, except dactylus have a pair of setae each, whereas dactylus has 4 terminal setae and a short one emerging slightly before its apex. Setae on exopodite of $Mxpd_2$ (Fig. 4 l) are also long and natatory. $Mxpd_3$ (Fig. 4 a) is still rudimentary as in *P. gracilis*. In Tel (Fig. 4 m) outer margin of lateral lobe is smooth, and terminal spine in it reaches beyond tip of median lobe ; setae on either side of median lobe are longer, inner one which is longest reaching far beyond tip of median lobe ; setae are completely covered with hairs.

Discussion

The eggs and larvae of *Pinnotheres gracilis* and *P. modiolicolus* resemble each other greatly in their morphological and meristic characters. But the differences tabulated below would help in distinguishing them from one another.

		P. gracilis	*P. modiolicolus*
1.	Eggs	0.28 mm in diameter in early stage and 0.30 mm after organogenesis.	0.48 mm in early stage and 0.50 mm later.
2.	Larvae	0.7 mm in length in pre-zoea and 0.8 mm in first zoea.	1.10 mm in length in pre-zoea and 1.25 mm in first zoea.
3.	Spines on carapace	Not discernible in pre-zoea.	Present in pre-zoea.
4.	Rostral spine	Measures half length of carapace.	Measures two-thirds length of carapace.
5.	Aesthetes in antennule	Rudimentary in pre-zoea	Long in pre-zoea.
6.	Antenna	Absent.	Present in first zoea.
7.	First maxilliped	4 setae on basipodite and 1 each on the first 3 segments of endopodite.	7 setae on basipodite and a pair each on first 4 segments of endopodite.
8.	Telson	Outer margin of lateral lobes clearly crenulated along posterior half in both prezoea and first zoea.	Outer margin of lateral lobes faintly crenulated in prezoea.

A comparative study of the first zoea of the different species of *Pinnotheres* shows considerable variations in certain features. The antenna is absent in the first zoea of *P. ostreum* described by Sandoz and Hopkins (1947). Similarly, Prasad and Tampi (1957) could not find the antenna in *P. ridgewayi*. In *P. pisum* and *P. pinnotheres* the antenna was observed as a small lobe with minute spine at its side by Atkins (1955). In the present study, while it is observed as a conical papilla with a seta at its apex in *P. modiolicolus* it could not be traced in *P. gracilis*.

The trilobed telson which is characteristic of the species of *Pinnotheres* also shows some differences. According to Lebour (1928), the outer margin of the lateral lobe of telson of the first zoea in *P. veterum* is smooth. In *P. modiolicolus*, the weak crenulations found in the outer margin of the lateral lobe of the pre-zoea disappeared in the first zoea. Prasad and Tampi (1957) observed almost half of the outer margin crenulated in *P. ridgewayi*. In *Pinnotheres* sp., in its second stage zoea, Menon (1937) found only 2 minute teeth in the outer margin of the lateral lobes of the telson. In *P. gracilis* clear crenulations are present in the posterior margin of the lateral lobes.

Of all the characters of the zoeae, the number of spines on the carapace exhibit the maximum diversity. The reduction of one or more spines or the absence of them altogether are not uncommon. While *P. ridgewayi* has no spines on the carapace (Prasad and Tampi 1957), *P. ostreum* has a rostral spine which is short and blunt

(Sandoz and Hopkins 1947). In both P.*gracilis* and *P. modiolicolus* the rostral spines are long and pointed. In addition, as described by Atkins (1955) in *P. pisum*, they possess the lateral spines also. Larvae of species such as *P. veterum*, *P. pinnotheres* and *Pinnotheres* sp. described by Lebour (1928), Atkins (1955) and Menon (1937) respectively have rostral, dorsal and lateral spines.

Because of the highly variable features, identification of these larvae is rather difficult. Hyman (1924) suggested the rudimentary antenna as a diagnostic character in their identification. But this feature is noticed in the larvae of *Ebalia* (Hymonosomidae) and *Elamena* (Leucosidae). Subsequently, Lebour (1928) considered trib-lobed telson as the characteristic feature of British species. But according to Gurney (1942) some species of *Pinnotheres* possess the primitive forked telson, while others have them trilobed. Larvae of species of other genera of family Pinnotheridae such as *Dissodactylus* sp. have forked telson, and *Ostracotheres tridacne and Pinnixa chaetopterina* have trilobed telson. The telson of *Ostracotheres tridacne* figured by Gohar and Al-Kholy (1957) resembles very much the telson of *P.modiolicolus* studied here. As in the case of the antenna and the telson, the number of spines on the carapace also cannot be taken as a diagnostic character because the diversity seen in the number of spines on the carapace is not an exclusive feature of pinnotherids alone, and it has been observed in the larvae of the crabs of Leucosidae also (Gurney 1942).

Thus the larvae of Pinnotheridae, Hymenosomidae and Leucosidae show great resemblances rendering it difficult to identify them. Complete larval studies on several of the species belonging to these families might throw further light on this problem.

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