

**LARVAL DEVELOPMENT OF *LEANDRITES CELEBENSIS* (DE MAN)  
(DECAPODA : PALAEMONIDAE), REARED IN THE LABORATORY**

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ABSTRACT

Early larval history of *Leandrites celebensis* (de Man), is described as a result of rearing the larvae obtained by laboratory spawning of berried females collected from tow-net operations. Zoea I, passed through 7 to 8 moults, to become post-larva I, within a period of 13-21 days. 7 well defined zoeal stages were described. Larvae were reared in a salinity range of 20 to 25‰. They were fed by freshly hatched *Artemia* nauplii.

INTRODUCTION

*LEANDRITES CELEBENSIS* (DE MAN), is a small brackish water shrimp growing up to 30 mm, in size, occurring in large numbers in Cochin backwaters during the period July to December. It was first described as *Leander celebensis* by de Man (1881) but Holthuis (1950) accommodated it under his new genus *Leandrites* and described it as *Leandrites celebensis*. Kemp (1925) recorded this species from Indian waters (Cochin and Tuticorin) and Nataraj (1942) has reported it from Vembanad Lake near Cochin as *Palaemonetes hornelli*. Pillai (1955) described an advanced post-larval stage of this shrimp from the plankton collections of Travancore Coast. A detailed study of the larval development of this species was undertaken by the present author and the results are presented here.

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MATERIAL AND METHODS

Ovigerous females of *Leandrites celebensis* were collected from Cochin Backwaters during July-December 1972 using experimental tow-nets. Females (TL-24-27 mm ; number of fertilized eggs on pleopods 426-596 ; size of eggs 0.45-0.66 mm along the long axis) with advanced stage of berry were sorted out and kept in six-litre glass troughs containing brackish water having a salinity range 20-25‰. Adults were fed on finely chopped and washed prawn meat once a day and excess food materials were removed after two hours.

The larvae were reared in the same salinity range in one litre beakers, each of which carried about 75 larvae. At a time five sets of rearing experiments were conducted. Larvae were fed by freshly hatched *Artemia* nauplii from zoea I onwards.

Larvae in each stage were preserved in 5% formalin. Measurements and camera lucida drawings were made from preserved larvae. Total length of the larvae was measured from the tip of the rostrum to the tip of the telson (excluding terminal spine). Carapace length includes rostrum also and was taken from the tip of the rostrum to the posterior margin of the mid dorsal region of the carapace.

Following abbreviations are used for describing the larvae:  $A_1$ —antennule;  $A_2$ —antenna; Md—mandible;  $Mx_1$ —maxillule;  $Mx_2$ —maxilla;  $Mxp_1$ —maxilliped I;  $Mxp_2$ —maxilliped II;  $Mxp_3$ —maxilliped III;  $P_1$ —pereopod I;  $P_2$ —pereopod II;  $P_3$ —pereopod III;  $P_4$ —pereopod IV;  $P_5$ —pereopod V; T—telson; TL—total length; CL—carapace length.

## RESULTS

Hatching took place during the early morning hours. Zoea I moulted to the next stage, 24 hours after hatching. From zoea II onwards its larvae took 2 to 3 days for every moult. Zoea I moulted 7 to 8 times before metamorphosing into post-larva I within a period of 13 to 21 days. As the survival rate was 1 to 2% from zoea III onwards, a number of rearing experiments were conducted separately to collect all the zoeal stages.

### DESCRIPTION OF LARVAL STAGES

*Zoea I* (Fig. 1 a-k): TL—1.7-1.8 mm (1.8 mm)\*; CL—0.5-0.6 mm (0.5 mm)\*. Number of larvae examined: 8.

Rostrum slender, pointed, reaching  $\frac{2}{3}$  length of antennular peduncle; carapace smooth, antero-lateral edge slightly produced; eyes large and sessile; antennule, antenna and mouth parts developed; biramous buds of first two pereopods developed; telson not separated from 6th abdominal segment.

$A_1$  (Fig. 1 b): uniramous; peduncle unsegmented, more than four times the length of outer flagellum, carrying distally 2 flagella; outer flagellum rectangular carrying one aesthetes, 3 long slender setae, and one short plumose seta, inner flagellum long and plumose.  $A_2$  (Fig. 1 c): scale 4-segmented distally, bearing 9 plumose and 2 non-plumose setae at its distal and lateral margins; flagellum long, shorter than scale, carrying at its apex one short spine and one long plumose seta. Md (Fig. 1 d): slightly asymmetrical; incisor process with 3 stout teeth; molar with 3-4 bristle-like teeth; one serrated movable tooth and a slender one in between the two processes.  $Mx_1$  (Fig. 1 e): uniramous; palp with 2 long setae at its apex; distal lacinia with 5 teeth, 2 of which are stout and setose; proximal lacinia with 4 terminal teeth and one lateral seta.  $Mx_2$  (Fig. 1 f): biramous; protopod with 3 masticatory processes, distal process with 4 and proximal 2 processes with 2 setae

\* Average size is given in brackets.

respectively; endopod terminates in a seta; exopod with 5 plumose setae along its margin, hindermost being longest.  $Mxp_1$  (Fig. 1 g): biramous; basipod with 8-9 setae on the inner margin; endopod unsegmented, reaching 2/3rd length of exopod, bearing 3 long apical and 3 short lateral setae; exopod with 4 long plumose setae terminally.  $Mxp_2$  (Fig. 1 h): biramous; basis with 2 small setae and a stout spine; endopod 3-segmented, disto-lateral aspect of 2nd segment with one seta and 2 spines, terminal segment with a claw and 3 short setae; exopod long with 4 long apical and 2 short sub-apical plumose setae.  $Mxp_3$  (Fig. 1 i): biramous; basis with one spine and 2 short setae; endopod 3-segmented, one small seta and a spine on the inner side of 1st segment, 2 long movable spines present on the inner disto-lateral aspect of 2nd segment, terminal segment with 2 spines; exopod long with 4 long plumose apical and 2 short plumose sub-apical setae. T (Fig. 1 j): broad, concave posteriorly carrying 7 spines on either side, outermost 2 spines on each side setose only on the inner side.

*Zoea II* (Fig. 2 a-m): TL—1.8-2.0 mm (1.9 mm); CL—0.5-0.6 mm (0.6 mm).  
Number of larvae examined: 8.

The characteristic features of the larvae are the stalked eye, anterolateral angle of the carapace produced to form a pterygostomial spine which is slightly pointed downwards (Fig. 2 b), development of first two pereopods, uniramous bud of 5th pereopod and a pair of prominent lateral spines on 5th abdominal segment.

$A_1$  (Fig. 2 c): peduncle 2-segmented, proximal segment with 3 plumose setae on outer distal aspect, a rounded prominence bearing 2 short plumose setae on dorsal side on distal segment, behind outer flagellum; outer flagellum with 2 aesthetes and 2 long slender setae. Md (Fig. 2 e): incisor process with 3-4 stout teeth; molar with 5 stout bristle-like teeth; one movable and serrated tooth and two long slender ones in between the two processes.  $Mx_1$  (Fig. 2 f): distal lacinia with 7 teeth.  $Mx_2$  (Fig. 2 g): exopod with 7 plumose setae along its margin; 2 setae on proximal masticatory process setose.  $Mxp_1$  (Fig. 2 i): basis with 2 spines and 2 small setae.  $Mxp_2$  (Fig. 2 j): endopod 4-segmented, 3rd segment with one long spine and 2 setae, terminal segment with 2 spines and 2 setae.  $P_1$  (Fig. 2 k): biramous; basis with a short seta; endopod 4-segmented, 1st segment with a stout seta on the inner side, 2nd segment with a short seta on outer side, 3rd segment carrying 2 long movable spines on inner disto-lateral aspect of segment, one of which serrated, terminal segment ends in a claw; exopod as long as 1st segment of endopod with 4 long apical and 2 short sub-apical plumose setae.  $P_2$  (Fig. 2 l): same as  $P_1$  but seta on inner side of 1st segment of endopod comparatively small in  $P_2$ . T (Fig. 2 m): 8 spines on either side of broad concave posterior margin, outermost spine on either side setose only on one side, innermost spine is smallest.

*Zoea III* (Fig. 3 a-m): TL—2.1-2.2 mm (2.2 mm); CL—0.6 mm. Number of larvae examined: 5.

Rostrum with an epigastric tooth; telson distinctly separated from last abdominal segment by an articulating joint; uropods developed with bare endopods.

$A_1$  (Fig. 3 b): peduncle 2-segmented; proximal segment with a long plumose seta on inner distal region and 2 short plumose setae on outer distal region, outer margin with 4 short plumose setae 2 of which are in middle, distal segment with 2 long plumose setae on ventral side and 4 short plumose setae on a prominence on

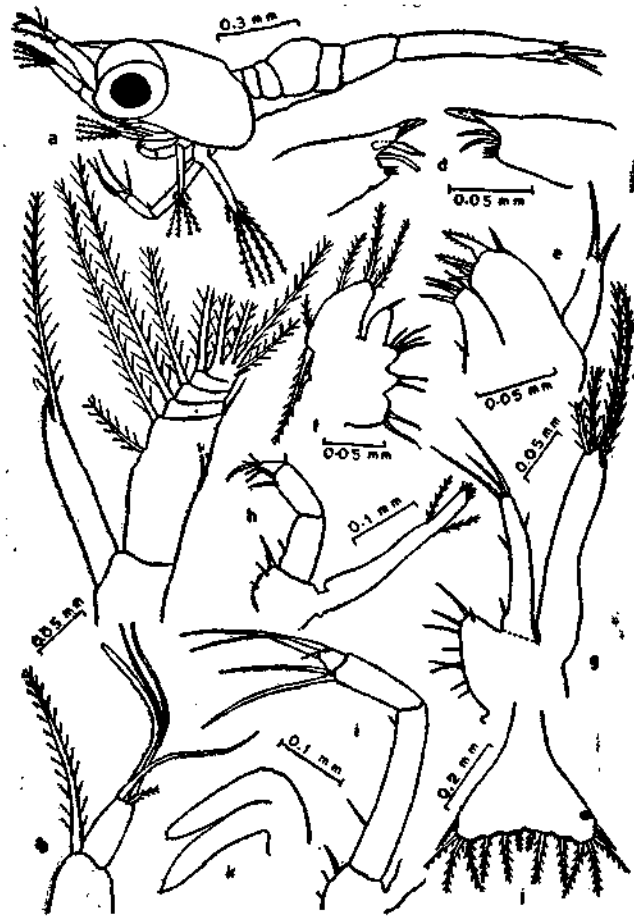


Fig. 1. *L. celebensis*-Zoea I: a. lateral view, b. tip of antennule, c. antenna, d. mandible, e. maxillule, f. maxilla, g. maxilliped I, h. maxilliped II, i. maxilliped III, j. telson and k. bud of pereopod I.

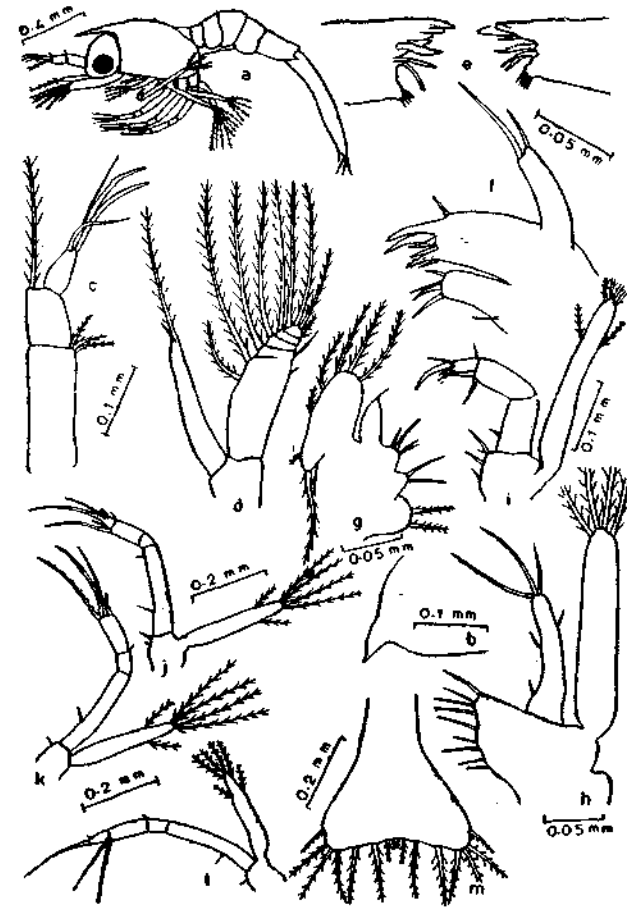


Fig. 2. *L. celebensis*-Zoea II: a. lateral view, b. anterolateral part of carapace, c. antennule (ventral view), d. antenna, e. mandible, f. maxillule, g. maxilla, h. maxilliped I, i. maxilliped II, j. maxilliped III, k. pereopod I, l. pereopod II and m. telson.



Fig. 3. *L. celebensis*-Zoea III: a. lateral view, b. antennule, c. antenna, d. mandible, e. maxillule, f. maxilla, g. maxilliped I, h. maxilliped II, i. maxilliped III, j. pereopod I, k. pereopod II, l. bud of pereopod V and m. uropod and telson.

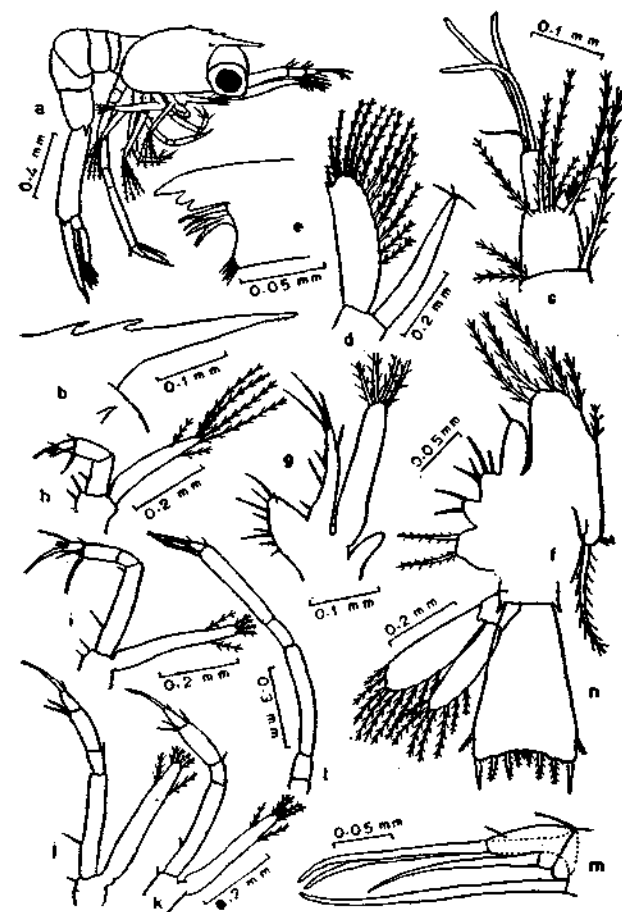


Fig. 4. *L. celebensis*-Zoea IV: a. lateral view, b. rostrum, c. tip of antennule, d. antenna, e. mandible, f. maxilla, g. maxilliped I, h. maxilliped II, i. maxilliped III, j. pereopod I, k. pereopod II, l. pereopod V, m. dactylus of pereopod V, n. uropod and telson.

dorsal side; outer flagellum with 3 aesthetes and one short seta; inner flagellum is like a small papilla.  $A_2$  (Fig. 3 c): scale partially segmented distally with 10 long plumose and 2 short non-plumose setae along distal and lateral margins; flagellum shorter than scale carrying 2 slender setae terminally.  $P_2$  (Fig. 3 k): same as in previous stage except for presence of 3 long spines on 3rd joint of endopod. Uniramous bud of  $P_5$  (Fig. 3 l) developed. T (Fig. 3 m): separated from last abdominal segment by an articulating joint, carrying 8 spines on each side of concave posterior margin, outermost and innermost spines non-setose; uropod biramous; exopod with 6 long plumose setae; endopod bare.

*Zoea IV* (Fig. 4 a-n): TL—2.5-2.7 mm (2.6 mm); CL—0.7 mm. Number of larvae examined: 2.

Rostrum with 2 dorsal teeth, tip of rostrum as well as inner side of rostral teeth serrated (Fig. 4 b); carapace with supra-orbital and pterygostomial spines; 5th pereopod developed and is the longest appendage of the larvae; biramous bud of 3rd pereopod and uniramous bud of 4th pereopod developed; endopod of uropod with plumose setae.

$A_1$  (Fig. 4 c): proximal segment of peduncle with 4 plumose setae at outer middle region and 2 short plumose and 2 long slender setae at outer basal prominence, inner side of proximal segment with 3 long plumose setae; distal segment with 4 long plumose setae on one side and 4 short plumose setae on a prominence on outer side; outer flagellum with 3 aesthetes and one seta; inner flagellum small and short.  $A_2$  (Fig. 4 d): scale not segmented distally, with a spine and 14 long plumose setae, one short non-plumose seta; flagellum as long as the scale with 3 setae terminally one of which is very small. Md (Fig. 4 e): incisor with 3-4 stout teeth; molar with 5-7 slender teeth; 3-4 long teeth in between two processes, of which one is serrated.  $Mx_2$  (Fig. 4 f): proximal masticatory process with 2 long plumose setae, exopod with 8 plumose setae along margin.  $Mxp_1$  (Fig. 4 g): endopod with 3 long terminal setae, laterally 4 setae present of which middle one on inner side longest; epipod buds developed.  $P_1$  (Fig. 4 j): endopod 4-segmented, 1st segment with a stout seta on inner side, 2nd segment with a small seta on outer side, 3rd segment with 2 setae on inner distal region and terminal segment ends in a claw and a short seta.  $P_2$  (Fig. 4 k): same as  $P_1$  except for presence of 3 setae on 3rd segment of endopod, seta on inner side of 1st segment just half size of seta on  $P_1$ .  $P_5$  (Fig. 4 l): uniramous; long and reaching beyond eye; endopod 5-segmented, distal part of propodus with 2 long spines and a short seta; in addition to terminal long spine, dactylus carries one short seta on outer side and one long spine on inner side (Fig. 4 m). T: narrower than in previous stage, carrying one lateral and 5 terminal spines on either side, outermost spines longest on both sides and non-setose. Exopod and endopod of uropod (Fig. 4 n) with 9 and 7 plumose setae respectively.

*Zoea V* (Fig. 5 a-j): TL—2.8-3.0 mm (2.9 mm); CL—0.8 mm. Number of larvae examined: 2.

Rudimentary chela seen in 1st and 2nd pereopods; biramous bud of 3rd pereopod and uniramous bud of 4th pereopod (Fig. 5 g) developed; uniramous buds of pleopods on all abdominal segments (Fig. 5 a); telson rectangular.

$A_1$  (Fig. 5 b): proximal segment of peduncle on outer side with 3 short plumose setae anteriorly, 4 near middle and 3 short plumose and 3 long slender

setae on stylocerite, distal segment with 5 long plumose setae on ventral side; inner flagellum finger-shaped, almost half length of outer flagellum, which carries 3 aesthetes and one seta.  $A_2$  (Fig. 5 c): scale with 17 plumose setae and one spine; flagellum longer than scale and 4-segmented with 2 small terminal setae 3rd segment longest. Md: same as in previous stage except for presence, of 4-5 long teeth in between incisor and molar processes, of which two are serrated.  $Mx_2$ : exopod with 10 plumose setae along margin.  $Mxp_1$ : epipod bilobed.  $Mxp_2$  (Fig. 5 d): basis with 2-3 setae, 1st segment of endopod with a spine and seta on inner side, 3rd segment with 3 setae, 2 of which are at inner disto-lateral region.  $P_1$  (Fig. 5 e) and  $P_2$  (Fig. 5 f): are almost identical but  $P_1$  can easily be distinguished by longer seta on inner side of 1st segment of endopod, disto-lateral part of 3rd segment slightly protruded indicating developing fingers of chela, this protuberance carries 2 slender setae at its distal end, terminal segment ends in a claw and a small seta; exopod of uropod (Fig. 5 i) with 12 plumose setae and a spine, endopod with 10 plumose setae.

*Zoea VI* (Fig. 5 k-n; 6 a-l): TL—3.4-3.7 mm (3.6 mm); CL—1.0 mm. Number of larvae examined: 4.

Chela of 1st and 2nd pereopods further developed; 3rd and 4th pereopods developed; telson narrower posteriorly.

$A_1$  (Fig. 6 a): a circlet of plumose setae developed towards middle of proximal segment of peduncle, stylocerite with 3 short plumose and 5 long slender, non-plumose setae, distal segment carries 5 short plumose setae on a prominence on dorsal side, and 5 long plumose setae on ventral side, outer flagellum carries a small seta on finger-shaped prominence, towards inner side of outer flagellum 3 aesthetes present, inner flagellum finger-shaped and smaller than the outer.  $A_2$  (Fig. 6 b): scale with 18 plumose setae and a spine.  $Mx_1$  (Fig. 5 m): distal lacinia with 8 teeth of which 3 are stout and setose.  $Mx_2$  (Fig. 6 c): exopod with 12 plumose setae along its margin, 3 of which are in hinder most region.  $Mxp_1$  (Fig. 6 d): endopod with 3 long terminal setae, of 3 long setae on inner side, middle one is longest; bi-lobed epipod developed.  $Mxp_2$  (Fig. 6 f): same as in the previous stage except for presence of a short seta on outer side of 2nd segment of endopod.  $P_1$  (Fig. 6 g),  $P_2$  (Fig. 6 h): chela further developed, fingers of chela almost of same size.  $P_3$  (Fig. 6 i): biramous; endopod 4-segmented, 2nd and 3rd segments with one and 3 small setae respectively, terminal segment with a spine and a small seta; exopod carrying 4 long apical and 2 short sub-apical plumose setae and as long as first segment of endopod.  $P_4$  (Fig. 6 j): uniramous; endopod 4-segmented, 1st segment with a small seta on outer margin, terminal segment with a spine and small seta. Pleopod buds biramous but bare. T: longer than uropod, narrower posteriorly, with one lateral and 5 terminal spines on either side, outermost and innermost terminal spines on either side non-setose (Fig. 6 l). Exopod of uropod with one spine and 16 plumose setae and endopod with 13 plumose setae.

In the course of the experiments, a single zoea, showing some intermediate characters of 5th and 6th zoeal stages was found after the fifth moult. TL and CL of this zoea were 2.99 and 0.88 mm respectively. Antenna, mouth parts, 1st, 2nd and 5th pereopods resembled those of zoea VI. As in zoea V, uniramous buds of pleopods were present on abdominal segments. 3rd pereopod was well developed and uniramous bud of 4th pereopod present. Telson carried 2 small lateral and 5 terminal spines on either side, in contrast to the single lateral and 5 terminal spines of zoea V and VI.

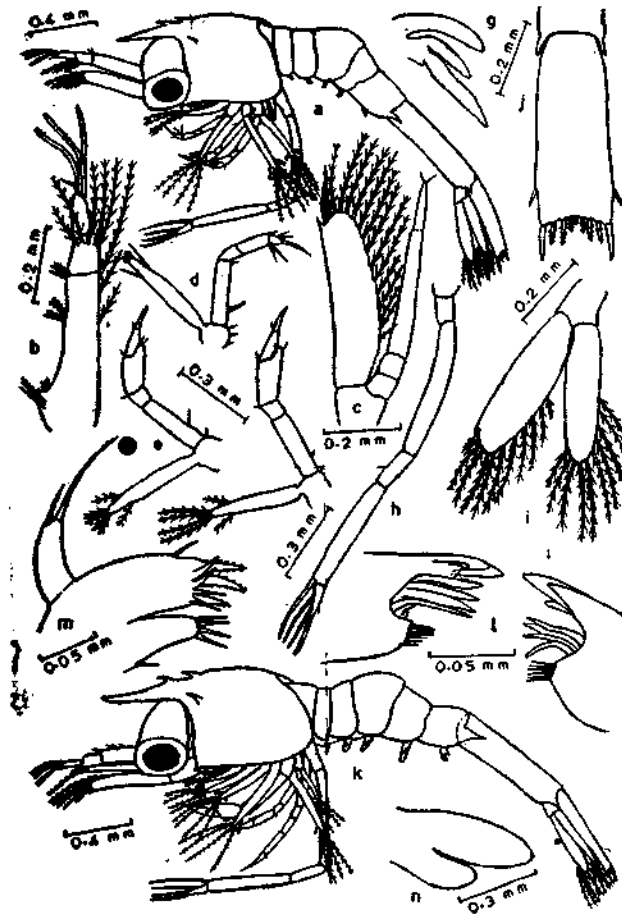


Fig. 5. *L. celebensis*-Zoea V: a. lateral view, b. antennule, c. antenna, d. maxilliped III, e. pereopod I, f. pereopod II, g. bud of pereopod III and IV, h. pereopod V, i. uropod, j. telson. Zoea VI: k. lateral view, l. mandible, m. maxillule and n. pleopod IV.

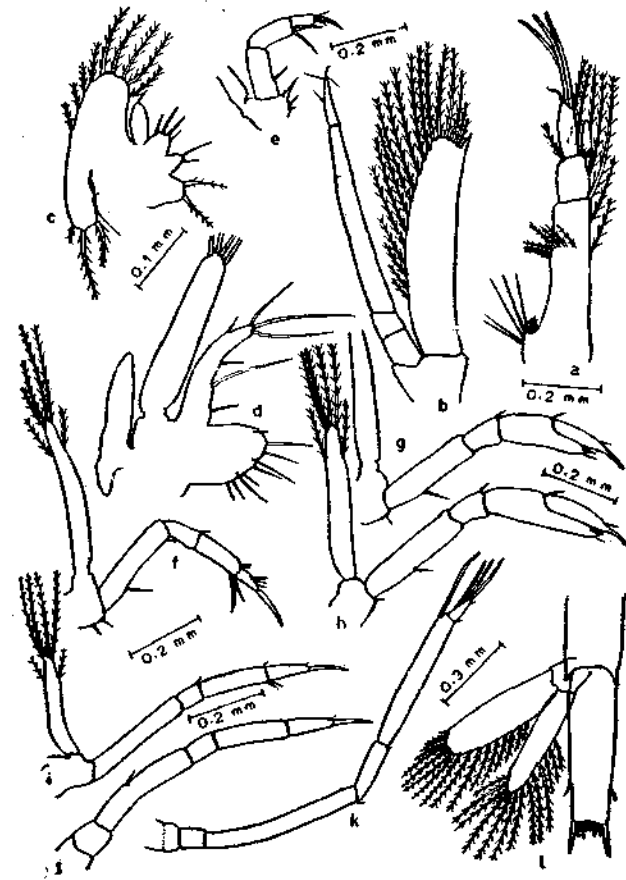


Fig. 6. *L. celebensis*-Zoea VI: a. antennule, b. antenna, c. maxilla, d. maxilliped I, e. maxilliped II, f. maxilliped III, g. pereopod I, h. pereopod II, i. pereopod III, j. pereopod IV, k. pereopod V and l. uropod and telson.



*Zoea VII* (Fig. 7 a-k): TL—4.2 mm; CL—1.2 mm. Number of larvae examined: 1.

2nd pereopod stouter and longer than the 1st. Pleopods non-setose but well developed, appendix interna present on the endopod of 2nd to 4th pleopods.

$A_1$  (Fig. 7 a): number of plumose setae on proximal segment increased, stylocerite with 3 short plumose and 7 long slender non-plumose setae, depression to hold eye well developed.  $A_2$  (Fig. 7 b): scale with 21 plumose setae and one spine, flagellum 6-segmented distal segment with 3 setae. Md (Fig. 7 c): 4-5 teeth present in between incisor and molar processes, of which 3-4 are serrated.  $Mx_2$  (Fig. 7 d): protopod with 3 masticatory processes, distal process with 3 and proximal 2 processes with 2 setae each, setae on proximal process long and plumose, exopod with 14 plumose setae of which 4 are at hinder most region.  $P_1$  (Fig. 7 e),  $P_2$  (Fig. 7 f): chela well developed,  $P_2$  longer and stouter than  $P_1$ ;  $P_3$ : endopod 4-segmented, 1st and 2nd segments with one seta on outer side, 3rd segment with 3 setae at distal end, last segment ends in a spine, exopod smaller than 1st segment of endopod bearing 4 apical and 2 sub-apical plumose setae; pleopods are bare but well developed, endopod of 2nd to 4th pleopods with appendix interna (Fig. 7 g, h, i). T: narrower posteriorly with 4 spines on either side, outermost spine longest and non-setose, one spine each on lateral side of telson. Exopod of uropod with one spine and 18 plumose setae, endopod with 16 plumose setae (Fig. 7 j).

*Post-larva I* (Fig. 7 l-o; 8 a-j; 9 a-c): TL—4.2 mm; CL—1.4 mm. Number of larvae examined: 1.

Larvae acquire a bottom-living habit and freely move about the bottom of the container using walking legs; rostrum with 9 dorsal teeth and a single ventral tooth, carapace with pterygostomial and branchiostegal spines; exopods on 1st to 3rd pereopods have become rudimentary; exopod and endopod of pleopods setose and endopod of pleopod 2 to 5 with appendix interna.

$A_1$  (Fig. 8 b): peduncle 3-segmented, proximal segment longest, with a spine at outer antero-lateral aspect, statocyst developed; outer flagellum with 2 branches, outer branch 2-segmented, inner branch with 4 aesthetes in 2 groups of 3 and, inner flagellum 3-segmented.  $A_2$ : scale with 26 plumose setae and one spine; flagellum segmented and 7 times the length of scale, basal segment of flagellum with a circle of setae. Md (Fig. 8 c): acquire shape of Md of adult; incisor and molar processes are distinctly separated; incisor ending in 3 stout teeth, molar with 5 stout short teeth.  $Mx_1$  (Fig. 8 d): palp without setae; distal lacinia with 9 teeth; 9-12 slender teeth present all round distal part of proximal lacinia.  $Mx_2$  (Fig. 8 e): considerable change is noticed from previous stage; basis with 2 endites, proximal and distal endites with 3 and 4 bristle like setae; endopod bare; 28 plumose setae around margin of exopod.  $Mxp_1$ : number of setae on inner side of basis increased; endopod with a single plumose seta on inner side; base of exopod slightly expanded bearing 3 long plumose setae at outer margin, terminally exopod has 4 long plumose setae, outer most setae on either side smaller than inner; bilobed epipod present.  $Mxp_2$  (Fig. 8 f): basipod with a seta on inner side; endopod 4-segmented, 1st segment shows an indistinct segmentation in middle, last two segments with several setae; exopod with 4 long apical and 2 short sub-apical plumose setae; bilobed epipod present.  $Mxp_3$  (Fig. 8 g): endopod 3-segmented, profusely setose on inner side; exopod as long as 1st segment of endopod with 4 apical and 2 sub-apical plumose setae.  $P_1$  (Fig. 8 h):

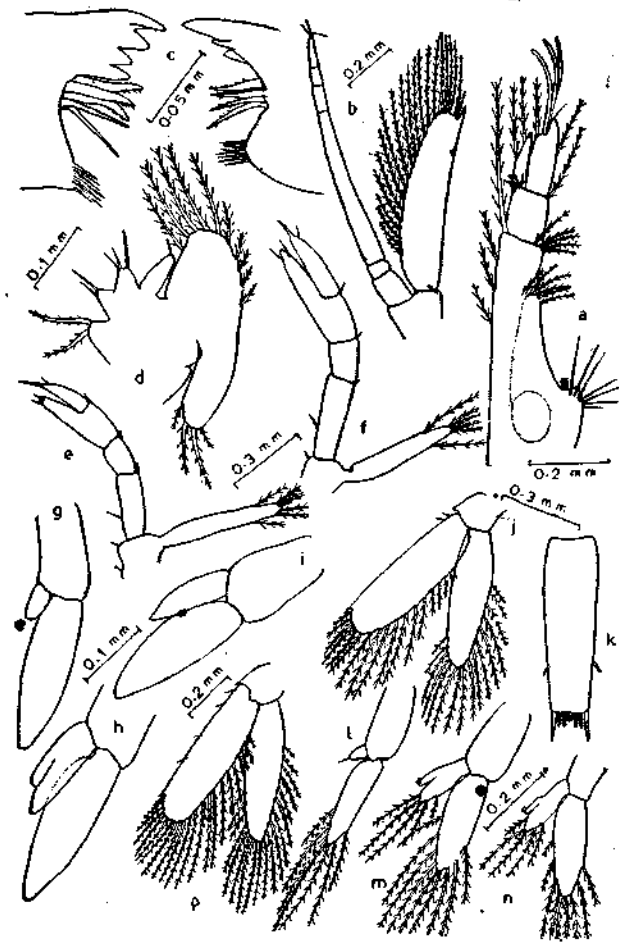


Fig. 7. *L. celebensis*-Zoea VII: a. antennule, b. antenna, c. mandible, d. maxilla, e. pereiopod I, f. pereiopod II, g. pleopod I, h. pleopod II, i. pleopod V, j. uropod, k. telson; Post larva I: l. pleopod I, m. pleopod III, n. pleopod V and o. uropod.

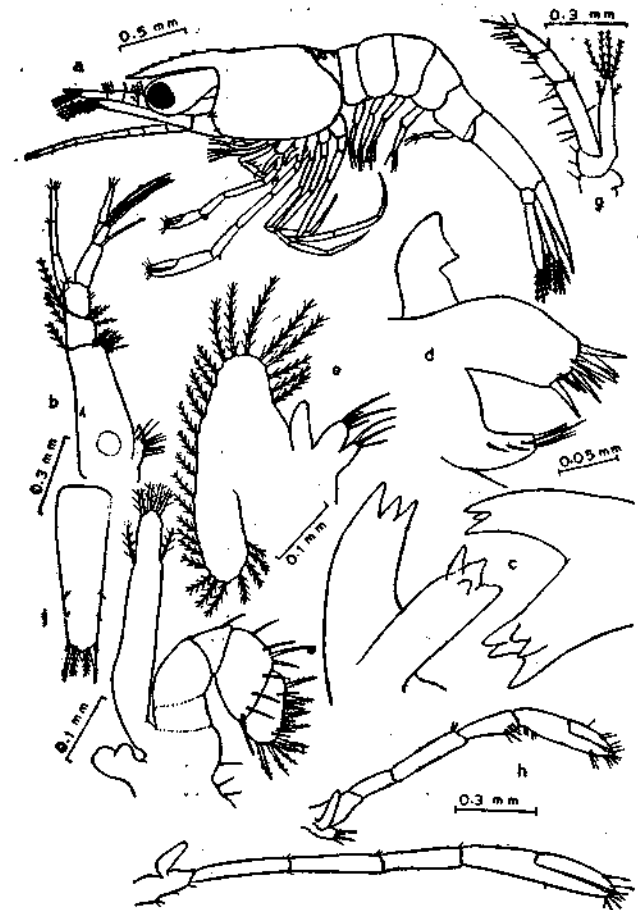


Fig. 8. *L. celebensis* Post-larva I: a. lateral view, b. antennule, c. mandible, d. maxillule e. maxilla, f. maxilliped II, g. maxilliped III, h. pereiopod I, i. pereiopod II and j. telson.

endopod 5-segmented, fingers of chela terminate a small claw surrounded by bristle-like setae, disto-lateral aspect of 3rd segment and inner lateral aspect of 4th segment with several small stout setae; rudimentary exopod present.  $P_2$  (Fig. 8 i): longer and stouter than  $P_1$ ; endopod 5-segmented, fingers of chela terminate in a small claw surrounded by bristle-like setae; rudimentary exopod present.  $P_3$  (Fig. 9 a): endopod 5-segmented, dactylus terminates in a long spine; rudimentary exopod present.  $P_4$  and  $P_5$  (Fig. 9 b, c): almost identical with 5-segmented endopod, distal segment ending in a long spine; exopod and endopod of pleopods with plumose setae; endopod of pleopod 1 (Fig. 7 l) small with a single seta; endopod of pleopods 2nd to 5th (Fig. 7 m, n) with appendix interna, which has got 2 curved small hooks on subapical region. T (Fig. 8 j): posterior margin convex with a single stout plumose seta and 2 spines on either side, outermost spine is smaller, 2 lateral spines on either side slightly shifted towards dorsal aspect of telson. Exopod of uropod with 22 plumose setae and 2 spines of which one is movable; endopod with 19 plumose setae (Fig. 7 o).

*Post-larva II* (Fig. 9 d-l): TL—4.6 mm; CL—1.6 mm. Number of larvae examined: 1.

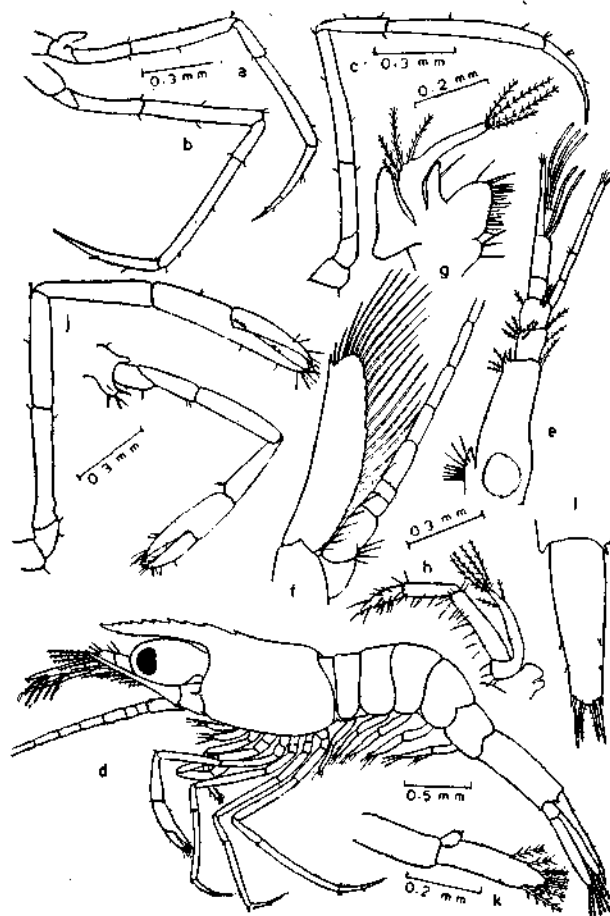


Fig. 9. *L. celebensis*-Post-larva I: a. pereiopod III, b. pereiopod IV, c. pereiopod V. Post-larva II: d. lateral view, e. antennule, f. antenna, g. maxilliped I, h. maxilliped III, i. pereiopod I, j. pereiopod II, k. pleopod I and l. telson.

Rostrum with 9 dorsal and 2 ventral teeth ; no exopods on pereopods.

A<sub>1</sub> (Fig. 9 e) : inner branch of outer flagellum with 5 aesthetes in two groups of 3 and 2 ; inner flagellum 4-segmented. A<sub>2</sub> (Fig. 9 f) : scale with 26 plumose setae and one spine. Mx<sub>1</sub> : palp terminates in 2 small protuberances one of which with a small seta, number of teeth on lacinia increased. Mxp<sub>1</sub> (Fig. 9 g) : same as in previous stage except for presence of 4 plumose setae at base of exopod. Number of setae on exopod and endopod of pleopods increased (Fig. 9 k). Exopod of uropod with 24 plumose setae and 2 spines of which one is movable ; endopod with 21 plumose setae.

#### DISCUSSION

The first three zoeal stages of *Leandrites celebensis* closely resemble the equivalent stages of other palaemonid shrimps having protracted life history. First zoea in all these forms are characterised by the sessile eyes, fully developed maxillipeds with functional exopods and with 7 spines on either side of the broad concave posterior margin of the telson which is not separated from the 6th abdominal segment as also noticed by Menon (1940). But the first zoea of *L. celebensis* can easily be distinguished by the conspicuous endopod of 3rd maxilliped in which the movable spines on the penultimate segment function like a prehensile organ. The development of supra-orbital spine, stalked eye, first and second pereopods, lateral spine on the 5th abdominal segment and an extra spine on either side of telson are the chief characteristics of the zoea II of all these forms. The absence of supra-orbital spines in *L. celebensis* is perhaps a specific character which is not shared with other species of the group. The epigastric tooth and the uropod appear in the 3rd stage when telson gets separated from the last abdominal segment with an articulating joint. In zoea III of *Macrobrachium* spp. (Uno and Kwon, 1969 ; Pillai and Mohamed, 1973) and *Leptocarpus potamiscus* (Pillai, 1973) the biramous buds of third pereopod and uniramous buds of fifth pereopods are developed whereas in *L. celebensis* only the latter has developed in the 3rd stage. From zoea IV onwards there is only very little similarity between the corresponding zoeal stages of these species. With the development of fifth pereopod in zoea IV, the prehensile function which was hitherto carried out by other limbs is completely taken over by this appendage. Consequently the spines on the terminal segments of other limbs show reduction in size and mobility. Till the zoea metamorphoses into the post-larva I, this prehensile function of fifth pereopod continues.

In the course of the experiments, a zoea obtained after the fifth moult showed certain intermediate characters of 5th and 6th stages. Although the characters of this zoea showed certain deviation, it cannot be considered as a separate stage as some of its characters are not in the usual pattern of development. The presence of 2 lateral spines on either side of telson of this zoea is only an abnormal condition as only one spine is observed in all stages of normal development of this species. Such deviations and abnormal characters in larval development stages are observed by Provenzano and Dobkin (1962) in *Tozeuma carolinensis* and Pillai and Mohamed (1971) in *Macrobrachium idella*. Again, different developmental rates among decapod larvae, which may be caused by external as well as internal factors have been noticed by earlier workers (Broad, 1957 ; Fraser, 1936 ; Heegaard, 1953).

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