

LARVAL DEVELOPMENT AND REARING OF THE BRACKISH WATER
SHRIMP *LEPTOCARPUS POTAMISCUS* (KEMP, 1917)
(DECAPODA, PALAEMONIDAE)

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ABSTRACT

Complete larval development of the brackish water shrimp, *Leptocarpus potamiscus* has been studied by rearing the larvae hatched out under laboratory conditions. The larvae undergo 16 or 17 moults during a period of 86 to 96 days and pass through 6 zoeal and 9 post-larval stages before metamorphosing into juveniles. The zoeal and post-larval stages are described in detail and illustrated. The early larval stages of *L. potamiscus* and *L. fluminicola* are compared and the salient features of the development of *L. potamiscus* are discussed. Observations made on the moulting periodicity, feeding habits and rearing of the larvae are also included in the paper.

INTRODUCTION

THE genus *Leptocarpus* created by Holthuis (1950), included two known species namely *Leptocarpus potamiscus* (Kemp) and *L. fluminicola* (Kemp). *L. potamiscus* (as *Leander potamiscus*) was first described by Kemp (1917) from Goa and it was subsequently reported from Bombay (Rai, 1933), Andaman Archipelago, Malayasia (Kemp, 1917, 1918a), Siam (Suvatti, 1937), Sumatra (Gordon, 1935 a) and from Java (Holthuis, 1950). The species thus appears to be widely distributed in the Indo-Pacific region and is known to occur in the marine and freshwater environment of the coastal areas. Rai (1933) reported that this species occurs in large numbers in the Bombay region, and that it grows to a size of 51 mm. Rajyalakshmi (1961) described the first three zoeal stages of *L. fluminicola* (as *Leander fluminicola*) obtained by rearing the larvae in the laboratory, and added further, a description of the fifth larval stage of the species collected by tow nets from Hooghly estuary. The present paper deals with the detailed description of the larval and post-larval stages of *L. potamiscus*, its moulting behaviour, feeding habits and salinity tolerance during rearing experiments.

The author is greatly indebted to Dr. E. G. Silas, Director, Central Marine Fisheries Research Institute for his keen interest in this work and the encouragements and to Shri K. H. Mohamed and Dr. P. Vedavyasa Rao for going through the manuscript and giving helpful suggestions through out the period of work. He is grateful to Shri M. Aravindakshan for providing *Artemia* eggs for rearing experiments.

MATERIAL AND METHODS

An ovigerous *L. potamiscus* measuring 48 mm in total length and 21 mm in carapace length was caught in a cast net while carrying out experimental fishing at the Thevara Canal connected with the Cochin Backwater on 14th August 1973. The shrimp was brought to the laboratory in live condition and was kept in a glass

trough (7 litre capacity) containing 6 litres of brackish water, the salinity of which was 17.2‰. To prevent the shrimp from jumping out of water, the mouth of the trough was kept covered with an organdy cloth. Finely minced and washed prawn meat was offered as food once a day, generally in the morning and the excess food was removed after an hour. When the eggs were hatched out completely, the mother was removed from the container. Fixed number of active and healthy larvae were transferred to one litre glass beakers containing prepared water of various salinity ranges. The medium of required salinity was prepared by diluting the sea water with fresh tap water devoid of Chlorine. Half of the water of the container along with bottom sediments and moults was siphoned out from the container once a day and an equal quantity of freshly prepared water of the same salinity was added.

The temperature of the medium varied between 24.5°C and 28.0°C and no effort was made to control it. Daily variations of temperature was within a range of $\pm 2^\circ\text{C}$. Zoel stages were fed with freshly hatched *Artemia* nauplii abundantly, while the post-larval stages were offered minced prawn meat and fresh crab eggs.

For detailed morphological studies, the larvae and post-larvae at different stages were preserved in 5% formaldehyde. The appendages were carefully dissected out and drawings were made using camera lucida mounted on a monocular compound microscope. The distribution of chromatophores was observed from live larvae.

The total length of the larva was taken from the tip of the rostrum to the tip of the telson excluding the terminal spines. The carapace length was measured from the tip of the rostrum to the middorsal point on the posterior margin of the carapace.

The following abbreviations are used in the description of different larval stages:

T1-Total length; C1-Carapace length; A1-Antennule; A2-Antenna; Md-Mandible; Mx1-maxillule; Mx2-Maxilla; Mxp1-Maxilliped I; Mxp2-Maxilliped II; Mxp3-Maxilliped III; P1-Pereiopod I; P2-Pereiopod II; P3-Pereiopod III; P4-Pereiopod IV; P5-Pereiopod V; Ur-Uropod; T-Telson.

Spawning: The shrimp was transferred to the trough at about 10 A. M. on 14th August 1973 and it soon got acclimatised to the new surroundings. It appeared to be sensitive and tried to jump out of the container when disturbed. It exhibited characteristic movements of the pleopods for the purpose of aerating the developing eggs. The shrimp did not take food on 15th August 1973. Spawning took place in the early morning hours of 16th August 1973, and the process continued for about 4 hours. The zoea I were seen actively swimming about in the relatively more lighted area of the trough.

DESCRIPTION OF LARVAL STAGES

Zoea I (Fig. 1 a to l); T1 2.2-2.4 mm (2.3 mm*); C1 0.6-0.7 mm (0.6 mm*).

* Figure given in the bracket pertains to the mean length

Diagnostic characters: Rostrum slender, pointed and slightly decurved at tip; carapace smooth, anterolateral angles drawn out into small pterygostomial spines; eyes large, sessile; antennule, antenna, mouth parts, and biramous buds of 1st and 2nd pereopods (Fig. 1k) developed; abdomen 6-segmented; telson not separated from 6th segment.

A1-uniramous, long, slender and unsegmented, carrying 2 flagella at apex; inner one long and plumose; outer unsegmented with 3 aesthetes and 2 short setae, one of which being plumose (Fig. 1 b). *A2*-biramous, exopod 5-segmented distally, bearing 9 plumose and one non-plumose setae along its terminal and inner margins; endopod unsegmented with a long plumose seta and a short spine at tip (Fig. 1c). *Md*-of both sides almost identical, incisor with one stout prominent tooth, in some specimens an additional small tooth discernible; molar with one small tooth; a stout tooth in between incisor and molar processes (Fig. 1 d, e). *Mx1*- uniramous, endopod with 2 small distal processes; distal lacinia with 2 stout spines and a small seta; proximal lacinia with 4 small teeth and a marginal seta (Fig. 1 f) *Mx2*-biramous, exopod with 5 long plumose setae along outer margin, hindermost being longest and directed backwards; endopod bilobed, distal lobe with one and proximal lobe with 2 non-plumose setae at tip; protopod with 3 masticatory processes, proximal process with 4 and both the distal processes with 3 non-plumose setae (Fig. 1g). *Mxp 1*-biramous, basis protuberant with 2 setae on its margin; endopod unsegmented with 5 setae, of which 3 are terminal; exopod longer than endopod and tipped with 4 long plumose setae (Fig. 1 h). *Mxp2*-biramous, basis with a long and slender seta at inner margin; endopod 3-segmented, with 2 setae at distal region, 3rd segment ending in a claw and 2 small setae; exopod long and with 4 apical and 2 sub-apical plumose setae (Fig. 1 i). *Mxp3*-biramous, basis with a short seta on inner margin; endopod 3-segmented, 2nd segment with 2 setae anteriorly, 3rd segment ending in a claw and 2 slender setae; exopod same as in *Mxp2*-(Fig. 1 j). *T*-broad and posterior margin concave, and bears 7 spines on each side, inner margin of the outer most two spines setose (Fig. 1 l). *P1* and *P2*-present in the form of biramous buds.

Zoea I moulted to the next stage after 24 hours from the time of hatching. *Zoea II* (Fig. 1 m-r; 2 a-h); T1 2.3–2.4 mm (2.4 mm); C1 0.6–0.7 mm (0.6 mm).

Diagnostic characters: Carapace with supra-orbital and pterygostomial spines (Fig. 1 m); eyes stalked; 5th abdominal segment with a pair of prominent lateral spines (Fig. 1 r). *Colouration:* Larvae as a whole appear light yellowish, peduncle of *A1* with light bluish and yellowish chromatophores, ventral side of eye stalk with yellowish branching chromatophores, the branches extending towards the sides also; junction of eye stalk with carapace deep bluish; orange branching chromatophores present at basis of *Mxp2* and *Mxp3*, on the dorsal aspect of the 3rd abdominal segment as well as on plura of 2nd and 3rd abdominal segments and at base of telson; 2 branching blue chromatophores also present on dorsal surface of 3rd abdominal segment.

A1-peduncle 2-segmented; proximal segment with 4 plumose setae near the joint and 2 on inner side; distal segment carries 2 flagella; inner flagellum long and plumose; outer flagellum with 4 aesthetes and one slender seta; antennular lobe at base of outer flagellum with 2 plumose setae (Fig. 2 a). *A2*-endopod unsegmented, carrying one short spine and 3 setae at apex, one of which is long and plumose (Fig. 2 b). *Md*-incisor process with 3 stout teeth and molar with 4 to 7 short teeth; between the two processes of right *Md* (Fig. 1 n) 2 slender teeth present while the

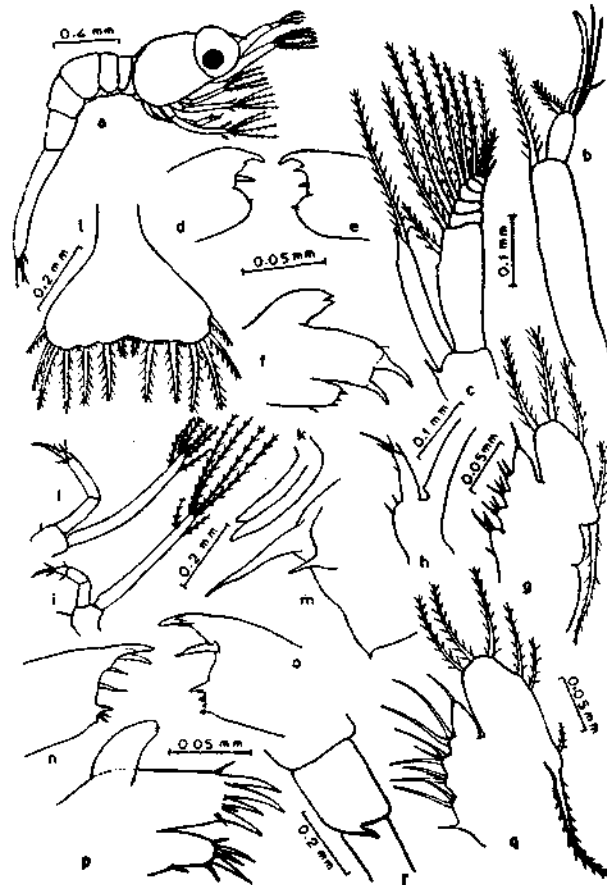


Fig. 1. *L. potamiscus*. Zoea I: a. lateral view; b. A-1; c. A-2; d. right Md; e. left Md; f. Mx-1; g. Mx-2; h. Mxp-1; i. Mxp-2; j. Mxp-3; k. bud of P-1; l. T. Zoea II: m. rostrum; n. right Md; o. left Md; p. Mx-1; q. Mx-2; and r. lateral view of 5th abdominal segment.

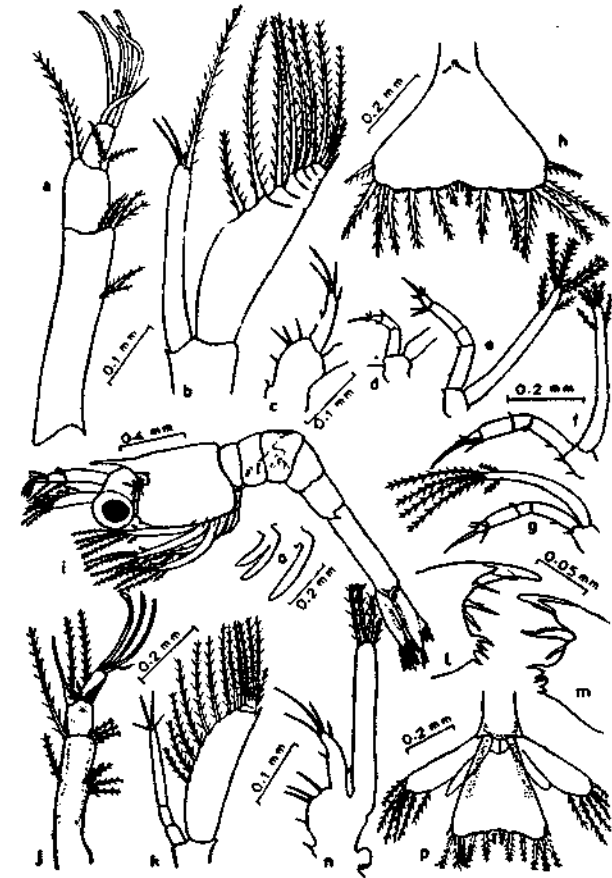


Fig. 2. *L. potamiscus*. Zoea II: a. A-1; b. A-2; c. Mxp-1; d. Mxp-2; e. Mxp-3; f. P-1; g. P-2; h. T. Zoea III: i. lateral view; j. A-1; k. A-2; l. right Md; m. left Md; n. Mxp-1; o. bud of 3rd and 5th P; and p. T.

left *Md* (Fig. 1 o) only one serrated movable tooth present between the processes. *Mx* 1-endopod with a distal projection; proximal lacinia with 5 teeth on posterior and a slender tooth on lateral margins; distal lacinia with 4 stout and 3 slender teeth (Fig. 1 p). *Mx* 2-margin of exopod with 7 long plumose setae (Fig. 1 q). *Mxp* 1-coxa with a single seta; protuberance of basis with 4 stout setae (Fig. 2 c) *Mxp* 2- distal segment of endopod ending in a claw and 3 setae (Fig. 2 d). *Mxp* 3-biramous basis with one seta on inner margin; endopod 4-segmented, 1st segment with 2 setae, 3rd segment with 2 long setae on inner side, 4th segment with a claw and 3 setae (Fig. 2 e). *P* 1-basipod with 2 small setae; endopod 4-segmented 1st and 2nd segments with 2 and one setae respectively, 3rd with 2 long setae, 4th with a claw and one seta terminally; exopod long, with 4 apical and 2 sub-apical plumose setae (Fig. 2 f). *P* 2-basipod and 1st segment of endopod with a single seta on inner margin, other characters similar to *P* 1 (Fig. 2 g). *T* broad, not separated from 6th abdominal segment, posterior margin concave and bears 8 spines on either side, inner margin of outermost spines setose, the innermost spine non-setose, and all the rest setose on both sides (Fig. 2 h).

Two days after the first moulting, Zoea II moulted to the next stage.

Zoea III (Fig. 2 i-p; 3 a-f); Tl 2.7-3.2 mm (3.0 mm); Cl 0.7-0.8 mm (0.7 mm).

Diagnostic characters: Biramous bud of 3rd pereopod and uniramous bud of 5th pereopod developed (Fig. 2 O); telson and uropods were separated from 6th abdominal segment by an articulating joint.

Colouration: Basis of *Mxp* 2, *Mxp* 3, *P* 1, *P* 2, lateral and dorsal aspects of 3rd abdominal segment, sides of 2nd abdominal segment, proximal dorso-lateral region of telson with orange branching chromatophores. Junction between eye stalk and carapace, mid-dorsal side of 3rd abdominal segment and junction between telson and 6th abdominal segment with blue chromatophores. Peduncle of *A* 1 with orange and blue chromatophores.

A 1-base of inner flagellum swollen; outer flagellum with 3 aesthetes and one seta; antennular lobe with 5 plumose setae; distal side of peduncle with 2 long plumose setae ventrally; proximal segment with 2, 4 and 3 plumose setae on inner and outer margins and near the articulation of joint respectively (Fig. 2 j). *A* 2-scale with 14 setae along margin, the outermost seta being slender, small and non-plumose, disto-lateral tip spine-like; flagellum 3-segmented carrying 4 slender terminal setae (Fig. 2 k). *Md* 3- stout teeth on incisor process and 4 to 5 short teeth on molar; between these processes 3 slender teeth, the middle one of which is long on right *Md* (Fig. 2 l); while in the left *Md* only 2 teeth one of which movable and serrated, present in between the incisor and molar processes (Fig. 2 m). *Mx* 1- distal process of endopod disappears (Fig. 3 a). *Mx* 2- exopod with 9 marginal plumose setae (Fig. 3 b). *Mxp* 1-bud like rudiments of epipod develop (Fig. 2 n). *Mxp* 3-basipod with 2 small setae on inner side and 3 setae, near the articulation of segments 3 and 4 (Fig. 3 d). *P* 1-provided with 3 setae near the articular joint of segments 3 and 4 (Fig. 3 e). *P* 2-basipod with 2 short setae on inner side; endopod 4-segmented, 1st with 2 setae on inner side, 2nd with a single seta on outer side, 3rd with 3 setae, and 4th ending in a claw and a small seta (Fig. 3 f). *T*-separated from last abdominal segment by an articulating joint, broad, posterior margin less concave bears 8 spines on either side, outer-most and inner-most spines being non-setose (Fig. 2 p). *Ur*-biramous, exopod with 6 long plumose setae; endopod bare.

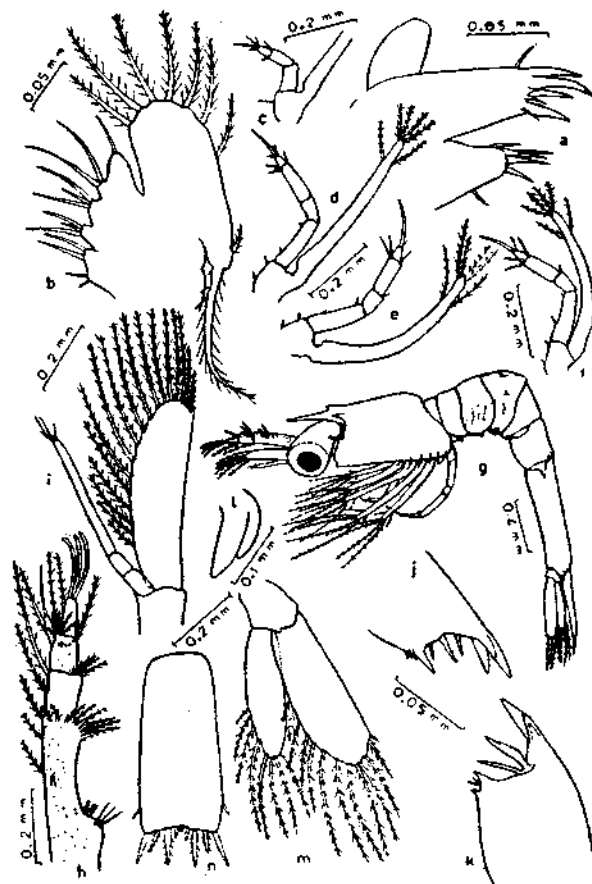


Fig. 3. *L. potamiscus*. Zoea III: a. Mx-1; b. Mx-2; c. Mxp-2; d. Mxp-3; e. P-1; f. P-2. Zoea IV: g. lateral view; h. A-1; i. A-2; j. right Md; k. left Md; l. bud of P-4; m. Ur; and n. T.

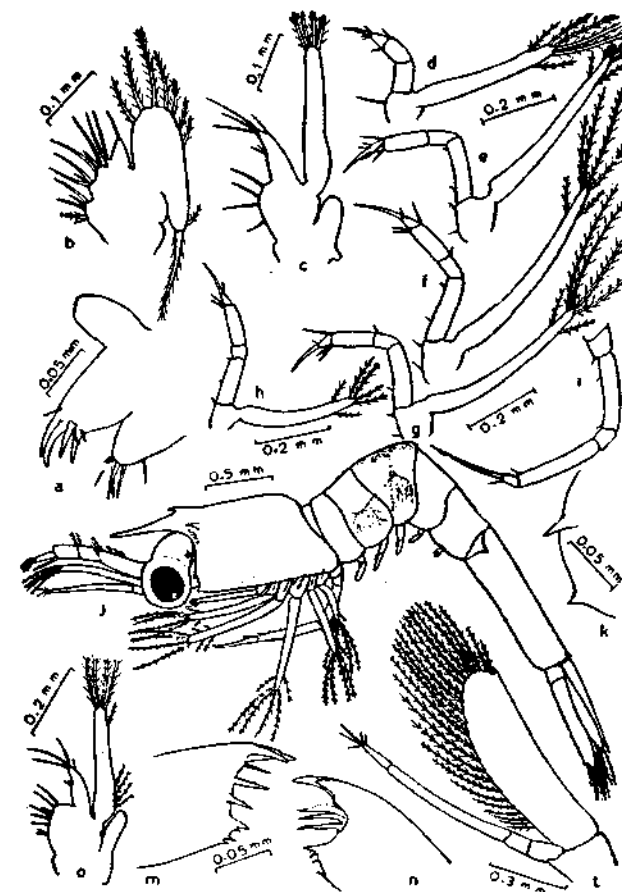


Fig. 4. *L. potamiscus*. Zoea IV: a. Mx-1; b. Mx-2; c. Mxp-1; d. Mxp-2; e. Mxp-3; f. P-1; g. P-2; h. P-3; i. P-5. Zoea V: j. lateral view; k. anterolateral side of carapace; l. A-2; m. right Md; n. left Md; and o. Mxp-1.

Zoea III moulted to zoea IV after 2 days from the second moulting.

Zoea IV (Fig. 3 g-n; 4 a-i); Tl 3.3-3.6 mm (3.5 mm); Cl 0.9 mm.

Diagnostic characters: Rostrum with an epigastric tooth; 3rd and 5th pereopod and biramous buds of 4th pereopod developed; rudimentary pleopod buds on 1st to 5th abdominal segments and endopod of uropod setose (Fig. 3 m).

Colouration: Orange chromatophores on ventral side of eye stalk, basis of *Mxp* 2, *Mxp* 3, *P* 1, *P* 2, dorsal and lateral aspect of 3rd abdominal segment, sides of 2nd abdominal segment and at the junction between 6th abdominal segment and telson. Orange and blue chromatophores present on the peduncle of *A* 1. Orbital margin of carapace with deep blue chromatophores.

*A*1-proximal segment with 5 plumose setae on inner side, and a spine and circlet of plumose setae near the middle of the segment; stylocerite bears 6 setae 3 of which plumose; inner flagellum shorter than outer and with a non-plumose seta at apex; outer flagellum with 3 aesthetes; antennular lobe with 5 plumose setae; distal segment with 4 long plumose ventral setae situated below the flagellum (Fig. 3 h). *A*2-distal part of scale unsegmented, 18 plumose setae and a spine; flagellum 3-segmented, with 4 slender terminal setae (Fig. 3 i). *Md*-same as in the previous stage, molar with 4 to 5 small teeth (Fig. 3 j, k). *Mx* 2-proximal masticatory process of protopod with 5 setae, one of which plumose (Fig. 4 b). *Mxp*1 - endopod with 6 setae, 3 of which terminal and long; epipod further developed and biramous (Fig. 4 c). *Mxp* 2, *Mxp* 3, *P* 1, and *P* 2-same as in the previous stage. *P* 3-biramous, basipod with a single seta on inner side, endopod 4-segmented, 1st segment with 2 small setae on inner side; at the 3rd joint 2 long setae present; last segment terminates in a claw and one slender seta; exopod with 4 apical and 2 sub-apical plumose setae (Fig. 4 h) *P*5-uniramous; 5-segmented, 1st, 2nd and 4th segments with one, 2 and one seta on inner side, 5th segment with a long terminal claw and one small seta (Fig. 4 i). *T*-almost rectangular, with 5 posterior spines on each side, innermost and outermost being non-plumose; a small spine on lateral margin on either side (Fig. 3 n).

Zoea IV moulted to Zoea V after 2 to 4 days from the 3rd moulting.

Zoea V (Fig. 4 j-o, 5 a-o); Tl 4.4-4.9 mm (4.7 mm); Cl 1.2-1.4 mm (1.3 mm).

Diagnostic characters: 4th pereopod well developed; pleopod buds on abdominal segments 1 to 5 biramous (Fig. 5 k - m).

Colouration: more conspicuous than in the previous stage.

*A*1- proximal segment with 8 plumose setae and a spine on inner margin; stylocerite with 7 setae, of which 3 are short and plumose; inner flagellum as long as outer and with 4 apical non-plumose setae; outer flagellum with a terminal finger-like projection bearing 2 setae and 4 aesthetes on inner side; antennular lobe with 5 plumose setae; distal segment with 5 plumose setae on ventral aspect below the flagellum (Fig. 5 a). *A*2-scale with 24 plumose setae and a spine; flagellum 4-segmented and with 5 setae at tip (Fig. 4 l). *Md*-incisor with 3 stout teeth and molar with 4 to 6 short teeth; in between the two processes 3 long teeth present (Fig. 4 m, n). *Mx*1-distal lacinia with 4 stout and long, 3 stumpy and one long

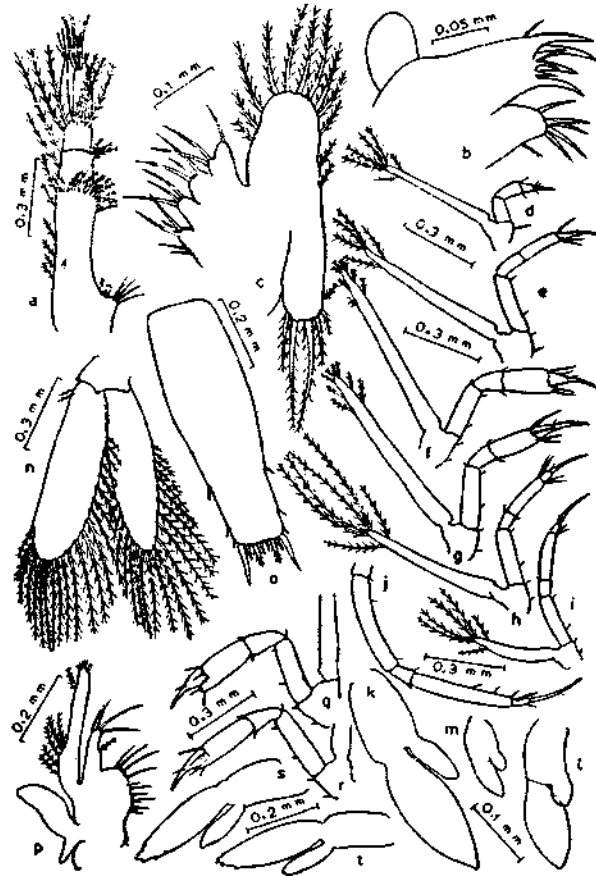


Fig. 5. *L. potamiscus*. Zoea V: a. A-1; b. Mx-1; c. Mx-2; d. Mxp-2; e. Mxp-3; f. P-1; g. P-2; h. P-3; i. P-4; j. P-5; k. pleopod III; l. pleopod IV; m. pleopod V; n. Ur; o. T. Zoea V A: p. Mxp-1; q. P-1; r. P-2; s. pleopod II; and t. pleopod III.

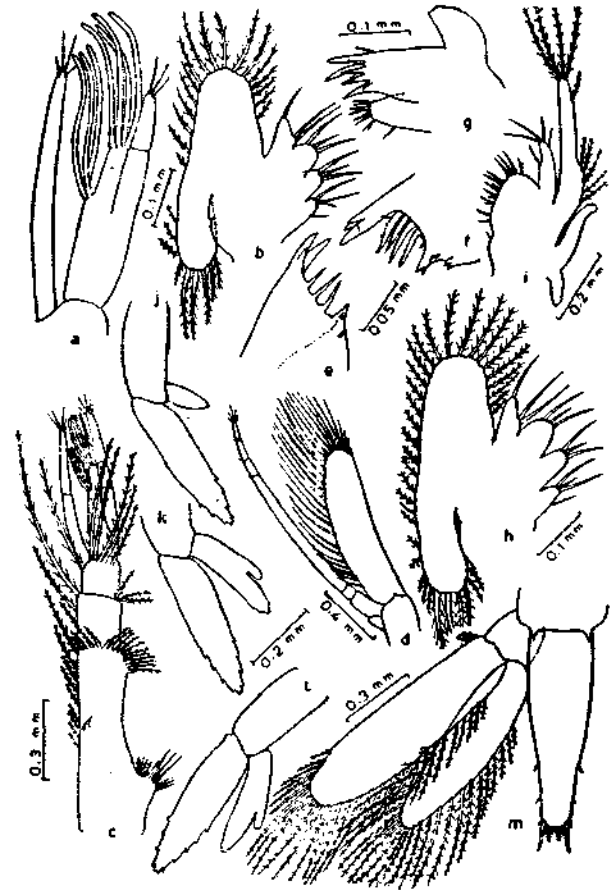


Fig. 6. *L. potamiscus*. Zoea V A: a. A-1 flagella, b. Mx-2. Zoea VI: c. A-1; d. A-2; e. right Md; f. left Md; g. Mx-1; h. Mx-2; i. Mxp-1; j. pleopod I; k. pleopod II; l. pleopod III; and m. Ur and T.

and slender teeth (Fig. 5 b). *Mx-2* margin of exopod with 18 to 20 plumose setae (Fig. 5 c). *Mxp-1* protuberance of basis with 8 slender and long setae along inner margin; exopod with 4 proximal, 4 apical and one sub-apical plumose setae (Fig. 4 o). *Mxp 2* and *Mxp 3* - same as in the previous stage. *P1-* (Fig. 5 f) and *P 2* (Fig. 5g)-basis with 2 short setae on inner side; endopod 4 segmented, distal segment ending in a claw and small seta, 3rd segment develops as inner lateral projection indicating developing chela, 3rd joint carries 4 setae, 1st and 2nd segments carry 3 and 2 setae respectively; exopod long and with 4 apical and 4 sub-apical plumose setae. *P3*-basis with 2 setae on inner side; endopod 4-segmented, 1st and 2nd segments with 2 setae each, 3rd joint with 4 long setae, 4th segment ending in a distinct claw and a seta (Fig. 5 h). *P4*-biramous, shortest, basis with 2 setae on inner side; endopod 4-segmented, 1st and 2nd with 2 and one setae respectively, 3rd with 2 setae on inner anterior margin, 4th terminates in a claw and a seta; exopod as long as the proximal 2 segments of endopod and bears 4 apical and 2 sub-apical plumose setae (Fig. 5 i). *P5*-further developed, 2nd segment with 2 setae, 4th with 3 setae in inner side, 5th with a stout spine on inner margin (Fig. 5 j). Pleopods on 1st to 5th abdominal segments, biramous, first 3 similar in size, 5th shortest; margin of exopods and endopods of all pleopod buds naked; *T*-lateral margin tapering posteriorly, 3 lateral and 4 posterior spines on each side, the outermost being stout and long; 3rd spine on each side at the posterior border plumose (Fig. 5 o). *Ur*-exopod with 22 plumose setae along anterior and inner margins and with a spine at the postero-lateral margin; outer margin of exopod with 2 plumose setae; endopod with 20 plumose setae (Fig. 5 n).

Zoea V moulted to Zoea VA 2 to 4 days after the 4th moulting.

Zoea VA (Fig. 5 p-t; 6 a, b); Tl 5.1-5.6 mm (5.3 mm); Cl 1.4-1.6 mm (1.5 mm).

Since the larva shows no significant morphological changes from the previous stage, but undergoes ecdysis, this zoeal stage is considered as a sub-stage of zoea V and designated as zoea VA.

A1-outer flagellum branched, outer branch 2-segmented and with 3 apical setae, inner branch with 7 aesthetes in 2 groups of 4 and 3 (Fig. 6 a). *A2*-scale with 27 plumose setae and an anterolateral spine; flagellum 5-segmented. *Md*-between the incisor and molar processes 4 long teeth present one of which serrated and movable; *Mx1*-endopod with a small inner distal projection; proximal lacinia with 6 teeth on distal and one tooth on lateral margin. *Mx2*-exopod with 26 plumose setae (Fig. 6 b) *Mxp1*-protuberance of basis with 11 setae; endopod with 5 setae, 3 of which long and terminal; base of exopod with 5 plumose setae; epipod bilobed (Fig. 5 p). *P4*-3rd joint encircled with 3 long setae, 2 of which placed on inner side. Exopod of pleopod 1 to 3 with a few small rudimentary projection representing the developing setae of later stage (Fig. 5 s, t). *Ur*-exopod with 27 plumose setae and a postero-lateral spine, endopod with 23 plumose setae.

Zoea VA moulted to the next stage after 2 to 4 days of 5th moulting.

Zoea VI (Fig. 6 c-m; 7 a-g); Tl 5.6-6.2 mm (5.9 mm); Cl 1.6-1.7 mm (1.7 mm).

Diagnostic characters: 5 to 6 small plumose setae in front of epigastric tooth developed. 1st and 2nd pereopod chelate. Endopods of pleopods 2 to 5 with appendix interna.

Colouration: Orange red chromatophores present on eye stalk, lateral aspect of 1st, 2nd and 3rd abdominal segments, basis of *Mxp* 1, *Mxp* 2, *P* 1, *P* 2, and at the junction between last abdominal segment and telson. Dorsal side of 3rd abdominal segment provided with branched orange and blue chromatophores.

*A*1-inner side of proximal segment with 10 to 12 setae; a shallow depression to accommodate eye developed on dorsal surface of the proximal segment; inner flagellum 2 to 3 segmented and with 5 slender setae at apex; outer branch of outer flagellum 3 or 4 segmented and with 5 terminal setae, inner branch with 7 aesthetes in 2 groups of 4 and 3; distal segment bears 6 long plumose setae ventrally below the flagellum (Fig. 6 c). *A*2-scale with 29 plumose setae and one spine, flagellum 6 segmented and longer than scale (Fig. 6 d). *Md*-molar with 6 to 7 teeth; the region between incisor and molar process of right *Md* (Fig. 6 e) bears 4 teeth and that of left *Md* (Fig. 6 f) 3 teeth. *Mx*1-distal lacinia with 9 teeth, of which 4 stout and long, 4 stumpy and one slender; proximal lacinia with 6 to 7 teeth and one seta (Fig. 6 g). *Mx*2-exopod with 32 to 35 plumose setae (Fig. 6 h). *Mxp*1-coxa with one seta; protuberance of basis with 12 to 14 setae; basal region of exopod with 5 to 7 plumose setae (Fig. 6 i). *Mxp*2-terminal segment of endopod bears a claw and 4 to 5 setae; exopod with 4 apical and 4 sub-apical plumose setae (Fig. 7 b). *Mxp*3 - exopod with 4 apical and 6 sub-apical plumose setae (Fig. 7 c). *P*1 (Fig. 7 d) and *P* 2 (Fig. 7 e)-chela further developed. *P*3-exopod with 4 apical and 6 sub-apical plumose setae. *P*4-junction of 3rd and 4th segment of endopod beset with 4 longsetae; exopod with 4 apical and 6 sub-apical plumose setae (Fig. 7 f). *P*5-4th segment with 4 to 5 setae on inner side (Fig. 7 g). Appendix interna present on endopod of pleopods 2 to 5; exopod of pleopods 1 to 5 (Fig. 6 j-1) with 9, 9 to 10, 10 to 11, 9, and 6 to 9 incipient setae respectively; endopod of 2 to 5 pleopods with 4, 4 to 5, 2 to 3 and 2 incipient setae. *Ur*-exopod with 29 to 30 plumose setae and one spine; endopod with 26 to 28 plumose setae (Fig. 6 m).

After moulting into zoea VI, it took 2 to 4 days for moulting to the next stage.

Zoea VIA (Fig. 7 h-p); Tl 6.2-6.7 mm (6.4 mm); Cl 1.7-1.9 mm (1.8 mm).

*A*1-proximal segment with 13 plumose setae and one spine on inner side; stylocerite with 12 setae, 4 of which are plumose; inner flagellum 3-segmented, outer branch of outer flagellum 4-segmented, inner branch with 9 aesthetes in 3 groups of 4, 3 and 2 (Fig. 7 h). *A*2-scale with 34 plumose setae and one spine; flagellum 7-segmented. *Mx*2-exopod with 43 plumose setae; 3 masticatory processes with 4, 4 and 3 to 4 setae respectively (Fig. 7 i). *Mxp*1- proximal region of exopod with 7 plumose seta (Fig. 7 j). Exopod of endopod of 1st to 5th pleopods (Fig. 7 l-o) with 11/0, 12/8, 11/6, 13/7 and 9/4 incipient setae respectively. *Ur*-exopod with 33 plumose setae and one spine and endopod with 31 plumose setae.

Zoea VI A moulted to post-larva I after 2 to 4 days of 7th moulting.

Post-larva I (Fig. 8 a- m; 9 a- f); Tl 5.8 - 6.3 mm (6.0 mm); Cl 1.8-2.0 mm (1.9 mm).

Diagnostic characters: Larvae leave the planktonic life and settle to the bottom life. Rostrum well developed with 7 to 8 dorsal teeth, and carapace with pterygostomial and antennal spines. Antennular peduncle 3-segmented. Pereiopod with degenerated exopods.

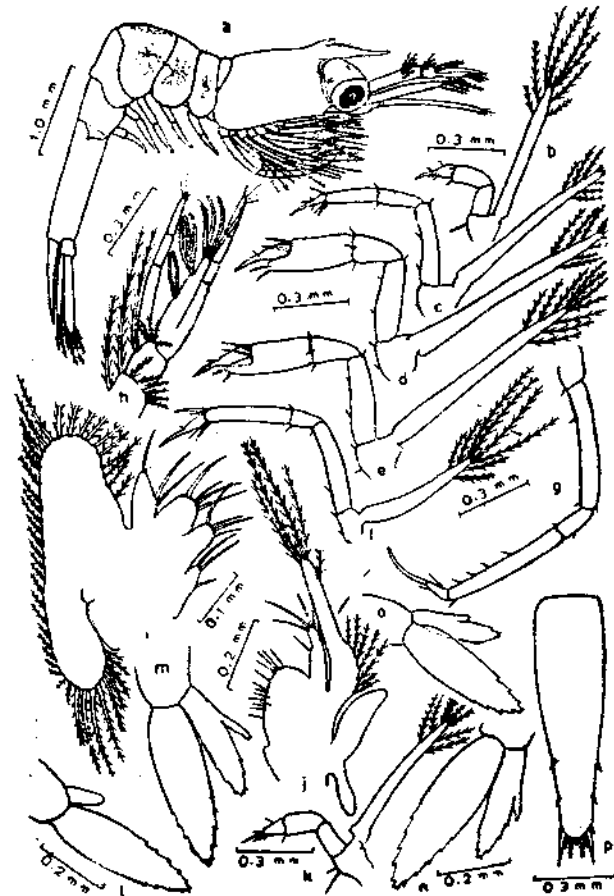


Fig. 7. *L. potamiscus*. Zoea VI: a. lateral view; b. Mxp-2; c. Mxp-3; d. P-1; e. P-2; f. P-4; g. P-5. Zoea VI A: h. A-1 tip; i. Mx-2; j. Mxp-1; k. Mxp-2; l. pleopod I; m. pleopod II, n. pleopod IV; o. pleopod V; and p. T.



Fig. 8. *L. Potamiscus*. Post-larva I: a. lateral view; b. A-1; c. Md; d. Mx-1; e. Mxp-1; f. Mxp-2; g. Mxp-3; h. pleopod I; i. pleopod III; j. tip of appendix interna of pleopod III; k. Ur; l. disto-lateral margin of exopod of uropod; and m. T.

Colouration: Orange chromatophores present on eye stalk, lateral aspect of carapace and at junction of telson with 6th abdominal segment; bases of 1 to 5 pleopods with conspicuous orange red chromatophores.

A1-peduncle 3-segmented; inner and outer flagellum each 8-segmented, inner branch of outer flagellum with 7 aesthetes in 2 groups of 4 and 3; proximal segment longest with stylocerite and a well developed antero-lateral spine; depression to

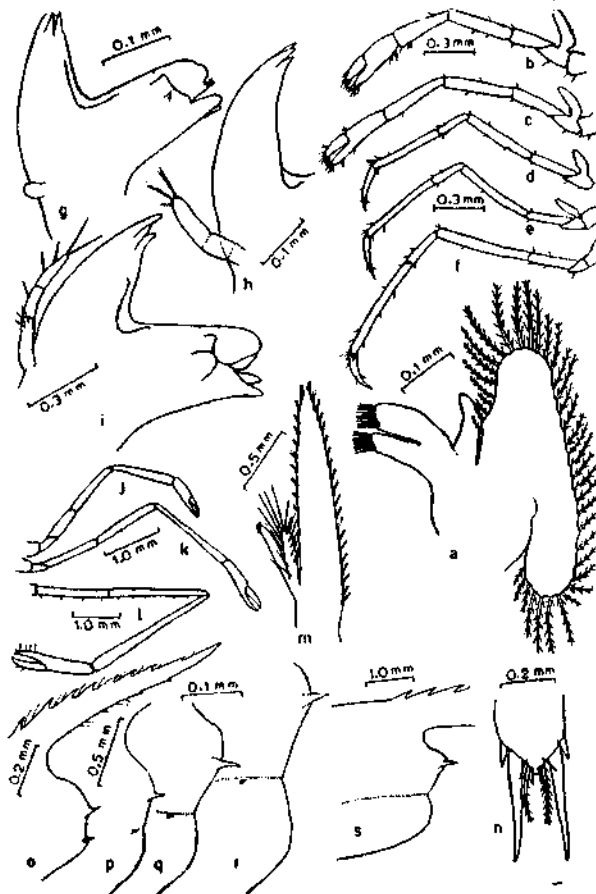


Fig. 9. *L. potamiscus*. Post-larva I: a. Mx-2; b. P-1; c. P-2; d. P-3; e. P-4; f. P-5. Advanced post-larva: g. Md of post-larva III; h. Md of post-larva IV; i. Md of post-larva IX; j. P-1 of post-larva V; k. P-2 of post-larva V; l. P-2 of post-larva IX; m. endopod of pleopod II of post-larva of T1-25 mm; n. T tip of post-larva of T1 24 mm; o. antero-lateral aspect of carapace of post-larva II; p. carapace of post-larva IV; q. carapace of post-larva VI; r. carapace of post-larva and IX; s. carapace of juvenile of T1 30 mm.

accommodate eye well defined (Fig. 8 b). A2-scale with 32 plumose setae and one spine; flagellum long, slightly more than 4 times the length of scale. Md-incisor process with 3 stout teeth and molar process with 5 to 7 blunt teeth at the distal end (Fig. 8 c). Mx1-endopod with 2 distal projections, proximal projection with a small seta; distal lacinia with 2 lateral and 11 apical teeth; proximal lacinia with 10

apically arranged teeth (Fig. 8 d). *Mx* 2—exopod with 39 plumose setae along the entire margin; endopod simple and bare, basis with 2 endites each with 9 to 10 bristle-like setae (Fig. 9 a). *Mxp* 1—basal portion bilobed, outer margin with numerous setae; endopod with a single plumose seta; exopod with 4 apical and one sub-apical plumose setae; epipod bi-lobed (Fig. 8 e). *Mxp* 2—endopod 4-segmented, distal two segments with several short setae; exopod with 4 apical and 2 sub-apical plumose setae; bilobed epipod present (Fig. 8 f). *Mxp* 3—endopod 3-segmented, profusely setose; exopod as long as 1st segment of endopod, and bears 4 apical and 4 sub-apical plumose setae (Fig. 8 g). *P* 1 (Fig. 9 b) and *P* 2 (Fig. 9 c)—chelate; *P* 1 stoutest and *P* 5 longest (Fig. 9 f); endopod of pleopods 2nd to 5th with appendix interna, which possess 3 hooks on inner margin of the distal end (Fig. 8 j). *T*-bearing posteriorly 4 spines and 2 plumose setae; 2 lateral spines on either side shifted to dorsal aspect (Fig. 8 m). Distolateral margin of exopod of uropod with 2 spines, one of which is movable (Fig. 8 k, l).

After 2 days of moulting into post-larva I, it moulted to post-larva II.

Advanced post-larvae (Fig. 9 g - s).

Unlike the zoeal stages that essentially swim about at the surface and sub-surface waters in the container, post-larva I settles down to the bottom and begins to live a bottom life. The post-larva undergoes 8 to 9 moults within a period of 67 to 75 days and becomes juvenile at a total length of 28 to 30 mm. In the course of development 9 post-larval stages may be recognised. During the course of this development and growth, the various appendages gradually attain the adult form. As the post-larva I transforms to post-larva II, the rostrum acquires ventral teeth. exopods of pereopod 1 to 4 disappear, endopod of 3rd maxilliped becomes 5 segmented. As the development proceeds, mandibular palp makes its appearance in post-larva III (Fig. 9 g) and it increases in size to become 3-segmented in post-larva IV (Fig. 9 h). The characteristic branchiostegal groove of the adult appears for the first time in post-larva VI (Fig. 9 q). The pterygostomial spine, situated in the lateral angle of the carapace in post-larva I gradually shifts upwards towards the branchiostegal groove and gets reduced in size (Fig. 9 o - s). The spine finally disappears when the post-larva transforms into juvenile after a period of about 90 to 96 days of larval and post-larval development.

MOULTING BEHAVIOUR

The larval development of *Leptocarpus potamiscus* passes through 8 moults and the post-larval development through 8 or 9 moults. Upto zoea V, each moult results in a distinct stage, but zoea V and VI stages undergo ecdysis twice before passing to the next stage. Such variations in the number of moults between 2 successive stages have been recorded in the larval development of several palaemonid prawns such as *Macrobrachium acanthurus* (Choudhury, 1970), *M. carcinus* (Choudhury, 1971) and *M. idella* (Pillai and Mohamed, 1973). Newly hatched zoea takes 24 hours to moult to zoea II. The interval between the second and third zoeal stages is found to be 48 hours. From the 4th zoeal stage onwards the duration between each moult varies between 2 to 4 days. Post-larva I takes 48 hours for the 1st moult. The intervening period between the two ecdysis gradually increases to 5 or 6 days in post-larva II and III, and 8 to 11 days from post-larva IV to juvenile (Table 1).

TABLE 1. Moulting periodicity and development of post-larvae of *L. potamiscus*

Post-larva	Duration of the Stage in days	Days after hatching	TI (mm)	CI (mm)	Rostral formula	Salient features
I	2	23	6.0	1.9	7-8/0	Carapace with antennal and pterygostomial spines. Branchiostegal groove absent. Mandible without palp. Endopod of <i>Mxp</i> 2 4-segmented. Rudimentary exopods present on <i>P</i> 1 to <i>P</i> 4
II	5	25	7.3	2.5	8/2	No exopod on <i>P</i> 1 to <i>P</i> 4; endopod of <i>Mxp</i> 2 5-segmented
III	6	30	8.2	2.9	9/2	Buds of <i>Md</i> palp present.
IV	8	36	10.3	4.3	7-8+2/4	<i>Md</i> palp 3-segmented.
V	8	44	13.8	5.0	7-8+2/5	
VI	11	52	18.0	7.5	7-8+2/5	Branchiostegal groove developed.
VII	11	63	20.5	9.5	7-8+2/5-6	
VIII	10	74	24.0	9.0	7-8+2/5-6	Pterygostomial spine which is shifted towards the branchiostegal groove is 1/5th of antennal spine.
IX	10	84	25.0	10.0	7-8+2/6	Pterygostomial spine 1/6th of antennal spine.
Juvenile	...	94	30.0	12.0	7-8+2/6	No pterygostomial spine.

REARING

Zoeae were reared in two types of media where salinity was ranging between 13-15‰ and 30-35‰. The post-larval stages were reared in three salinity media namely, 4 to 6‰, 13-15‰ and 30-35‰. The results obtained showed that higher mortality rate occurred when larvae were reared in salinity ranges below 15‰. Higher salinity ranges were found to be suitable for the culture of this species upto the juvenile stage. Further rearing of the species in the laboratory was rendered difficult due to excessive mortality and cannibalistic tendencies.

DISCUSSION

Early larval development of *L. potamiscus* closely resembles that of *L. fluminicola* described by Rajyalakshmi (1961). The general larval morphology of the first 3 zoeal stages of the two species is similar in all respects except for the size of the larvae and the segmentation of the endopod of the 2nd and 3rd maxillipeds. The larvae of *L. potamiscus* are relatively smaller than that of *L. fluminicola*. The larvae collected from Hooghly estuary and described as possibly of zoea V of *L. fluminicola* by Rajyalakshmi (1961) show significant differences from the corresponding zoeal stages of *L. potamiscus*. Zoea V of *L. fluminicola* is characterised by the presence of two dorsal teeth on rostrum, 3-segmented antennular peduncle, chelate first and second pereopods, relatively broader nature of posterior margin of telson and by the non-setose endopod of uropods. But the earlier zoeal stages as well as zoea V of *L. potamiscus* has only one dorsal tooth on the rostrum and the antennular peduncle is composed of two segments. The first and second pereopods become chelate only in zoea VI. The posterior margin of the telson which is broader upto zoea III becomes rectangular in zoea IV and from zoea V onwards it gradually gets narrower and attains the adult shape in post-larva I. The endopod of the uropod acquires setae in zoea IV. In view of the very close similarity of development upto zoea III in both the species, the differences noticed in the larva

collected from Hooghly estuary from the corresponding stage larvae of *L. potamiscus* reared in the laboratory makes it difficult to reconcile that they belong to any of these species.

One of the interesting features observed in the development of *L. potamiscus* is the gradual shifting of the pterygostomial spine which makes its first appearance in post-larva I, at its normal position on the antero-lateral margin of the carapace. As the development of post-larva proceeds, the position of this spine shifts and with every ecdysis it moves towards the branchiostegal spine in post-larva VI. In further development, the size of the spine is gradually reduced and it ultimately disappears completely when the post-larva develops into the juvenile (Fig. 9 o-s). Such shifting of position of spine was also observed by Gurney and Lebour (1941), in the development of the larvae of Palaemonidae. These authors opined that it would seem most probable that the 'pterygostomial' is not a spine in the usual sense, but rather a notch in the margin without homology to spine. They also suggested that in the larvae of the Palaemoninae the carapace may at first have an anterior point which has been called the pterygostomial spine. Later, this point becomes a well-defined spine and moves upwards, while a second spine appears either below it (*Leander*) or behind it (*Brachycarpus*). Although the pterygostomial spine is present in some of the larval stages of *L. potamiscus*, it is completely absent in the juveniles and adults. As absence of this spine is the most important generic character of the adults, the late disappearance of the spine is of special significance in the context of identity of the post-larvae belonging to the sub-family Palaemoninae.

The larvae of *L. potamiscus* are voracious feeders and they continuously feed when provided with sufficient food. These larvae generally prefer large sized food particles, even as big as the size of the larva itself. The larva carry the food particles by their pereopods and feed on them while swimming about. When large size food is offered, the larvae cling on to the food and feed on them. Cannibalism is also observed among these larvae and it has been observed that this habit increases gradually as the development of the larvae advances. This habit of the larva is one of the main reasons for the mortality encountered during the rearing experiments of larvae.

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