

ON THE EARLY LARVAL DEVELOPMENT OF *CARIDINA* SP.
(CRUSTACEA, DECAPODA, ATYIDAE).

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ABSTRACT

The early larval development of *Caridina* sp. collected from the low-saline inshore waters of Cochin is described. The larvae hatch out in relatively advanced stage and pass through 5 moults during a period of 11 days, under laboratory conditions. Rearing experiments were carried out in the medium with salinity, 16-17‰, and at temperature, 28.0°C to 28.5°C. Descriptions of the adult shrimp and the first three zoeal stages are given with illustrations. A comparison of the early larval development of *Caridina* sp. with that of the allied species is made.

INTRODUCTION

The species belonging to the genus *Caridina* generally occur in fresh water and are widely distributed throughout the world. Although relatively small in size, these shrimps contribute to a subsistence fishery in certain fresh-water and estuarine systems and are quite suitable for culture in the confined waters. They also form an important source of forage of many carnivorous fishes. Most of the investigations carried out on this group of shrimps are in relation to their taxonomy and distribution; the important studies on the Indian species are by de Man (1892, 1908a, 1908b), Kemp (1913, 1915, 1918), Roux (1931), Nataraj (1942), Chopra and Tiwari (1947), Pillai (1964) and Tiwari and Pillai (1971). Information on the larval development of the species is available from the works of Daday (1907), Gurney (1927), Shen (1939), Nair (1949) and Babu (1963). Daday (1907) has described in detail the larval development of *Caridina wyckii* from Lake Victoria and Nyasa, while Gurney (1927) dealt with 3 larval and 2 postlarval stages of *Caridina nilotica* var. *typica* obtained from the freshwater lagoon of Ismailia. Shen (1939) has described 5 larval stages of *Caridina denticulata* from Peiping waters. From India, a description of zoea I of *Caridina laevis* and the complete larval development of *Caridina propinqua* reared in the laboratory are available from the works of Nair (1949) and Babu (1963), respectively. The present paper deals with the early development of a species of *Caridina* obtained from the inshore waters of Cochin and reared in the laboratory.

MATERIAL AND METHODS

A single ovigerous specimen of *Caridina* sp. was collected on 30th October 1973 from the inshore waters of Cochin by a tow net. The salinity and temperature of the surface waters from where the specimen was collected were 18.04‰ and 29.8°C respectively. The specimen was brought to the laboratory and kept in a glass beaker of 500-cc capacity, containing 400 cc of prepared water, the salinity of which was 16-17‰. The temperature of the water during the period of rearing ranged between 28.0°C to 28.5°C. The specimen carried only a few large eggs on the pleopods and these were in an advanced stage of development. On 31-10-1973, all the eggs hatched out into zoea larvae and soon after, the mother shrimp underwent moulting. Altogether 11 larvae were obtained. They were transferred to freshly prepared medium of the same salinity and fed with newly hatched *Artemia* nauplii. The water in the container was changed daily. During the 11 days which followed, they underwent 5 moults, but, as a few larvae had to be killed and preserved for studies after each moult, it was possible to describe only the first three stages here.

To study the detailed morphological features, the appendages were dissected out and the illustrations were prepared with the aid of a monocular microscope and camera lucida. The total length of the larvae was measured from the tip of the rostrum to the tip of the telson and the carapace length from the tip of rostrum to the mid-posterior border of the carapace.

DESCRIPTION OF ADULT

As specific identification of the specimen at hand has not been possible, a brief description of the important characters is given below.

Rostrum (Fig. 1,a), dagger-shaped and extends to middle of third segment of antennular peduncle, upper margin straight and provided with 18 teeth of which 6 are postorbital, lower margin bears 5 teeth; carapace with a sharp antennal spine; stylocerite reaches middle of first segment of antennular peduncle; carpus and chela of first pereiopod (Fig. 1,b) 2.4 times as long as broad, and finger 1.4 times the length of palm; carpus of second pereiopod (Fig. 1,c) slender, ratio between length and breadth of carpus and chela 7.4 and 3.4, respectively; ratio between length of palm and finger 1.5; propodus of 5th pereiopod 15.7 times as long as broad and 2.6 times length of dactylus which bears 53 short spinules (Fig. 1,d); 6th abdominal somite 1.7 times as long as broad; telson (Fig. 1,f) with 3 pairs of dorsolateral and 4 pairs of posterior spines, of which median pair is longest and with setules on both margins, second pair from the middle stouter and plumose, third a little longer than second with setules on inner margin only and outermost spines shortest and nonplumose; posterior edge of telson convex; diaeresis in the exopod of uropod bears 12 spinules (Fig. 1,e).

The total length and various body measurements of the specimen are given below:

Total length (from tip of rostrum to tip of telson).	13.7 mm
Length of carapace (from orbital border to the posterior border of carapace).	2.9 mm
Length of abdomen	7.0 mm
Length of 6th abdominal segment	1.6 mm
Length of telson	1.7 mm
Preorbital length of antennular peduncle / Postorbital length of carapace	0.55
Length of the propodus of pereiopod 5 / Postorbital length of carapace	0.50
Length of the digit of pereiopod 5 / Length of propodus of pereiopod 5	0.38
Length of 6th abdominal segment / Postorbital length of carapace	0.55

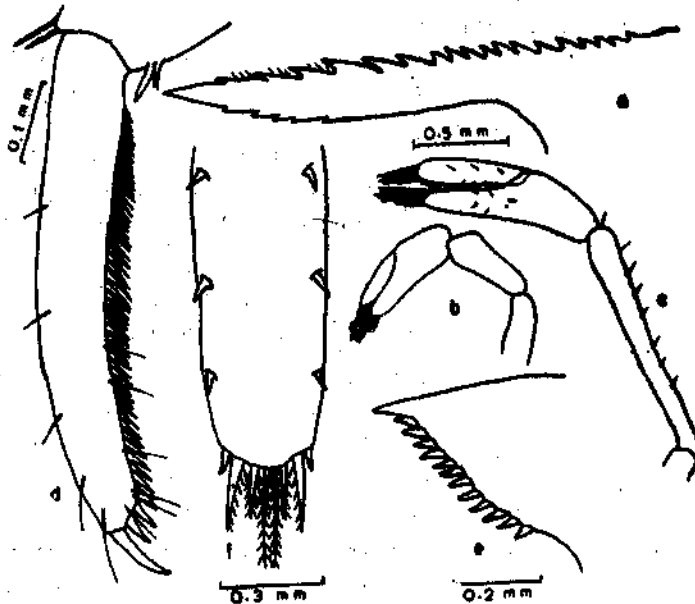


FIG. 1. *Caridina* sp. Adult. a — rostrum, b — first pereiopod, c — second pereiopod, d — dactylus of 5th pereiopod, e — diaeresis of uropodal exopod, f — telson.

Remarks: In regard to the specific characters (Bouvier 1913) such as the relative length of antennular peduncle, the nature of the epipodal prolongation of third maxilliped, dactylus of 5th pereopod being equal to one-third of propodus and the number of spines in the diaeresis of the uropodal exopod the specimen differs from *Caridina laevis* Heller, but resembles *Caridina togoensis* Hilgendorf 1893, described from Africa. However, it differs from the latter in regard to a number of other characters. In the number of spines on rostrum, general characters of pereopods and in the ratio between the length of 6th abdominal segment and carapace, the present specimen is closely related to *Caridina laevis* Heller which has already been recorded from this region (Nataraj 1942, Pillai 1964). The number of spines in dactylus of 5th pereopod in *C. laevis* appears to be variable as Bouvier (1925) records it as 90-100, de Man (1908) as 75-78 and Pillai (1964) as 58-64. In the present specimen the number of these spines is 53. According to Bouvier (1913) the dactylus of 5th pereopod is about half of propodus in *Caridina laevis* Heller, while Pillai (1964) gives this ratio as 0.35. In the present specimen this ratio is found to be 0.38. Because of these differences, similarities and variations exhibited within the species of *C. laevis* group, as seen by different authors, it is difficult to assign the single specimen to any of the species so far described and hence designated as *Caridina* sp.

DESCRIPTION OF LARVAL STAGES

Zoea I (Fig. 2,a-m): Total length, 2.38 mm; Carapace length, 0.70 mm.

Newly hatched larva is an advanced zoea. Carapace devoid of spines; rostrum short, unarmed and slightly decurved at tip. Yolk granules discernible through the carapace. Eyes large and sessile. All the mouth parts and the pereopods well developed. Rudiments of gills present. Abdomen consists of six well-defined segments and rudimentary bud-like biramous pleopods (Fig. 2,l) on segments 1-5. Telson not separated from sixth abdominal segment, bilobed, with median posterior margin slightly indented and it bears 2 posterolateral and 6 posterior plumose spines on each side (Fig. 2,m). Uropods undeveloped.

Antennule (Fig. 2,b): Peduncle long, unsegmented, bearing 2 unequal flagella at apex; outer flagellum longer with 2 aesthetes and 2 setae, the outer one being short and plumose; inner flagellum stumpy, ending in a long plumose seta.

Antenna (Fig. 2,c): Scale unsegmented, bearing 10 plumose setae along inner and slightly wider distal margins; a short nonplumose seta present in between the posterolateral plumose setae at apex; in addition to these setae, scale also carries a plumose seta situated midway on outer margin; endopod longer than scale, indistinctly segmented and with an apical nonplumose seta.

Mandible (Fig. 2,d): Asymmetrical; without palp; incisor process with a conspicuous tooth; molar process with several small and pointed teeth; molar region of opposite side smooth and devoid of teeth; a sharp spine present in between the incisor and molar process.

Maxillule (Fig. 2,e): Bilobed; proximal lobe with 5 short and stout spines, one of which widely separated and situated in the anterior border; distal lobe with a conspicuous and sharp tooth and 2 small blunt teeth; palp unsegmented and carries 2 apical setae.

Maxilla (Fig. 2,f): Biramous; protopod with 3 endites, proximal one largest and bears 9 marginal setae; endopod with 3 proximal bristle-like setae and 2 apical and 1 subapical setae; exopod long, with 4 plumose setae, the posterior of which is short and directed backwards.

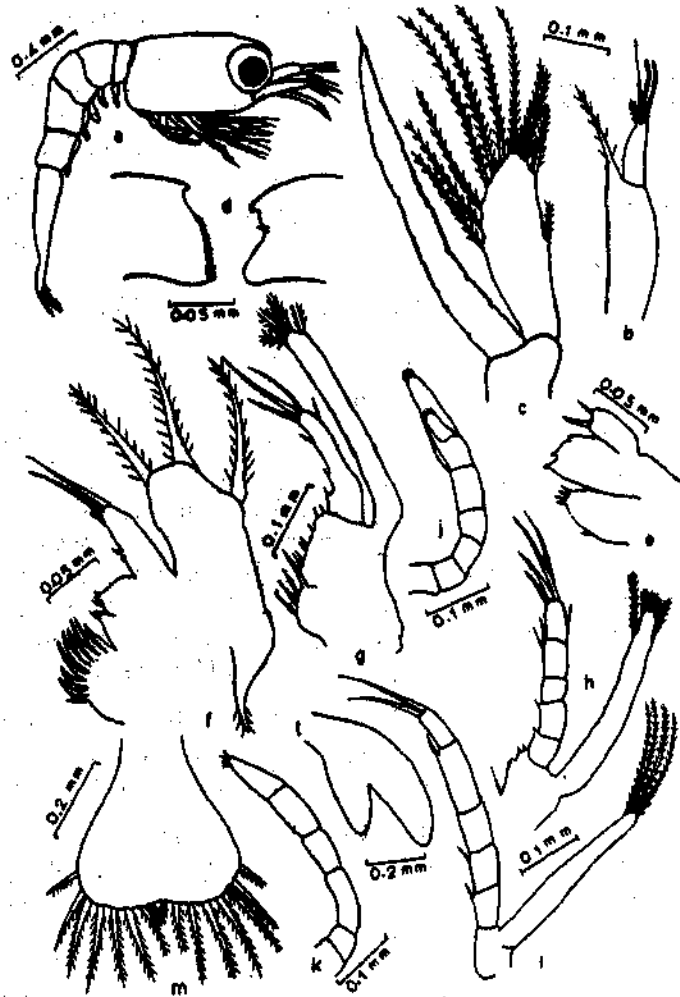


FIG. 2. *Caridina* sp. Zoea I. a — lateral view, b — antennule, c — antenna, d — mandible, e — maxillule, f — maxilla, g — first maxilliped, h — second maxilliped, i — third maxilliped, j — first pereopod, k — fifth pereopod, l — second biramous pleopod bud, m — telson.

Maxilliped I (Fig. 2,g): Biramous; protopod 2-segmented; proximal segment with 4 longer spines and the distal segment with 7 smaller spines; endopod with 3 short setae on inner margin, 3 terminal setae and 1 outer subapical seta; exopod twice as long as endopod and bears 4 long plumose terminal setae.

Maxilliped II (Fig. 2,h): Biramous; endopod 5-segmented, first and second segment each with a single seta on inner border, fourth segment with 2 larger setae on the same margin, fifth having 2 very much longer and 2 shorter spines at apex and an additional seta at outer middle margin of the segment; exopod as long as endopod with 4 apical and 2 subapical plumose setae.

Maxilliped III (Fig. 2,i): Endopod 5-segmented, first, second and fourth segments each with a small seta on inner margin, distal segment with 2 long non-plumose apical setae; endopod as long as exopod with 4 plumose terminal setae.

Pereiopods (Fig. 2,j,k): Uniramous, 5-segmented, first and second legs with developing chela (Fig. 2,j); legs 3-5 (Fig. 2,k) nonchelate, distal segment with 4 or 5 minute setae.

Zoea II (Fig. 3,a-m): Total length, 2.42 mm; Carapace length, 0.78 mm.

Zoea I moults into the second stage after 24 h. The larva (Fig. 3,a) at this stage is characterised by the presence of pterygostomial spine on carapace, stalked eyes and appendix interna on the last four pairs of pleopod buds.

Antennule (Fig. 3,b): Peduncle 3-segmented, first segment with a developing stylocerite which bears 2 apical setae, proximal outer border with 3, outer distal corner with 5 and inner border with a single plumose setae; second and third segment almost equal, the former carries 3 long setae on outer margin and 2 setae at inner distolateral margin, third segment with 5 plumose setae at distal margin and carries 2 flagella; outer flagellum indistinctly segmented, the distal segment with 2 aesthetes and 2 unequal setae; inner flagellum indistinctly 3 segmented and bears 3 unequal apical setae.

Antenna (Fig. 3c): Scale with 14 setae along inner and terminal margin and a spine on outer lateral corner; endopod many-segmented, the proximal segment longest.

Mandible (Fig. 3,d): Incisor process with 5 spines, one of which is stout and conspicuous; molar region with 5 large and several minute teeth; in between the two processes, 2 long and smooth spines present.

Maxillule (Fig. 3,e): Almost similar to that of previous stage except for the increased number of spines on both the lobes.

Maxilla (Fig. 3,f): Proximal endite of protopod with 16 marginal setae; endopod considerably reduced in size, finger-like and with 2 small apical setae;

exopod broader and carries 17 long plumose setae on entire upper margin, and 4 setae posteriorly.

Maxilliped I (Fig. 3,g): Proximal segment of protopod with 3 longer setae; distal segment with 12 short setae; endopod short and carries a minute seta near the base and 3 apical setae; exopod same as in the preceding stage.

Maxilliped II (Fig. 3,h): First and fourth segment of endopod with one small seta each on the inner side, distal segment with 5 spines of which 2 are small;

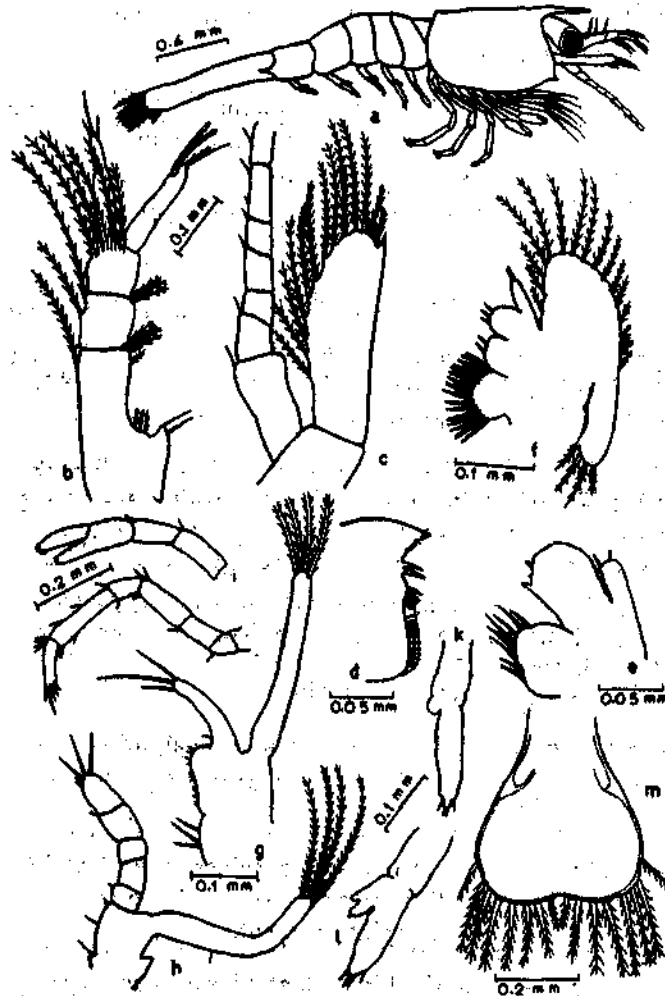


FIG. 3. *Caridina* sp. Zoea II. a — lateral view, b — antennule, c — antenna, d — mandible, e — maxillule, f — maxilla, g — first maxilliped, h — second maxilliped, i — first pereopod, j — fifth pereopod, k — first pleopod, l — third pleopod, m — telson.

other characters almost same as previous stage except for the presence of a small epipod.

Pereiopods (Fig. 3,i,j): First and second pereiopods (Fig. 3,i) chelate; chela well developed and bears minute denticle at tip; third to fifth pereiopod almost identical; dactylus of 5th pereiopod (Fig. 3,j) with one large and 4 small spines at distal end.

Pleopods: Endopod of first pleopod (Fig. 3,k) bud-like; exopod longer and finger-like with 2 apical and 2 subapical setae; pleopods 2-5 (Fig. 3,l) identical, possessing appendix interna.

Telson (Fig. 3,m): With 8 + 8 spines, innermost pair of spines shortest; outermost spines with setules on inner margin only; outlines of developing uropods discernible at the base of the telson. In one of the specimens, telson had 8+1+8 spines, median one being the shortest.

Zoea III (Fig. 4, a-o): Total length, 2.74 mm; Carapace length, 0.78 mm.

In this stage, the larva develops for the first time a dorsal tooth on the rostrum, characteristic tuft of hairs at tip of chelae, long plumose setae on pleopods and well-developed uropods. Carapace with pterygostomian and branchiostegal spines (Fig. 4,a).

Antennule (Fig. 4,b): Stylocerite further enlarges; outer flagellum 2-segmented, distal segment twice as long as proximal with 2 aesthetes on the inner side and tipped with 4 setae; inner flagellum 4-segmented, last segment carries 4 apical setae.

Antenna (Fig. 4,c): Except for increase of setae on scale and segments on endopod, no appreciable change from that of previous stage.

Mandible (Fig. 4,d): Number of teeth increases.

Maxillule (Fig. 4,e): Number of spines on maxillular lobes increases.

Maxilla (Fig. 4,f): Endites with several setae; endopod further reduced in size and much shorter than distal endite; scaphognathite broader anteriorly and bears 19 setae along upper margin, posterior region narrow and possesses 6 setae, of which one very much longer than others.

Maxilliped I (Fig. 4,g): Protopod very conspicuous, with several setae on inner margin; endopod smaller and devoid of any setae; exopod slender and curved inwards.

Maxilliped II (Fig. 4,h): Endopod 5-segmented, last two segments flat, bent inwards, fifth segment with several setae on inner margin; endopod finger-shaped; epipod increases in size.

Maxilliped III (Fig. 4,i): Endopod 5-segmented, third segment longest, fourth with 3 setae on the inner margin and 2 pairs of setae near the upper joint; distal segment ending in a claw-like spine and 2 subapical setae; exopod shorter than endopod, slender and with 4 terminal setae; rudimentary epipod present.

Pereiopods: Of the 2 chelipeds (Fig. 4,j,k), first is short and stout; chela bears tufts of hair at tip; third to fifth pereiopods (Fig. 4,l) same as in previous stage.

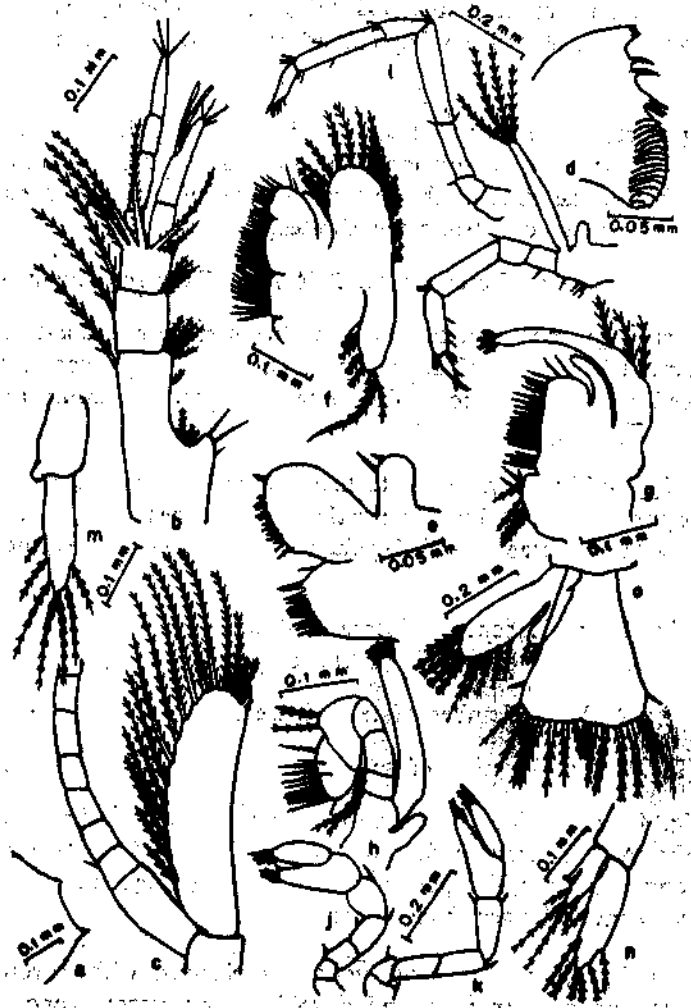


FIG. 4. *Caridina* sp. Zoea III. a — anterior tip of carapace, b — antennule, c — antenna, d — mandible, e — maxillule, f — maxilla, g — first maxilliped, h — second maxilliped, i — third maxilliped, j — first pereiopod, k — second pereiopod, l — third pereiopod, m — first pleopod, n — fourth pleopod, o — telson and uropod.

Pleopods (Fig. 4,m,n): Exopods of pleopods 1 to 4 with 7 plumose setae and that of 5th with 6 plumose setae; similarly, endopod of pleopods 2 to 4 each with 4 setae and that of 5th with 3 setae; appendix interna on pleopods 2 and 3 with a pair of hooks, that on 4th only a single hook and that on 5th none.

Telson (Fig. 4,o): Separated from 6th abdominal somite, narrower anteriorly and broader posteriorly; posterior margin nearly straight, bears 8 spines on each side, 7 plumose and placed on the posterior margin and one nonplumose on the lateral margin.

Uropods: Exopod long with 10 setae and a small spine on outer posterolateral corner; endopod with 2 apical setae.

DISCUSSION

Intra- and inter-specific variations in the larval development of the shrimps of the family Atyidae are well known. Most of the species have an abbreviated larval development which is common among the freshwater and brackishwater species. However, the number of stages recognized varies from species to species, the maximum being 8, in *Paratya compressa* (Yokoya 1931) and minimum, 5, in *Caridina nilotica* (Gurney 1927) and *Caridina denticulata* (Shen 1939). Although the present series is incomplete, the general organization of the relatively advanced morphological features of third zoeal stage suggests that the larval development of the species may be completed in 5 or 6 stages.

The pattern of development of the larvae of the present species of *Caridina* is almost similar to those of *C. wyckii* (Daday 1907), *C. nilotica* (Gurney 1927), *C. laevis* (Nair 1949) and *C. propinqua* (Babu 1963). But it is less advanced than that of *C. denticulata* described by Shen (1939). In the characters such as absence of spines on carapace and rostrum, and sessile nature of eye, zoea I of the present species agrees with the corresponding larval stage of *C. nilotica* (Gurney 1927) and *C. laevis* (Nair 1949). But it differs from these species in having uniramous pereopods. In telsonic armature, the species resembles *C. laevis* and *C. denticulata*. The biramous pleopods on the first 5 abdominal segments are developed both in *Caridina* sp. and *C. denticulata*, while it is uniramous in the case of *C. laevis* and completely absent in the other species. In *C. denticulata*, the appendix interna appears in the 1st zoea stage itself, but, in *Caridina* sp. it develops only in zoea II. In second zoea of all the species, eyes acquire stalks and telson possesses 8+8 spines. Similarly, the uropods develop in all the species except *C. denticulata* in the third stage. A general comparison of the various morphological features of the zoea larvae of the present species with the corresponding larvae of other species of the genus reveals that the larval development of the present form is intermediate between the highly advanced development observed in *C. denticulata* and the less advanced larvae of other species.

Although, the adult *Caridina* generally inhabits the freshwater regions, they also occur in the brackishwaters (de Man 1908, Johnson 1961, Mohamed and Rao 1971). The larvae of these species that are so far described are obtained either from the freshwater areas or reared in the freshwater medium. Gurney (1927) reports that the larvae of *C. nilotica* which are carried out into Lake Timsah along with the outflow from their natural habitat in the freshwater lagoons of Ismailia are killed by the salt water of the lake. This indicates that the larvae of this species cannot withstand the salinity of the lake waters. In this connection, it is interesting to note that the present specimen has been obtained from the low-saline waters (18.4‰) in the inshore sea of Cochin and the larvae have been successfully reared in the brackishwater medium, the salinity of which was 16-17‰. Perhaps the specimen might have been brought into the sea by the tidal flow from the Pampa and Periyar river systems.

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