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Larval development — *PARAPENAEOPSIS STYLIFERA* (H. MILNE EDWARDS)

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Parapenaeopsis stylifera was reared from the egg to the postlarval stage in the Narakkal laboratory. It passes through 6 nauplius substages, 3 protozoea substages, and 7 mysis substages before reching postlarva I. At the rearing temperature of 25.6°C to 27.7°C the nauplii hatch out from the egg 15 to 16 hours after spawning; the duration of the nauplius stage is 40 to 50 hours: the protozoea stage lasts for 4½ to 7 days, and the larvae remain in the mysis stage for 10 to 16 days before becoming postlarva I. The complete development from egg to postlarva I takes 17 to 26 days. All the larval substages are described and illustrated in detail and compared with the earlier larval descriptions of this species.

Parapenaeopsis stylifera which is an important component in the prawn catch of the southwest coast of India was successfully made to spawn in the Prawn Culture Laboratory at Narakkal on a number of occasions and the larvae reared to the juvenile stage While routinely checking the larval characters with the description given by Rao (1974, *J.mar. biol. Ass. India*, 15(1): 95-124[1]), who had traced the complete life cycle of *P. stylifera* from the material collected from the plankton, it was apparent that the larvae differed considerably from Rao's[1] description. Our studies based on larvae of known parentage, gave us an opportunity to present here an authentic description of the complete series of larval stages of *P. stylifera*. The temperature of the water in the rearing basins was 25.6°C to 27.7°C and the salinity 33.1 - 34.3 ppt. The authors are grateful to Dr.E.G. Silas, Director, Central Marine Fisheries Research Institute, for his constant encouragement and valuable suggestions.

DESCRIPTION OF DEVELOPMENTAL STAGES

EGGS

The eggs (Fig.,1a,b,c) opaque with fairly wide perivitelline space, chorion with bluish sheen, egg diameter varied from 0.35 to 0.38 mm and yolk mass 0.22 to 0.27 mm. Embryonic development takes 15-16 hours.

NAUPLIUS I

MTL : 0.27 mm (0.26 - 0.28 mm); MW: 0.15mm (0.14-0.15 mm) MFS: 0.08 mm (0.07-0.08 mm)

Furcal setae 1+1; A1 with 3 short lateral setae on inner margin, 1 long lateral seta on outer margin and 2 long setae and 1 minute setal rudiment terminally (Fig.1,d); A2 exopod with 5 long setae, endopod with 2 long terminal and 2 short inner lateral setae; Md with 3 setae on both exopod and endopod; setae nonplumose. Duration of this substage was 3-4 hours.

NAUPLIUS II

MTL: 0.27 mm (0.26-0.28 mm); MW: 0.15mm (0.14-0.15 mm); MFS: 0.10mm (0.08-0.11mm).

Furcal setae 1+1; outer lateral and outer terminal setae of A1 short, setal rudiment of

nauplius I grown into a short seta (Fig.1,e); minute setal rudiment added to exopod and endopod of A2, 4th exopod seta counting

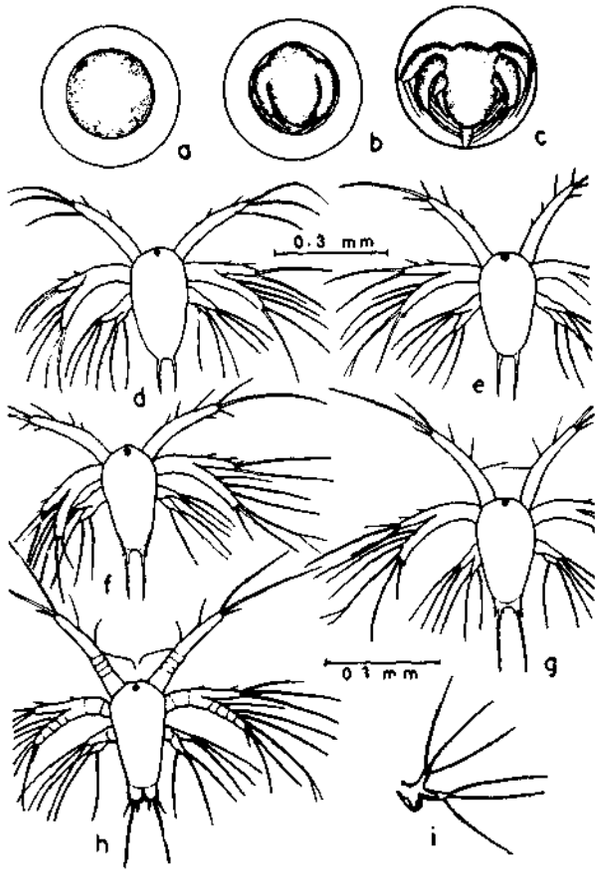

Fig. 1 *Parapenaeopsis stylifera:* a, b and c - egg in different stages of development: d - Nauplius I; e - Nauplius II; f - Nauplius III; g - Nauplius IV; h - Nauplius V: i - Md of nauplius VI.

from proximal end is bifurcate, this bifurcate condition retained in all subsequent nauplius substages; setae plumose. Duration of this substage was 3-4 hours.

NAUPLIUS III

MTL; 0.27 mm (0.26-0.29 mm);MW: 0.15 mm (0.14 - 0.15 mm);MFS:0.13 mm (0.11-0.14 mm).

Furcal setae 3+3; outer terminal seta of A1 smaller and inner terminal seta longer than in nauplius II (Fig. 1,f), outer lateral seta usually absent, if present hair-like and very thin, the 3 inner lateral setae longer; exopod of A2 with 6 plumose setae and a setal rudiment. Duration of this substage was 4-6 hours.

NAUPLIUS IV

MTL : 0.30 mm (0.28 - 0.31 mm); MW: 0.15 mm (0.14 - 0.15 mm); MFS: 0.16 mm (0.14 - 0.17 mm).

Furcal setae 4+4 (Fig.1, g),inner terminal seta of A1 longer, of the 3 inner lateral setae, the most proximal one is thin and very long; terminal setal rudiment of A2 endopod of previous stage grown into medium nonplumose seta; buds of mouth parts visible through cuticle. Duration of this substage was 3 - 4 hours.

NAUPLIUS V

MTL: 0.31 mm (0.29-0.32 mm); MW: 0.15 mm (0.14-0.15 mm); MFS: 0.19mm (0.18 0.20mm).

Furcal setae 6+6 (Fig.1,h), A1 faintly segmented basally, proximal inner lateral seta very long, bent and directed posteriorly and often seen overlapping its fellow on opposite side; A2 exopod with 6 plumose setae and 1 nonplumose seta, endopod with 3 long plumose setae apically, 5 indistinct segments on exopod; Md has a prominent swelling near base. Duration of this substage was 10-12 hours.

NAUPLIUS VI

MTL: 0.37 mm (0.35-0.39 mm) MW: 0.15 mm (0.14-0.16 mm) MFS: 0.22 mm (0.21-0.23mm).

Furcal setae 7+7; (Fig.2,a,) the pair of setae immediately inner to longest pair, bent ventrally and outwardly; carapace demarcated, frontal organs prominent; A1 with 4 basal segments, a short outer terminal seta added next to existing one, 1 short seta and 1 minute seta added on outer distal margin; A2 exopod 7 segmented, exopod with 7 plumose setae and 2 setal rudiments, 1 proximal and 1 terminal, endopod with 3 long plumose setae and 1 short non-plumose seta apically, distal of 2 inner lateral setae longer; swelling at base of Md (Fig.1,i) very prominent with cutting blades visible inside. Duration of this substage was 17 to 20 hours.

PROTOZOEA I

MTL: 0.64 mm (0.61-0.66 mm); MCL: 0.27 mm (0.25-0.28 mm).

Frontal organs rounded (Fig.2,b); A1 longer than A2; telson deeply forked, with 7+7 setae,

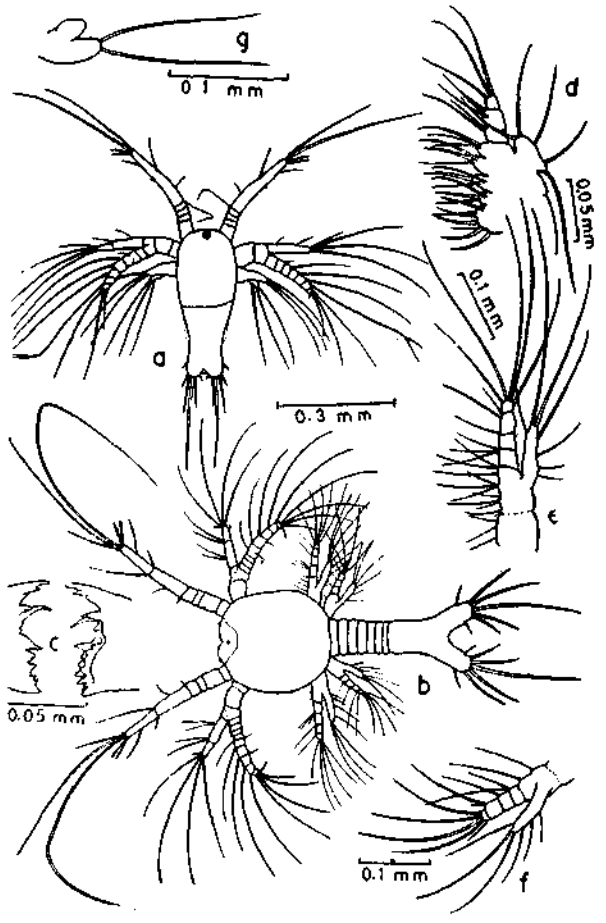

Fig. 2 *Parapenaeopsis stylifera*, a - Nauplius VI; Protozoea I: b - dorsal view; c - Md; d - Mx2; e - Mxpl; f - Mxp2; g - Mxp3.

each caudal furca relatively long and narrow, outermost pair of lateral setae separated from penultimate pair by a wide gap.

A1 (Fig.2,b) 3 segmented, basal segment with 4 subsegments, 3 inner lateral setae on middle segment, characteristic long proximal seta of nauplius VI reduced in size, distal one longest, terminally 2 very long setae, 1 medium seta, 2 short aesthaetes and 1 minute setal rudiment, 2 setae present on outer lateral aspect; A2(Fig.2,b) exopod 10 segmented with 10 setae along inner and distal margin, 2 smaller lateral setae on outer margin, endopod 2 segmented with 2+2 lateral setae and 4 long setae and a short hair apically; Md (Fig,2,c) more or less symmetrical with 1 standing tooth between incisor and molar processes; Mx1 (Fig.3,a) protopod with 2 endites, distal one with 4 setae and proximal with 6 to 7 setae, endopod short and 2 segmented, distal segment with 4 terminal setae and 1 inner lateral seta, proximal segment with 3 inner lateral setae, exopod button-like with 4 feathery setae; Mx2 (Fig.2,d) protopod with 5 endites, large proximal one with 7 setae and rest with 3 setae each, endopod short

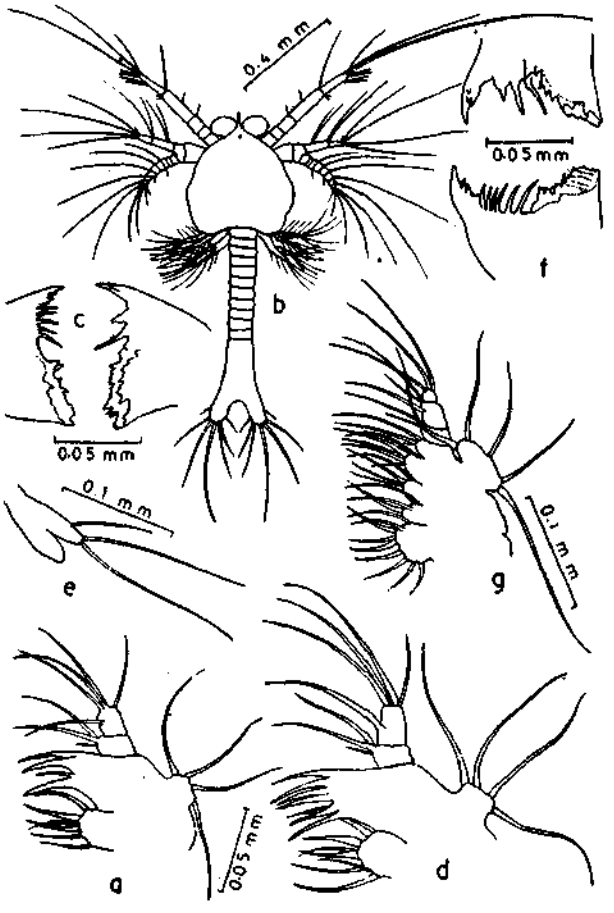

Fig. 3 *Parapenaeopsis stylifera:* Protozoea I : a - Mxl. Protozoea II: b - dorsal view; c - Md; d - Mxl e - Mxp3; Protozoea III: f - Md; g - Mx2.

with 3 segments, distal segment with 3 long terminal setae, middle one with 2 distolateral and one lateral seta in middle and basal segment with 2 distolateral setae, exopod with 5 feathery setae; Mxp1 (Fig.2,e) protopod indistinctly 2 segmented, distal segment bearing 11 to 12 inner lateral setae and proximal one with 3 inner lateral setae, endopod 4 segmented, 1st segment with 3, 2nd with 1, 3rd with 2, and 4th with 5 setae, exopod shorter than endopod, with 7 setae, terminal setae on exopod and endopod very long, more than twice length of exopod and endopod; Mxp2 (Fig.2,f) protopod faintly 2 segmented with fewer number of setae, endopod 4 segmented with 2 setae on 1st segment, 1 on 2nd, 2 on 3rd and 5 setae

on distal segment, exopod unsegmented with 6 setae; Mxp3 (Fig.2,g) biramous bud with 2 setae on exopod. Duration of this substage was 24-48 hours.

PROTOZOEA II

MTL: 1.12 mm (1.08-1.18)mm; MCL:

Short rostrum, no supraorbital spines, eyes stalked (Fig.3,b); intermoult lengthening of abdominal segments noticed, buds of thoracic appendages developed during intermoult growth and developing uropods could be seen inside cuticle.

A1 (Fig.3,b), one more seta added to distal seta on outer lateral aspect and 1 to 2 hair-like setae added at junction of distal and middle segments, basal segment with 3 subsegments; Md (Fig.3,c) asymmetrical, right Md with single free standing tooth between incisor and molar processes and left with 5 free standing teeth, a blunt tooth present just above standing tooth on right Md; Mx1 (Fig. 3,d) distal and proximal endites with 7 setae. each; Mx2, basal endite with 9 setae and the rest with 3 to 4 setae, no change in exopod or endopod; 2 more setae added to basal segment of protopod of Mxp1; Mxp3 (Fig.3,e) exopod with 3 setae. Duration of this substage was 56-72 hours.

PROTOZOEA III

MTL: 1.55 mm (1.51 - 1.64 mm ; MCL: 0.51 mm (0.50 - 0.53 mm).

No change in carapace; abdominal segments 1 to 5 (Fig.4,a) with dorsomedian spines, 5th segment with a pair of lateral spines, 6th abdominal segment without dorsal spine, but with a pair of posteroventral spines; telson with 8+8 setae; uropods developed, exopods tipped with 6 small setae (Fig.4,a) ; biramous rudiments of thoracic legs present.

A1 (Fig.4,a) clearly 4 segmented, 3 subsegments of basal segment fused into one, setation not changed from previous stage, except for a few more hair like setae added to junction of distal segment with penultimate segment; Md (Fig.3,f) 2 standing teeth in right Md and 6 in left; Mx1 with 8 setae on distal endite; Mx2 (Fig.3,g) basal endite with 9 setae and the rest with 3 to 5 setae; Mxp1 (Fig.4,b) exopod with 9 setae, no other

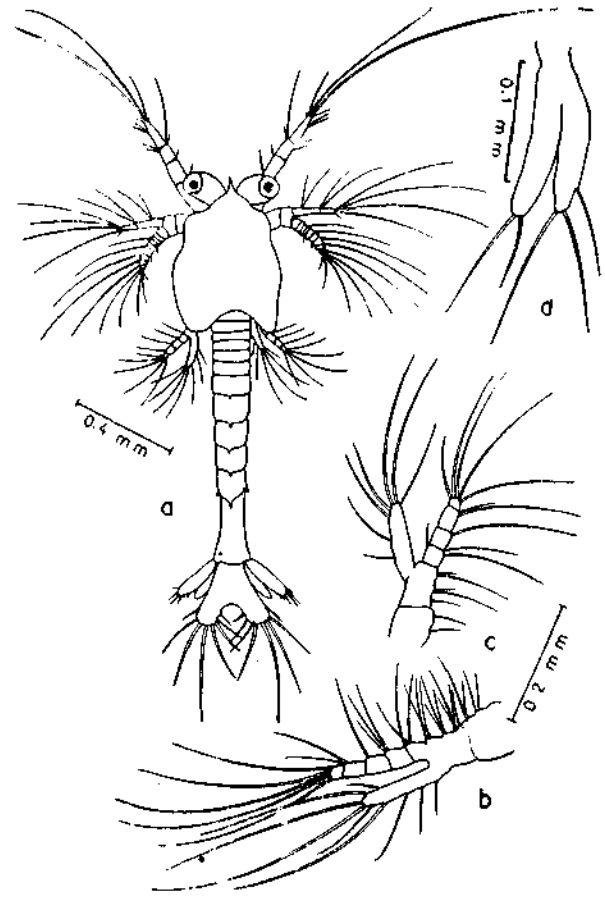

Fig 4. *parapenaeopsis stylifera*: Protozoea III; a - dorsal view; b - Mxp 1; c - Mxp2; d - Mxp3.

change, Mxp2 (Fig.4,c) exopod with 7 setae; a short outer lateral seta added to basal segment of endopod; Mxp3 (Fig.4,d) exopod bud with 3 setae and endopod bud with 2setae. Duration of this substage was 24-48 hours.

MYSIS I

MTL: 2.00 mm (1.8- 2.1 mm); MCL: 0.64 mm (0.58 - 0.66 mm) .

Carapace with rostrum shorter than eye (Fig.5,a), a minute supraorbital spine, a prominent pterygostomial spine and a smaller antennal spine present; dorsal organ prominent in lateral view; dorsomedian spine present only on 5th and 6th abdominal segments; a vestige of lateral spine on 5th abdominal segment still present; a ventral posteromedian curved spine present on 6th segment; telson with 8 pairs of setae (Fig.5,k); cleft on telson extending to level of origin of outermost pair of lateral setae.

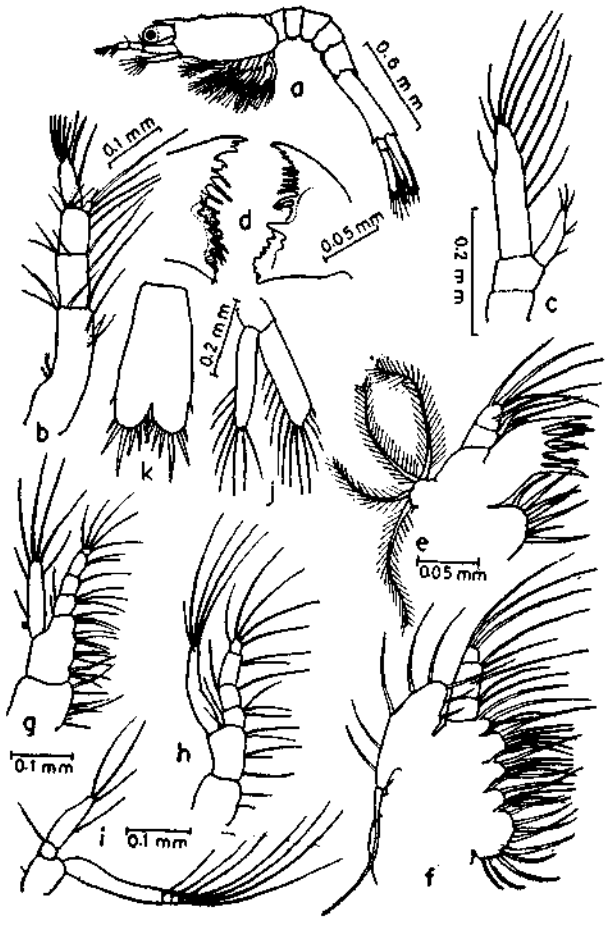

Fig. 5. *Parapenaeopsis stylifera:* Mysis I: a - lateral view; b - A1; c - A2; d - Md; e - Mx1; f - Mx2, g - Mxp1; h - Mxp2; i - P1; j - uropod: k - telson;

A1 (Fig.5,b) 3 segmented, distal segment carries 2 flagellar rudiments, larger one tipped with 6 aesthaetes and 1 small seta and smaller bud-like one tipped with 2 setae, 1 long and 1 short, the 1st segment has a basal swelling wherein statocyst is developed in later substages , 2 short setae present above this swelling distally, on the ventromedian aspect a prominent spine present; A2 (Fig.5,c) scaphocerite with 10 setae on inner and distal margin and 1 disto-lateral seta, endopod very short with 3 terminal setae and 2+1 lateral setae; Md (Fig.5,d) 3 free standing teeth in right Md and 7 in left; Mx1 (Fig.5,e) exopod with 4 feathery setae still present, distal endite with 9 setae; Mx2 (Fig.5,f) exopod larger with 9 feathery setae, basal endite with 10 setae, distal endite with 3 and 3 middle endites with 5 to 7 setae; Mxp1 (Fig.5,g) protopod broader, exopod with 7 long setae and a few hair-like setae below the proximal outer setae, 1 outer lateral seta added to 1st segment of endopod, 1 outer seta at junction with protopod, terminal setae of endopod shorter than length of endopod; Mxp2 (Fig.5,h) exopod with 6 setae, 4 terminal and 2 subterminal, endopod still 4 segmented with outer lateral setae on 1st and 2nd segments and also at junction with exopod, 1 more inner seta added to basal segment of endopod. Mxp3 (Fig.6,a) well developed, endopod 5 segmented distal segment with 5 setae, 4th segment with 1 outer and 1 inner lateral setae, 3rd segment without any seta, 2nd with 1 outer and 1 inner seta and the 1st with one inner lateral seta; exopod as long as endopod, with 4 long terminal setae and 2 pairs of subterminal setae, 2 indistinct segmentations seen at distal end; endopod of P1 to P3 (Fig. 5, i) 2 segmented without rudiments of chela, distal segment with 3 terminal setae and 1 long outer lateral seta in middle of segment and 1 inner lateral seta on basal segment, exopods with 4 terminal and 3 pairs of subterminal setae, tip of exopod indistinctly 3 segmented; endopod of P4 to P5 unsegmented with 3 terminal setae, exopods with 4 terminal and 3 pairs of subterminal setae; exopod of uropod (Fig. 5, j) with 12 plumose setae and one short nonplumose seta at outer lateral corner, endopod with 8 setae. Duration of this substage was 24-36 hours.

MYSIS II

MTL: 2.25 mm (2.21-2.28 mm); MCL: 0.69 mm (0.67-0.71 mm).

Carapace without prominent dorsal organ, minute supraorbital still present, no hepatic spine, no pleopod buds on abdominal segments (Fig. 6, b); vestiges of the pair of lateral spines on 5th abdominal segment lost; telson with cleft extending only up to level of origin of penultimate pair of lateral setae (Fig. 6, i).

A1 with 3 setae above statocyst swelling; A2 (Fig. 6,c) with 14 setae on scaphocerite, distolateral seta replaced by a prominent spine, endopod small with a short basal segment; Md (Fig.6,d) small palp seen; Mx1 (Fig.6,e) exopod, lost; Mx2 exopod with 13 setae; Mxp1 terminal setae on endopod slightly shorter than endopod, 1 outer lateral seta added to 2nd segment; Mxp2 endopod 5 segmented, penultimate segment of mysis I divided into 2; Mxp3, 1 more seta added to inner margin of basal segment of endopod,

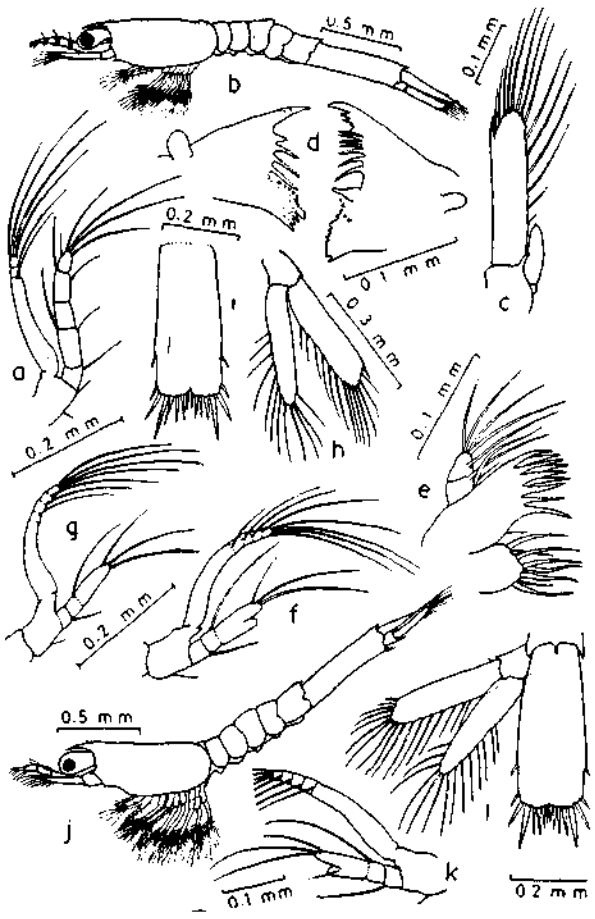

Fig. 6. *Parapenaeopsis stylifera:* Mysis I: a - Mxp3. Mysis II: b - lateral view; c - A2; d - Md; e - Mx1; f - P1; g - P5; h - uropod; i - telson. Mysis III: j - lateral view; k - P1; l - uropod and telson.

exopod with 4 terminal and 3 pairs of subterminal setae; P1 to P3 (Fig. 6, f) endopod with incipient chelae bearing 3 long setae terminally, with faint segmentation at level of origin of long outer seta, exopods with 4 pairs of subterminal setae arranged symmetrically below the 4 terminal setae, in some it may be 3 + 4 + 4, distally 4 indistinct segments seen; P4 and P5 identical, similar to P1 to P3 but without chela (Fig. 6,g); uropod (Fig. 6, h) exopod with 12 to 13 plumose setae and 1 nonplumose, short distolateral seta. outer margin of exopod not produced into a fixed spine, endopod with 11 to 12 setae. Duration of this substage was 24-48 hours.

MYSIS III

MTL: 2. 39 mm (2.28 - 2.41 mm); MCL: 0.75 mm (0.74 - 0.76mm).

A minute rostral tooth present (Fig. 6, j), supraorbital spine absent, no hepatic spine, still no pleopod buds, telson with shallow cleft (Fig. 6,l).

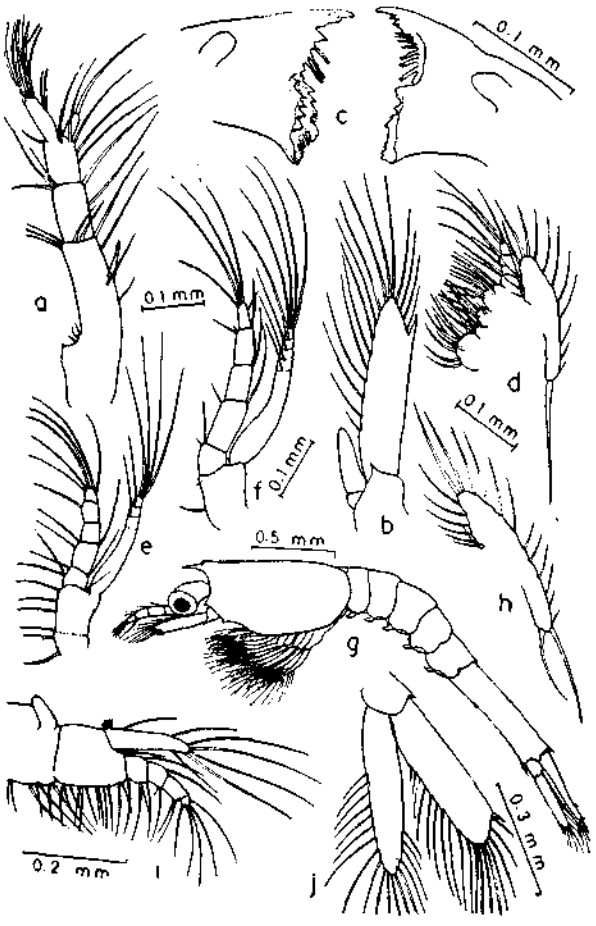

Fig. 7. *Parapenaeopsis stylifera:* Mysis III: a - A1; b - A2; c - Md; d - Mx2; e - Mxp2; f - Mxp3. Mysis IV; g - lateral view; h - exopod of Mx2; i - Mxp1; j - uropod.

A1 (Fig. 7,a) 2 subterminal aesthaetes added to outer flagellar rudiment; A2 (Fig 7,b) scaphocerite with 16 setae and a distolateral spine, endopod 1/3 length of scale; Md (Fig.7,c) palp larger; Mx1 distal endite with 10 setae, proximal endite with 8 setae; Mx2 (Fig. 7,d) exopod with 15 setae; Mxp1 a small gill rudiment present on outer distal corner of basal segment of protopod, 1 inner lateral seta added to 2nd segment of endopod; Mxp2, (Fig.7,e) one more inner lateral seta added to 2nd segment and another terminal seta to distal segment, 1 seta added to junction of exopod and endopod, exopod with 8 setae, 4 terminal and 2 pairs of subterminal; Mxp3 (Fig.7,f) exopod with 12 setae, 4 terminal and 4 pairs of subtermial, 1 outer lateral seta

added to 3rd segment of endopod; P1 to P3 (Fig.6,k) exopods with 12 setae (4+4+4),endopod with an additional seta in well formed cleft of chela; P4 and P5 with an additional short inner distolateral seta; uropod (Fig.6.l), exopod with 16 plumose setae and 1 nonplumose distolateral seta, endopod with 14 setae. Duration of this substage was 48-72 hours.

MYSIS IV

MTL: 3.19 mm (3.10-3.36 mm); MCL: 0.93 mm (0.91-1.05 mm).

Rostrum extending only up to ½ eye, rostral tooth well formed, no hepatic spine (Fig.7,g), cleft of telson very shallow, short pleopod buds appear (Fig.7,g).

A1 with 4 setae above stylocerite, 1 more terminal aesthaetes added to outer flagellar rudiment and 1 short seta to inner flagellar, rudiment; A2 (Fig.8,a) scaphocerite with 17 setae and one distolateral spine, endopod nearly ½ length of scale, Md (Fig.8,b) palp prominent; Mx2 exopod with 20 setae (Fig.7,h), one outer seta added to basal segment of endopod; Mxp1 (Fig.7,i) gill rudiment more prominent, tuft of hair-like setae on outer proximal margin prominent; Mxp2 with one outer lateral seta added to 3rd segment of endopod, exopod with 2+4+2 setae: P1 to P3 (Fig.8,c) with well formed chela, tips of chelae pointed, endopod 4 segmented, 2 additional setae originate from faint demarcation of dactylus from propodus, 1 short inner seta added to 3rd segment, exopod with 4+4+4 setae, appears to have 4 distal segments; P4 and P5 (Fig.8,d) with 5 segmented endopod, 2 additional setae at junction of dactylus with propodus; uropod (Fig.7,j) exopod with 17 to 18 plumose setae and 1 nonplumose distolateral seta; endopod with 17 to 18 setae. Duration of this substage was 48-72 hours.

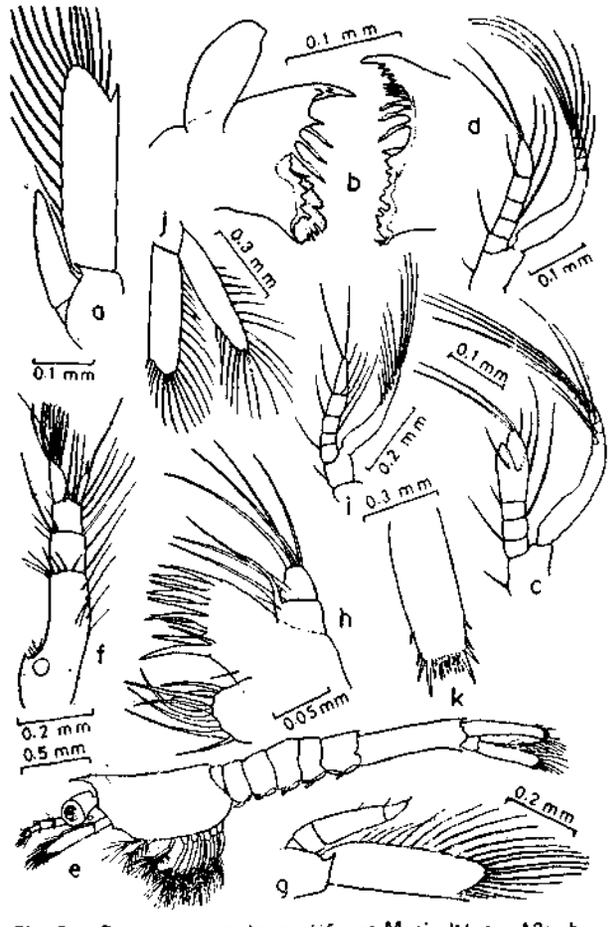

Fig. 8- *Parapenaeopsis stylifera*; Mysis IV: a - A2; b - Md; c-P1; d - P5. Mysis V: e - lateral view; f - A1; g - A2; h - Mx1; i - P5; j - uropod; k - telson.

MYSIS V

MTL: 3.49 mm (3.48 - 3.51 mm); MCL: 1.01 mm (1.01-1.02 mm).

Rostrum short, extending to ½ eye (Fig.8,e), single rostral tooth, pleopod rudiment longer, unsegmented, telson without cleft (Fig.8,k).

A1 (Fig.8,g) scaphocerite with 21 setae and 1 diatolateral spine, endopod 4 segmented, tipped with a seta, 2 minute lateral setae may be present; Md with large palp; Mx1 (Fig.8,h) with 11 setae on distal and 8 setae on proximal endites; Mx2 (Fig 9,a) exopod with 25 setae; Mxp1 with gill rudiment longer, exopod with more hair-like setae proximal to outermost seta; Mxp2 no change in endopod, exopod with 3+4+3 setae; Mxp3 (Fig.9,b) exopod with 5+4+5 setae, gill rudiment present on basal segment of protopod; exopod of P1 to P3 (Fig.9,c) with 6+4+6 setae; exopod of P4 and P5 (Fig.8,i) with 6+4+6 setae, some with 5+4+6 setae; uropod (Fig,8,j) exopod with 20 plumose setae and a nonplumose distolateral seta, endopod with 19 setae. Duration of this substage was 36-56 hours.

MYSIS VI

MTL: 3.85 mm (3.76 -3.93 mm); MCL: 1 12 mm.

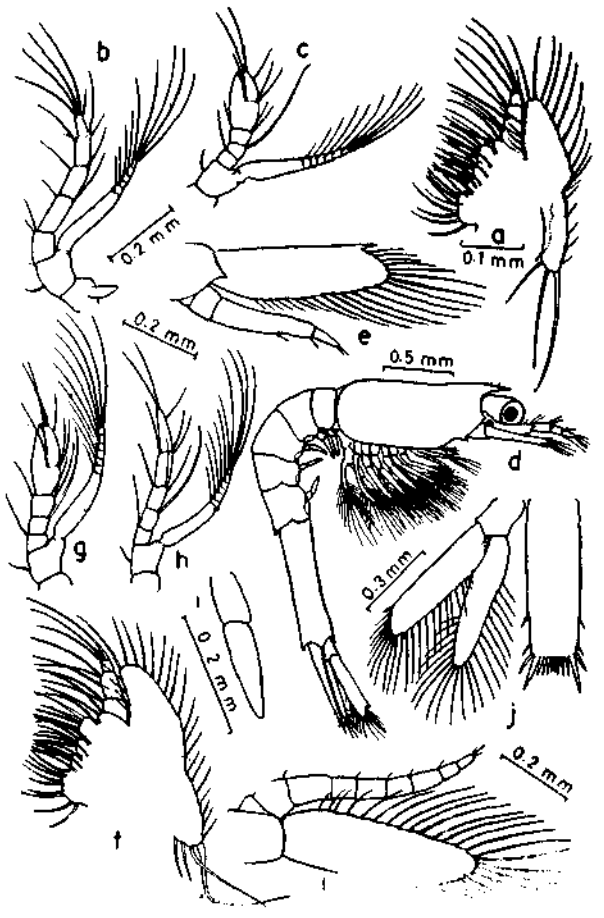

Fig. 9. *Parapenaeopsis stylifera*: Mysis:V: a - Mx2 b - Mxp3; c - P3. Mysis VI: d - lateral view; e - A2d f - Mx2; g - P3; h - P5; i - pleopod; j - uropod an; telson. Mysis VII: k - A2.

Rostrum (Fig.9,d) with 1 tooth, pleopods short but 2 segmented (Fig.9,i).

A2 (Fig.9,e) scaphocerite with 21 to 22 plumose setae and a distolateral spine, endopod ¾ of scale, 4 segmented, tipped with 2 setae, 2 lateral setae present; Md palp larger; Mx2 (Fig.9,f) exopod with 27 setae; Mxp2 exopod with 4+4+4 setae; P1 to P3 chelae longer (Fig.9,g) ; endopods of P4 and P5 longer than exopods (Fig.9,h) ; uropod(Fig.9,j) exopod with 21 to 23 plumose setae and a nonplumose distolateral seta; endopod with 21 to 22 setae. Duration of this substage was 36-56 hours.

MYSIS VII

MTL: 3.85 mm (3.68 - 4.09 mm); MCL: 1.13 mm (1.12 - 1.16 mm).

2 rostral teeth (Fig. 10, a) hepatic spine still absent, pleopods long and 2 segmented, but without setae (Fig. 10,h), telson slightly convex.

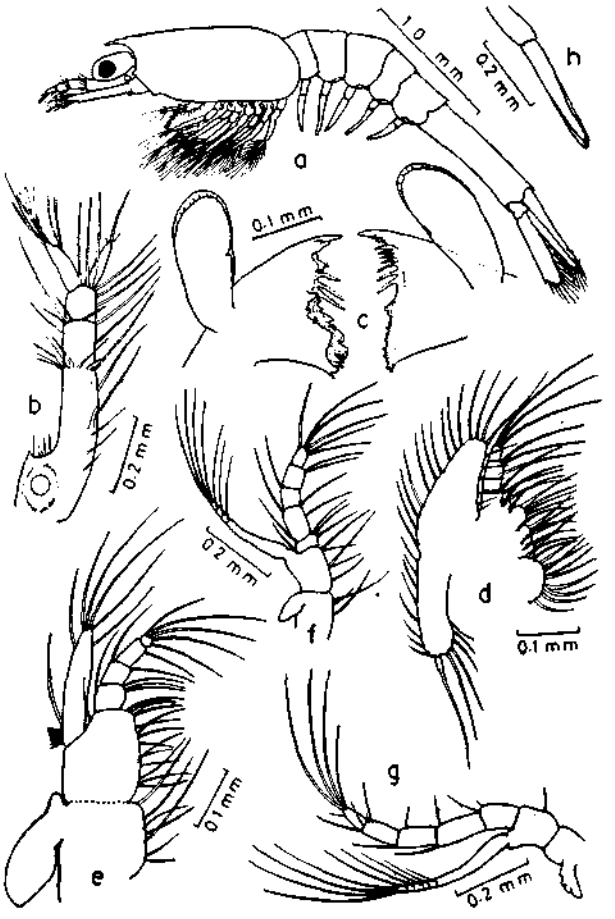

Fig. 10. *Parapenaeopsis stylifera*: Mysis VII: a - lateral view; b A1; c - Md; d - Mx2; e - Mxp1; f - Mxp2; g - Mxp3; h - pleopod.

A1 (Fig. 10,b) with 5 setae above stylocerite, inner flagellum almost as long as outer; A2 (Fig. 9,k) scaphocerite with 24 setae and a distolateral spine, endopod longer than scaphocerite and 8 segmented with 5 lateral and 3 terminal setae; Md (Fig. 10,c) with palp large and club; shaped; Mx2 (Fig. 10,d) exopod with 33 setae Mxp1 (Fig. 10,e), gill larger, number of hair-like setae on exopod increased; Mxp2 (Fig. 10,f), gill rudiment prominent; Mxp3 (Fig. 10,g) exopod with 6 + 4 + 6 setae, gill rudiments prominent; P1 to P5 endopods longer than exopods, dactylus clearly demarcated from propodus in the chelate legs, dactylus of P4 and P 5 pointed, bearing 2 setae and a minute spine; exopod of uropod with 22 plumose setae and a distolateral nonplumose seta, endopod with 21 setae. Duration of this substage was 24-48 hours.

POSTLARVA I

MTL: 3. 80 mm (3. 72- 3. 86 mm); MCL: 1.18 mm (1.13- 1.20 mm).

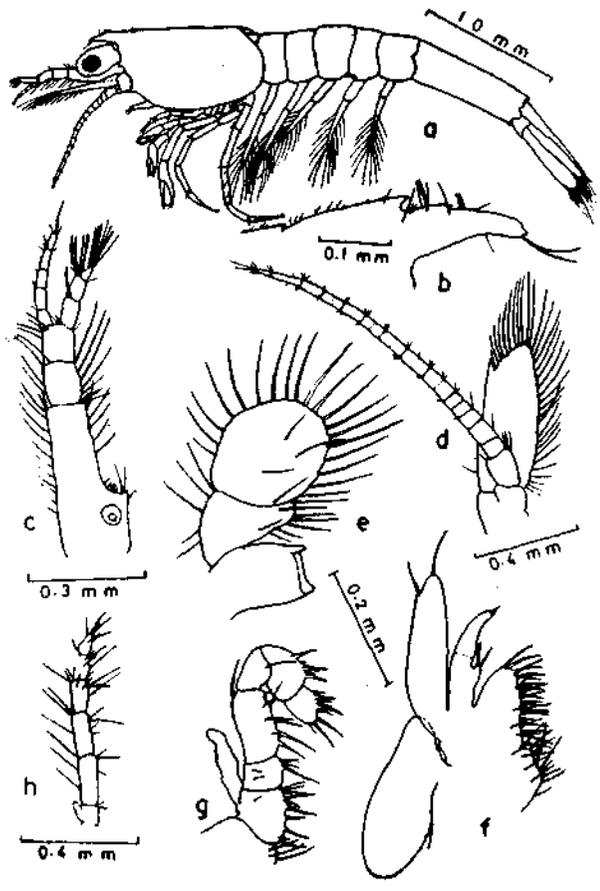

Fig. 11. *Parapenaeopsis stylifera*: Postlarva I: a - lateral view; b - tip of rostrum; c - A1; d - A2 e - Md; f-Mxp1; g - Mxp2; h - Mxp3.

Carapace with 2 rostral teeth and an epigastric tooth (Fig. 11,a), 2 long plumose setae originate subterminally on ventral side of rostrum, 2 short stout setae in front of 2 distal rostral teeth (Fig. 11,b), 3 spinules in between epigastric and penultimate rostral tooth and 1 minute spinule posterior to epigastric, hepatic spine present, dorsal spine on 5th abdominal segment has disappeared; posterior margin of telson tapering and ends in a prominent median spine which is longer than the 4 pairs of telsonic setae (Fig.12,j) present on either side of it; pleopods setose (Fig.12,g & h).

A1 (Fig.11,c) outer flagellum shorter than inner and 3 segmented, inner flagellum 5 segmented; A2 (Fig.11,d) scaphocerite broad with 33 plumose setae and a distolateral spine, flagellum longer than scale with 15 segments, some segments faintly subdivided into 2; Md (Fig.11,e) standing teeth absent but with sharp cutting edge between incisor and molar processes, palp well developed with 2 segments,

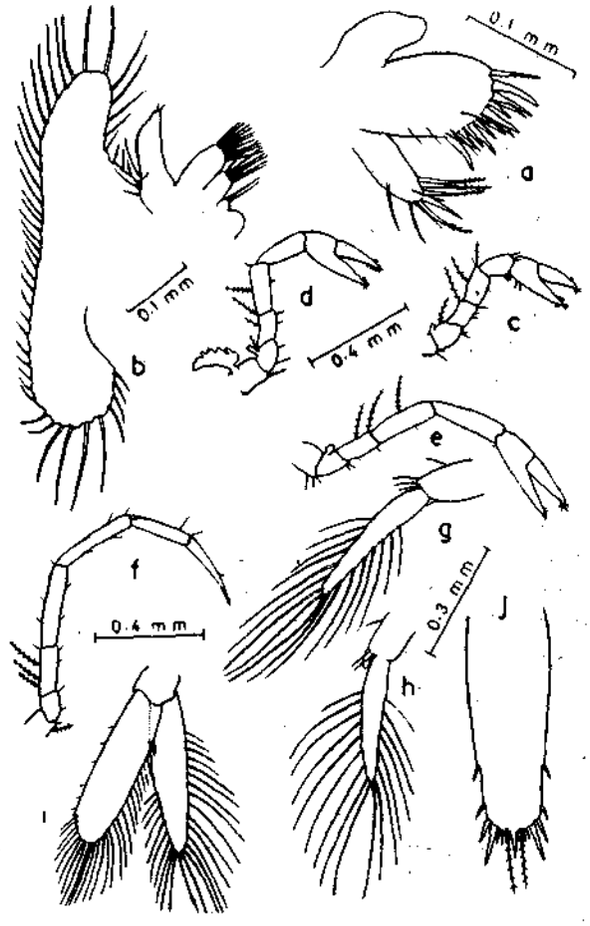

Fig. 12. *Parapenaeopsis stylifera*: Postlarva I; a-Mx1 b - Mx2; c - P1; d - P2; e - P3; f - P5; g - pleopod IV; h - pleopod V; i - uropod; j - telson.

distal oval one longer than proximal segment, numerous plumose setae on both segments; Mx1 (Fig.12,a), endopod reduced to unsegmented naked palp, more setae added to endites; Mx2 (Fig.12,b) exopod with 48 to 50 plumose setae, endopod reduced to unsegmented palp bearing 3 outer lateral setae and 2 minute terminal setae, 4 endites seen, distal bearing 10 setae, 3rd 6 to 7, 2nd 2 and 1st none; Mxp1 (Fig.11,f) protopod broad with more number of setae, endopod reduced to faintly

2 segmented palp with 3 short terminal setae and 2 small lateral setae, exopod with only 2 setae, 1 terminal and 1 subterminal, gill rudiment large; Mxp2 (Fig.11,g) endopod recurved, with stout bristles on distal and penultimate segments, exopod shrunken, without setae; Mxp3 (Fig.11,h) exopod vestigial and endopod with more nonplumose setae; P1 to P3 (Fig. 12,c,d,e) with functional chelae, without long terminal and lateral plumose setae, minute teeth present on inner distal margin of dactylus and propodus, exopod vestigial; endopod of P4 and P5 (Fig.12,f) with sharply pointed dactylus without long terminal plumose setae; distal segment of pleopods (Fig.12,g.h) with 17 to 19 long plumose setae, basal segment with 3 short distal setae and 1 short lateral seta; the 5th pleopod with small endopod bud (Fig.12,h); uropod (Fig.12,i) exopod with 27 to 29 Plumose setae and a distolateral tooth, endopod with 25 to 27 plumose setae.

DISCUSSION

Nauplius IV, V and VI of *Parapenaeopsis stylifera* possess a characteristically long proximal inner lateral seta on A1. This seta is so long that it overlaps its fellow from the other A1; it is directed posteriorly and invariably bent sharply in distal 1/3. Another interesting naupliar character of *P.stylifera* is the ventrally and outwardly bent disposition of the pair of furcal setae immediately medial to the longest pair of furcal setae in nauplius VI. The characteristic A1 setation and the peculiarly bent furcal setae are not seen in the nauplii of *P. stylifera* described and illustrated by Rao[1]. During the present study 6 nauplius substages were evident, whereas Rao[1] and Thomas et. al. (1974, *Indian J. Fish*), 21 (1) : 266-271) have described only 5.

During the present study it was found that the protozoea of *P. stylifera* are characterised by the following features: (1) the frontal organs are rounded in protozoea I; (2) A1 is distinctly longer than A2; (3) A2 endopod has 2 + 2 lateral setae and 4 long setae and 1 short hair terminally, in all the 3 protozoea substages; (4) the basal A1 segment has 4 subsegments in protozoea I and 3 subsegments in protozoea II; (5) the caudal furcae are narrow, long and widely separated from each other, in protozoea I and II; (6) supraorbital spines are absent in protozoea II and III; (7) A1 is clearly 4 segmented in protozoea III; (8) the endopod of Mx1 has only 2 segments, the distal segment bearing 4 terminal setae and 1 inner lateral seta whose origin appears to mark the position of the missing segment; (9) the endopod of Mx2 has only 3 segments, the single inner lateral seta on the middle segment appears to mark the position of the missing segment; (10) Mxp3 is rudimentary, represented by a setose biramous bud.

When compared with the present description the following discrepancies are noted in the illustrations of protozoea substages given by Rao[1]: (1) basal segment of the A1 has 5 subsegments in protozoea I and II (2) A^1 bears 3 subequal terminal setae in protozoea I, while in the present material one of them is considerably longer than the others; (3) proximal pair of lateral setae on the A2 endopod is shown as originating from the junction of the endopod with the protopod whereas they actually originate from the middle of the proximal endopod segment; (4) endopod of Mx2 is 5 segmented instead of being 3 segmented; (5) endopod of Mx1 is 3 segmented and not 2 segmented as observed in the present study; (6) A1 of protozoea III has only 3 segments, not 4; (7) Mxp3 of protozoea II and III are shown as fully developed biramous setose appendages with 4 segmented endopods, whereas they are actually very small biramous buds.

Based on the present study it can be said that the mysis stage of *P. stylifera* is characterised by the following features; (1) rostrum is short extending to about ½ length of eye; (2) hepatic spine is absent in all mysis substages; (3) small supraorbital spine present in mysis I and II; (4) left Md has 7 free standing teeth; (5) endopod of Mx1 2 segmented, the distal segment bears 4 terminal setae and 1 inner lateral seta in the middle; (6) endopod of Mx2 3 segmented, the middle segment has 2 distolateral setae and a single lateral seta in the middle of the segment; (7) exopod of Mxp1 with 7 plumose setae and a tuft of very thin hair-like setae on outer margin just below the outermost lateral seta; (8) telson bears 8 pairs of setae; (9) exopod of P1 to P5 with 10 plumose setae in mysis I, the number increasing to 16 in later mysis substages: (10) endopod

of P1 to P5 with a very long outer lateral plumose seta extending well beyond the tip of the endopod; (11) outer margin of the exopod of uropod is not produced into a short tooth or spine distolaterally; (2) there are at least 7 mysis substages.

Rao[1] in his account of the larval history of *P. stylifera* recognised only 3 mysis substages, has drawn hepatic spines for mysis II and III and has not shown the supraorbital spines even in mysis I. The absence of hepatic spine in all the mysis substages and the presence of supraorbital spine in mysis I and II were confirmed during the present study by examining hundreds of fresh specimens. Further, in the mysis substages of *P. stylifera* studied by us the setae on the exopod of Mx2 are distributed uniformly along the entire margin, but they are shown confined to the distal and proximal ends in the figures given by Rao, and the number of setae is also considerably lower than in the present material. The mysis substages attributed by George and Paulinose (1973, *I. O. B. C. Handbook*, v : 60-69) [3] to *P. stylifera* do not appear to belong to this species for the following reasons: (1) the rostrum extends well beyond the eye whereas in *P. stylifera* it clearly falls short of anterior end of eye; (2) the dorsal spine on 5th and 6th abdominal segments are very long. But the larvae described by them undoubtedly belong to some species of *Parapenaeopsis*.

The postlarva I does not differ much from the description of Mohamed et. al. (1969, *FAO Fish. Rep.*, 57 (2): 487-503). The broad A2 scale, the long multisegmented A2 flagellum, the 5 segmented inner A1 flagellum, the large Md palp with many plumose setae and the posterior median spine on the telson appear to be characteristic features of postlarva I of *P. stylifera*. The occurrence of a small endopod bud on the 5th pair of pelopods is a peculiar feature which has not been mentioned by the earlier workers.

Sometimes the last mysis substage moults into an intermediate stage, which has all the characteristics of the postlarva except for the fact that the appendages have fewer number of setae and may lack the posteromedian spine on the telson.