IV. LARVAL DEVELOPMENT
FAMILY PALAEMONIDAE
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Though the prawns of the family Palaemonidae are the most well known amongst the caridean prawns, a review of larval literature shows that larvae of the subfamily Palaemoninae are better known than those of the subfamily Pontoniinae.

SUBFAMILY PALAEMONINAE

This subfamily as listed by Holthuis (1950) contains 12 genera (inclusive of the subgenera) and though larvae of most of these genera are somewhat fairly known, details of the larval works have been given here only for the genera Palaemon and Macrobrachium with which the present thesis deals (in the genus Leandrites, however, no larvae are described so far) and for the remaining genera, mainly the following important works may be mentioned:

Genus Palaemonetes: Sollaud, 1923; Gurney, 1924; Meehean, 1936; Shen, 1939; Broad, 1957; Broad and Hubschman, 1960; Boschii, 1961 and Dobkin, 1963 and 1971.

Genus **Leander** : Gurney, 1939.
Genus **Brachycarpus** : Gurney, 1938.
Genus **Pseudopalaemon** : Sollaud, 1923.
Genus **Desmocaris** : Sollaud, 1912.

In Karwar, this subfamily is represented by 3 genera viz. **Leandrites**, **Palaemon** and **Macrobrachium**.
GENUS LEANDRITES
GENUS LEANDRITES

As far as the author is aware, so far no larvae have been described in this genus, except for a late postlarval specimen of what Pillai (1965) ascribes to Palaemonetes hornelli (= Leandrites celebensis).

Leandrites celebensis is the only species representing this genus in Karwar. Attempts to work out the lifehistory of this species did not meet with success beyond stage I.

1. Leandrites celebensis (De Man)

Description of Larval Stages

Zoea I

(Fig. 26)

Total length = 1.90 mm; duration of stage = lived up to 48 hrs.

Eyes sessile, rostrum slender, about as long as antennal peduncle. Abdomen 5-segmented, all segments smooth.

Antennule (Fig. 26, b): Outer ramus with 4 aesthetascs + 1 plumose seta, future inner ramus represented by a long subterminal, delicate, plumose seta.

Antenna (Fig. 26, c): Scale with 3 distal segments and with 9 marginal, plumose setae; endopod rather broad, reaching to about 2/3 of scale, terminating in a small spine from inner angle of which arises a long plumose seta.
Mandibles (Fig. 26, d): Slightly assymetrical, both incisor and molar processes with minute teeth, no palp.

First maxilla (Fig. 26, e): Coxal endite with 4 bristles, basal with 2 stout and 3 small serrated teeth; palp slender and comparatively long, with 2 terminal setae.

Second maxilla (Fig. 26, f): Coxal endite single lobed with 2 setae, basal endite bilobed with 1 and 4 setae; endopod with a single terminal seta, scaphognathite with 3 distal + 1 posterior setae.

First maxilliped (Fig. 26, g): Endopod 3-segmented with 1, 1, 3 setae distalwards; exopod having 4 terminal setae; basis rather peculiar, protruding on distal inner margin, having 8 setae.

Second maxilliped (Fig. 26, h): Endopod 4-segmented with 1, 0, 2, 4 setae; exopod with 4 terminal setae; basis normal with 3 setae.

Third maxilliped (Fig. 26, i): Endopod 4-segmented, setation being 1, 0, 2 + 1 and last segment drawn into a long seta and with another equally long seta subterminally, exopod with 4 terminal natatory setae.

Pereiopod buds (Fig. 26, j): First and second pereiopods as fairly long, biramous buds.

Telson (Fig. 26, q): Triangular, with a very shallow median notch on posterior margin; process formula 7 + 7, third and fourth processes being longest, minute spinules inbetween processes from fifth to seventh.
No anal spine.

Chromatophores: Inner half of antennal peduncle speckled with red dots; densely stellate, large (unpaired) red chromatophores on middorsal region of second and third abdominal segments and on anal region; a smaller posterodorsally on fifth abdominal segment and posterolaterally on telson.

Discussion:

So far only 4 species are known in the genus *Leandrites* (Holthuis, 1950; Fujino and Miyake, 1969), but except for a short description of an advanced postlarval stage from the Travancore plankton, referred by Pillai (1955) to *Palaemonetes hornelli* (= *L. celebensis*) no information is available on the larvae in the genus.

Based on the stage I larva of the present species *L. celebensis*, it is interesting to observe that the larvae besides having subfamily Palaemoninae characters, also share some features of the genus *Periclimenes* (Harpilius) of the subfamily Pontoniinae viz. protruding distal part of the first maxilliped basis and dactylus drawn out into long seta-like process besides similar long subterminal seta of the third maxilliped etc. Its closer affinity with Pontoniinae however, can be confirmed only when more number of stages as well as species is known in the genus *Leandrites*.

Following can be considered as the distinctive features of stage I of *Leandrites* larvae, based on the present species:

Rostrum acute, fairly long and slender; carapace and
abdomen smooth; palp of first maxilla long, slender with 2 apical setae, that of second maxilla small, single lobed with a small seta at tip; first maxilliped with basis characteristically protruded distally; third maxilliped endoped tip drawn into a long seta with a similar subterminal seta; first 2 pairs of well developed biramous pereioped buds; telson with second to fifth processes on lobed margin, median notch of posterior margin very shallow.
GENUS *PALAEMON*

Subgenus *Palaemon*

Though many Palaemonid larvae have been described from plankton by various authors (Gurney, 1924, 1938; Gurney and Lebour, 1941; Williamson, 1970 etc), larvae with known parentage have been known only in the following species as far as the subgenus *Palaemon* of the genus *Palaemon* is concerned:

- P. (P.) *serratus* and P. (P.) *squilla* (= *Leander squilla* and *L. serratus* respectively) have been described by Webb (1922) and Gurney (1924) from Plymouth waters. P. (P.) *longirostris* (= *L. longirostris*) and P. (P.) *pacificus* (= *L. pacificus*) have been described by Gurney (1924 and 1938) respectively, stage I being hatched in laboratory. P. (P.) *paucidens* (= *Leander paucidens*) has been described by Yokoya (1931) while dealing with Japanese fresh water Palaemonids. First 2 stages (obtained in the laboratory) of P. (P.) *affinis* (= *Leander affinis*) has been described by Gurney and Lebour (1941) from Bermuda. Amongst later works mention must be made of the following species: P. (P.) *adsperus* (= *Leander adsperus*) of which lifehistory is dealt by Jensen (1958). Kurata (1968) deals with the complete metamorphosis in the laboratory of 4 Japanese species viz. P. (P.) *serrifer*, P. (P.) *pacificus*, P. (P.) *ortmanni* and P. (P.) *macrodactylus*, the lifehistories of last mentioned species again described by Little (1969) from the American waters.

From India, Naik (1972, unpublished) gives an account of
complete lifehistory of *P. (P.) pacificus* and *P. (P.) serrifer* observed in the laboratory from the Bombay waters except for which no larvae of this subgenus have been so far described.

In Karwar the subgenus *Palaemon* is represented by 4 species viz. 1. *P. (P.) belindae*, 2. *P. (P.) debilis*, 3. *P. (P.) serrifer* and 4. *P. (P.) pacificus*, of which complete lifehistory in one species, i.e. *P. (P.) debilis* Dana, comprising 13 zoeal and a postlarval stages and upto zoea X only in another species *P. (P.) belindae* (Kemp), could be worked out in the present studies (larvae of the remaining 2 species viz. *serrifer* and *pacificus* were also reared through entire metamorphosis by the author and his colleagues, but have not been included in the present thesis).

2. *Palaemon (Palaemon) belindae* (Kemp)

**Description of Larval Stages**

**Zoea I**

(Fig. 27)

Total length = 2.85 mm; duration of stage = 36 to 44 hrs.

Eyes sessile. Rostrum slightly overreaching antennal scale, its tip ventrally serrated, carapace smooth; abdomen 5-segmented, all segmented smooth.

Antennule (Fig. 27, b): Peduncle unsegmented, outer ramus with 4 aesthetascs + 1 short plumose seta; inner ramus not yet developed, but in its place a long plumose seta present.
Antenna (Fig. 27, c) : Scale with 5 distal segments and 10 + 1 (outer) setae; endopod reaching to about 2/3 of scale terminating into a tooth-like spine, from inner angle of which a long plumose seta arise.

Mandibles (Fig. 27, d) : Slightly asymmetrical, without palp, incisor and molar processes differentiated and with teeth.

First maxilla (Fig. 27, e) : Coxal endite with 6 setae; basal endite with 5 incurved teeth; palp unsegmented with a single terminal seta.

Second maxilla (Fig. 27, f) : Coxal endite single lobed with 3 setae, basal endite bilobed with 3 + 4 setae; endopod bilobed, basal lobe with 2 and distal with 1 setae; scaphognathite with 4 + 1 (posterior rather long) setae, inner margin fringed with hairs.

First maxilliped (Fig. 27, g) : Endopod 3-segmented with 0, 1, 4 setae distalwards; exopod faintly segmented at tip with 4 terminal + 1 subterminal setae; basis with 5 setae.

Second maxilliped (Fig. 27, h) : Endopod 4-segmented with 0, 0, 2, 3 setae distalwards; exopod faintly 2-segmented at tip with 4 terminal and 2 + 2 (small) subterminal setae; basis with 3 setae.

Third maxilliped (Fig. 27, i) : Endopod 4-segmented with 1, 1, 2, 3 setae distalwards (terminal seta long, bristal-like); exopod as in second maxilliped; basis with 3 setae.

Pereiopod buds (Fig. 27, j) : Only first two pereiopods present as biramous, unsegmented buds.
Telson (Fig. 27, q): Triangular, process formula 7 + 7, first and seventh processes smallest, second to fourth longest; all processes plumose; posterior margin almost straight and spinulose in between processes from fourth to seventh.

Chromatophores: Much branched red chromatophores distributed as in figure (Fig. 27, a): Base of antenna; eyes dorsally; about 4 along ventral margin of carapace and each abdominal segment in addition to a prominent middorsal one on third abdominal segment.

Zoea II
(Fig. 28)

Total length = 3.20 mm; duration of stage = 44 to 48 hrs.

The salient changes over 1st zoea are:

i) Carapace with epigastric and antennal and pterygostomial spines; ii) rostrum ventrally hooked at tip; iii) eyes stalked; iv) fifth abdominal segment with a fairly long posterolateral pair of spines; v) antennular peduncle 2-segmented, both segments with setae as in figure, outer side of proximal segment dilated basally; vi) scale with distal segments reduced to 4, marginal plumose setae increased to 15 + 1; endopod with a small seta in place of small tooth-like spine of previous stage; vii) basal endite of first maxilla with 1 more tooth; viii) marginal setae of scaphognathite increased to 8; ix) endopod of third maxillipede 5-segmented with 1, 0, 0, 2, 3 setae distallywards; x) first two pereiopods functional, with 5-segmented endopod having 1, 0, 1, 2, 1 + 1 setae; xi) pereiopods third and fourth
biramous, unsegmented buds; fifth uniramous, unsegmented small bud; xii) telson process formula increased to 3 - 3.

**Zoea III**
(Fig. 29)

Total length = 3.75 mm; duration of stage = 48 - 52 hrs.

This stage is characterised by:

i) Epigastric spines increased to 2; ii) antennular peduncle basally more dilated, ventral spine present; iii) antennal scale with distal segments reduced to 2 and marginal setae increased to 18 + 1; endopod 3-segmented with 3 terminal setae; iv) basal endite of first maxilla with 4 big + 3 small teeth; v) marginal setae of scaphognathite increased to 11; vi) first and second pereiopods well developed but third to fifth still in bud stage; vii) telson separated from sixth abdominal segment, process formula reduced to 7 + 7; viii) uropods functional, exopod with 12 setae and endopod bud-like.

**Zoea IV**
(Fig. 30)

Total length = 4.00 mm; duration of stage = 46 to 50 hrs.

Advancements over the previous stage are:

i) Epigastric spines increased to 3; ii) antennule with both rami developed, inner ramus about 1/2 of outer with a seta; small stylocerite formed; iii) antennal scale without any distal
segments; endopod about as long as scale; iv) scaphognathite marginal setae increased to 19; v) a small epipod bud on first maxilliped; vi) third pereiopod functional, endopod 5-segmented with 1, 0, 1, 4, 1 setae distalwards; vii) fourth pereiopod as biramous bud; viii) fifth functional, without exopod; ix) telson narrow, rectangular, process formula reduced to 5 + 5; x) endopod of uropods with setae.

Zoea V
(Fig. 31)

Total length = 4.50 mm; duration of stage = 50 - 52 hrs.

Changes from the stage IV are:

1) Endopod of antenna 4-segmented; ii) from this stage onwards, distal notch on endopod of second maxilla becomes much shallower so much so that in late stages, endopod appears almost single lobed, scaphognathite setae increased to 21; iii) fourth pereiopods functional, endopod 5-segmented with only distal 2 segments having 2 setae each; exopod small, less than half of endopod with 4 + 2 setae; iv) a small outer, terminal spine present on exopod of uropod.

Zoea VI
(Fig. 32)

Total length = 4.5 mm; duration of stage = 48 - 52 hrs.

This stage differs from the previous stage as:

1) Scaphognathite setae increased to 23; ii) epipod on
first maxilliped bilobed and exopod setae on all maxillipeds increased in number; iii) pleopods as tiny uniramous buds.

**Zoea VII**  
*(Fig. 33)*

Total length = 5.5 mm; duration of stage = 50 - 54 hrs.

Salient features of this stage are:

1) Outer ramus of antennule with 6 aesthetascs, in two groups (2 + 4); ii) antennal endopod 5-segmented; iii) scaphognathite with marginal setae increased to 26; iv) pleopod buds longer; v) telson more elongated.

**Zoea VIII**  
*(Fig. 34)*

Total length = 6.10 mm; duration of stage = 48 - 52 hrs.

Advancements over stage VII are:

1) Both rami of antennule almost equal; ii) endopod of antenna more flagellar with 6 segments; iii) scaphognathite marginal setae increased to 35; iv) exopod of first maxilliped with 4 outer, basal setae; v) pleopods further developed but still in bud form.

**Zoea IX**  
*(Fig. 35)*

Total length = 6.9 mm; duration of stage = 50 - 54 hrs.
Important changes from previous stage are:

1) Both rami of antennule more elongated, outer ramus with 4 groups of 4 aesthetasc each; ii) antennal endopod more elongated, longer than scale and 9-segmented; iii) marginal setae of scaphognathite increased to 42; iv) first maxilliped with caridean lobe well marked; v) exopod setae on second and third maxillipeds increased to 4+6 and 4+10 respectively; vi) first and second pereiopods showing chelate nature; vii) all pleopods biramous, only exopods with 3-5 stumpy setae; viii) distal end of telson narrower than proximal.

**Zoea X**

(Fig. 36)

All larvae died in this stage without moulting further.

Total length = 7.10 mm; duration of stage = died after 40 hrs.

This stage differs from stage IX as under:

1) Outer ramus of antennule 2-segmented and with more aesthetasc; ii) antennal endopod more flagellar with 11 segments and peduncle now with a blunt spine; iii) marginal setae on scaphognathite increased to 46; iv) basal setae of exopod of first maxilliped increased to 7; v) endopod of pleopods with more setae, rudiments of *appendix interna* on endopod of second and third pleopods.
3. **PALAEON (PALAEON) DEBILIS DANA**

**Description of Larval Stages**

**Zoea I**

(Fig. 37)

Total length = 2.5 mm; duration of stage = 30 - 36 hrs.

Eyes sessile. Rostrum with tip ventrally serrated and just short of reaching antennule; carapace smooth, except for pterygostomial spine; abdomen 5-segmented, all segments smooth except for fifth bearing a pair of posterolateral spines.

Antennule (Fig. 37, b): Outer ramus with 3 aesthetascs and 1 plumose seta terminally and future inner ramus represented by a long subterminal plumose seta.

Antenna (Fig. 37, c): Scale with 5 distal segments and with 9 long plumose setae on inner side; one small hair-like seta as in figure besides 1 small outer plumose seta; endopod rather long, reaching to about 3/4 of scale, terminating into a tooth-like spine, from inner angle of which a long plumose seta arises as shown in figure.

Mandibles (Fig. 37, d): Slightly asymmetrical, both incisor and molar processes with minute teeth; no palp.

First maxilla (Fig. 37, e): Coxal endite with 6 bristles, basal with 4 unequal teeth and 1 seta; palp unsegmented with a single, simple terminal seta.

Second maxilla (Fig. 37, f): Coxal endite single lobed with 2 + 2 setae, basal endite bilobed with 3 and 4 setae;
endopod unsegmented and bilobed, distal lobe with a single terminal seta and proximal with 2 setae. Scaphognathite with 3 + 1 (posterior rather long) setae.

First maxilliped (Fig. 37, g): Endopod 3-segmented with 0, 1 and 3 + 1 minute hair-like setae distalwards; exopod 2-segmented with 4 long, terminal plumose setae on smaller distal segment and 1 subterminal small seta on proximal segment. Basis with 6 and coxa with single setae.

Second maxilliped (Fig. 37, h): Endopod 4-segmented with 1, 0, 3, 3 setae distalwards (terminal segment ending in a long bristle-like seta as in fig.); exopod 3-segmented, with 4 terminal and 2 + 1 subterminal setae; basis with 3 setae.

Third maxilliped (Fig. 37, i): Endopod 4-segmented (first segment small) with 1, 1, 3 & 3 setae distalwards (terminal segment ending in a bristle-like seta); basis with 2 setae; exopod as in second maxilliped.

Pereiopod buds (Fig. 37, j): Only first and second pereiopods present as biramous, unsegmented buds.

Telson (Fig. 37, q): Triangular, process formula 7 + 7, first process smallest, third and fourth longest, rest almost equal. All processes plumose, posterior margin almost straight and spinulose inbetween processes from fourth to seventh.

Chromatophores: Red branched chromatophores on antennular peduncle; on eyes near base of rostrum; 3 on ventrolateral side of carapace; one each on ventrolateral side of first to fifth abdominal segments as shown in Fig. 37, a.
Also, a median pair of red chromatophores with diffused yellow around on fourth abdominal segment.

**Zoea II**

(Fig. 38)

Total length = 2.7 mm; duration of stage = 45 - 48 hrs.

Carapace with 1 epigastric and antennal (though supraorbital in position in this stage) and pterygostomial spines. Eyes stalked.

Antennule (Fig. 38, b): Peduncle 2-segmented; outer ramus with 1 more aesthetasc (in all 4). 2 more plumose setae added onto peduncle as in figure.

Antenna (Fig. 38, c): Scale 4-segmented distally, in all with 14 setae as shown in figure; endopod with 1 additional plumose seta than in first stage.

Except for addition of 1 long tooth on basal endite of first maxilla, 4 more setae on scaphognathite of second maxilla, 1 seta each on exopod of first and third maxillipeds, there is no change in mouth appendages.

Pereiopods (Fig. 38, k,l): Both first and second pairs functional, biramous. Endopod of first 5-segmented with 1, 1, 1, 3, 3 setae distally and that of second also (Fig. 1) 5-segmented but with setation 0, 0, 1, 3, 3 distally. Exopod in both with 4 terminal and 2 + 2 subterminal plumose setae; basis with 2 setae each.
Telson (Fig. 38, q) : Process formula increased to $8+8$, median eighth pair being smallest.

**Zoea III**
(Fig. 39)

Total length = 2.7 mm ; duration of stage = 45 - 48 hrs.

Rostrum with 3 teeth on carapace; abdomen now 6-segmented, with sixth segment separated from telson, biramous uropods with only exopods functional.

Antennule (Fig. 39, b) : Outer ramus with 3 aesthetascos; peduncle with basal segment armed with a small ventral spine and setae as in figure.

Antenna (Fig. 39, c) : Scale still segmented at tip, with 19 setae in all; endopod 2-segmented, distal segment with 4 unequal setae.

Marginal plumose setae of scaphognathite increased to 13 and pereiopod (3 - 5) buds seen. Endopod of third maxilliped 5-segmented. Otherwise no change in oral appendages and also the first two pereiopods.

Telson (Fig. 39, q) : Now narrower and longer, separated from sixth abdominal segment, process formula $7+7$.

Uropods (Fig. 39, q) : Now appear with functional exopod having 9 - 10 marginal setae and a small non-functional endopod.
Zoea IV
(Fig. 40)

Total length = 3.04 mm ; duration of stage = 45 - 50 hrs.

The salient changes over third stage are :

i) Inner ramus of antennule somewhat differentiated from peduncle, basal portion of peduncle slightly lobed as in figure; ii) antennal endopod 4-segmented, distal segmentation and outer seta of scale lost but terminal spine developed; iii) celson considerably narrower and longer than in previous stage, first 3 processes completely reduced, process formula 5 + 5; iv) both rami of uropod functional, almost equal in length with 15 setae on exopod and 9 on endopod, both rami distinctly articulated with protopod.

Zoea V
(Fig. 41)

Total length = 3.6 mm ; duration of stage = 48 - 54 hrs.

This stage differs from fourth stage mainly as under :

i) Antennal scale spine longer; ii) scaphognathite now with 15 setae; iii) all pereiopods present, third biramous with its endopod 5-segmented and exopod functional, fourth biramous but still in bud form and fifth uniramous, segmented as in figure.

Zoea VI
(Fig. 42)

Total length = 3.68 mm ; duration of stage = 44 - 48 hrs.
This stage is characterized by:

1) **Endopod of antenna 6-segmented;** ii) **scaphognathite with 22 marginal setae;** iii) fourth pereiopod which was rudimentary in previous stage, now functional with endopod 5-segmented and exopod with 4 terminal setae; iv) telson rather rectangular in shape, much longer than broad (L : B = 2.8 : 1), process formula still 5 + 5 and v) rami of uropods reaching almost entire length of telson.

**Zoea VII**
*(Fig. 43)*

Total length = 4.0 mm; duration of stage = 48 - 60 hrs.

The significant changes over previous stage are:

i) **Exopod of first maxilliped now with 2 plumose setae proximally on outer margin in addition to a distal long plumose seta;** ii) **uropod rami a little longer than telson and iii) telson narrower than in previous stage (L : B = 2.6 : 1).**

**Zoea VIII**
*(Fig. 44)*

Total length = 4.0 mm; duration of stage = 48 - 54 hrs.

Following are the main changes from previous stage:

1) **Both rami of antennule rather more developed;** ii) endopod of antenna 7-segmented reaching slightly beyond scale; iii) **mandible with more teeth on its process;** iv) first
maxilliped with basal setae on its margin; v) first pereiopod 
now showing traces of chelate nature and its exopod with 10 
setae; vi) second pereiopod with exopod setae as in first 
pereiopod; vii) minute pleopod buds (5 pairs) present and 
iviii) telson becoming gradually narrower posteriorly.

**Zoea IX**
(Fig. 45)

Total length = 4.9 mm ; duration of stage = 44 - 48 hrs.

Following are the advancements over the previous stage :

1) Antennal endopod 10-segmented, longer than scale 
assuming flagellar appearance; ii) first maxilliped with 8 setae 
on proximal lobe of exopod; iii) first 2 pairs of pereiopods now 
distinctly showing their chelate nature and iv) 5 pairs of 
pleopods as biramous buds on first to fifth abdominal segments.

**Zoea X**
(Fig. 46)

Total length = 4.95 mm ; duration of stage = 44 - 48 hrs.

Larva has the following characteristics :

i) Both rami of antennule longer; ii) antenna with a 
small ventral spine and its endopod with 11 segments and iii) 
first maxilliped with increased number of basal setae and with 
an epipod bud.
Zoea XI
(Fig. 47)

Total length = 5.4 mm; duration of stage = 44 - 48 hrs.

No marked changes over previous stage except for general increase in size of larva and in setation; pleopods a little elongated, but still in bud form.

Zoea XII
(Fig. 48)

Total length = 5.6 mm; duration of stage = 48 - 54 hrs.

Advancements over the previous stage are:

1) Outer ramus of antennule 2-segmented with aesthetasc in 3 groups of 2 each; ii) antenna with its flagellum overreaching scale by its 1/3 length and with spine on basal segment now distinct; iii) second maxilla with 3 + 1 setae on coxal endite and with 8 and 6 setae respectively on proximal and distal lobes of basal endite; iv) first and second pereiopods distinctly chelate; v) pleopods with traces of setation in distal part of exopod and buds of appendix interna on endopods of second to fifth and vi) outer ramus of uropod with a small terminal spine.

Zoea XIII
(Fig. 49)

Total length = 5.80 mm; duration of stage = 44 - 48 hrs.

This last larval stage is characterized by the following
advancements:

1) Antenna with 14-segmented flagellum; ii) in second maxilla, endopod with 1 + 3 setae while both lobes of basal endite with 9 setae each and 3 + 1 setae on coxal endite; iii) first and second pereiopods with 11 setae each on exopod and with both fingers of almost equal length and iv) pleopods with traces of setae on both exopod and endopod except endopod of first appendix interna now more elongated.

Postlarva

(Fig. 50)

Total length = 6.50 mm.

Almost as in adult except for exopods of pereiopods which persist but in much reduced condition.

Rostrum slightly curved upwards at tip not as distinctly as in adult, falling short of reaching antennal scale, upper margin with 6 teeth (1 postorbital tooth), distal 1/3 without teeth and without subapical tooth of adult, lower margin with 2 teeth only; upper margin with a single row of setae, lower without setae, unlike that of adult where double row is present; carapace with antennal and brachioseptal spines.

Antennule (Fig. 50, b) : Basal segment with a ventral spine; stylocerite reaching almost to middle of basal segment, distolateral margin produced into a spine; second and third segments nearly equal in length; both inner and outer remi
almost of equal length, outer ramus not bifid unlike adult and 8-segmented with 1, 2, 3 aesthetascs on first to third segments, inner ramus 6-segmented.

Antenna (Fig. 50, c) : Scale slightly overreaching rostrum and its spine slightly longer than its anterior margin. Flagellum about 3.5-times length of scale, tooth on basal segment distinct.

Mandibles (Fig. 50, d) : Similar and with incisor and molar processes well differentiated and palp not yet developed unlike in adult.

Maxillae (Figs. 50, e & f) : Almost like in adult but palp of second maxilla still bilobed with a subterminal seta, posterior lobe of scaphognathite still long and narrow as in zoeal stages.

Maxillipeds (Fig. 50, g-i) : First with 2-segmented endopod unlike unsegmented one of adults; second almost as in adult; exopod of third with 4 terminal setae and reaching to 1/2 of antepenultimate segment of endopod.

Pereiopods : Unlike in adult, exopods still persist on first to fourth pereiopods though much reduced.

First pereiopod (Fig. 50, k) : Chelate, cutting edges smooth, fingers about as long as palm; chela longer than carpus; merus and carpus of almost equal length; exopod with 4 terminal setae.

Second pereiopod (Fig. 50, l) : Slightly longer than first, fingers slightly shorter or as long as palm; chela
slightly longer than carpus; merus and carpus subequal, exopod with setae.

Third to fifth pereiopods (Fig. 50, m-o): Almost like in adult, but third and fourth nonsetose and with rudiment of exopod.

Abdomen: All segments smooth with rounded pleura, the posterolateral spine of fifth segment of zoeal stages being absent in this stage.

Pleopods (Fig. 50, p₁ & p₂): Well developed with both exopod and endopod setose, appendix interna on second to fifth pleopods. Endopod 1/2 to 2/3 length of exopod in second to fifth but much reduced in first.

Telson (Fig. 50, q): In shape and structure almost as in adult with 2 pairs of dorsal spines, tip acute. Posterior margin with 4 pairs of spines (of which second pair longest) as against 2 pairs in adult, while with a pair of feathered setae as in adult.

Uropods (Fig. 50, q): Almost as in adult, except that exopod with 3 external spines instead of 2 of adult.

Discussion:

Gurney (1938), Gurney and Lebour (1941) and Gurney (1942), while dealing with various Palaemonid larvae both from plankton as well as those hatched in the laboratory, summarise the larval characters of the subfamily Palaemoninae and the genus Leander, most of the species of which are now placed under the genus Palaemon, particularly subgenus Palaemon e.g. P. (P.) debilis,
The larvae of both the present species viz. *P. (P.) belinda* and *P. (P.) debilis*, fit in well in Gurney's definition of the larvae of this group.

The study of the known larvae of *Palaemon* reveals an interesting uniformity and overlapping of larval features, thus rendering it difficult to separate out the larvae even at the generic level. Also, even in cases where complete metamorphosis is known, the larval features as well as the number of stages even in the same species like in *P. (P.) pacificus* and *P. (P.) serrifer*, are so much variable that a detailed comparison of larvae is rather difficult. In *P. (P.) pacificus*, Kurata (1968) describes 9 stages before postlarva, from the Japanese waters while Naik (1972, unpublished) observes 14 stages in his material from Bombay, India and 10 stages before postlarva are observed in the Karwar material reared by the author and his senior colleagues (unpublished, not included in this thesis). Similarly *P. (P.) serrifer* exhibits 7 stages before postlarva as worked out by Kurata (1968) from Japanese waters, 10 stages and 8 stages respectively as observed by Naik (1972, unpublished) from Bombay and author and his senior colleagues from Karwar, (unpublished, not included in the thesis) from India. Thus it has not been possible to give here any definition of larvae either for the subgenus or even for the genus.

**Subgenus Palaender**

In the subgenus *Palaender*, as far as the laboratory
reared complete lifehistory is concerned, information is so far available in only one species, Palaemon (Palaender) elegans Rathke from western Sweden (Hoglund, 1943) and from the Israel coast (Tsurnamal, 1963) (its third and last zoeal stages recorded from plankton off the Mediterranean Coast of Israel by Williamson, 1967), while in P. (P.) semmelinkii, only the stage I obtained from laboratory hatching, has been described by Prasad and Tampi (1957), from Mandapam along the east coast of India.

This subgenus is represented by only one species, P. (P.) semmelinkii (De Man) in Karwar and its entire metamorphosis, comprising 12 zoeal + 1 postlarval stages could be worked out in the present thesis. Though zoea I of the species has been described by Prasad and Tampi (1957), their larvae show considerable differences from corresponding stage of the present material and therefore, this stage is redescribed in detail in the present work.

4. Palaemon (Palaender) semmelinkii (De Man)

Description of Larval Stages

Zoea I

(Fig. 51)

Total length = 2.35 mm; duration of stage = 44 - 48 hrs.

Eyes sessile. Rostrum overreaching antennal scale, with its tip ventrally serrated; carapace smooth; abdomen 5-segmented, all segments smooth.
Antennule (Fig. 51, b) : Peduncle unsegmented, outer ramus with 4 unequal aesthetasc + 1 short, plumose seta; inner ramus not yet developed but in its place a long plumose seta present.

Antenna (Fig. 51, c) : Scale with 5 distal segments and 9 + 1 (outer) setae; endopod rather long, reaching to about 3/4 of scale, terminating into a tooth-like spine, from inner angle of which a long plumose seta arises as shown in figure.

Mandibles (Fig. 51, d) : Slightly asymmetrical, without palp, incisor and molar processes differentiated and armed with teeth.

First maxilla (Fig. 51, e) : Coxal endite with 5 setae, basal with 2 large and 2 small, rather incurved teeth and a plumose seta; palp unsegmented with a single terminal seta.

Second maxilla (Fig. 51, f) : Coxal endite single lobed with 2 setae; basal endite bilobed with 2 + 4 setae; endopod unsegmented, bilobed, basal lobe with 2 and distal with 1 setae; scaphognathite with 4 + 1 (posterior rather long) setae, inner margin fringed with fine hairs.

First maxilliped (Fig. 51, g) : Endopod 3-segmented with 0, 1, 4 setae distalwards; exopod faintly segmented at tip with 4 terminal + 2 subterminal setae; basis with 6 setae.

Second maxilliped (Fig. 51, h) : Endopod 4-segmented with 0, 0, 3, 1 + 2 setae distalwards; exopod faintly 2-segmented with 4 terminal and 2 + 2 subterminal setae; basis with a single seta.
Third maxilliped (Fig. 51, i): Endopod 4-segmented with 0, 0, 2, 1 setae distally (terminally ending in a bristle-like seta); exopod as in second maxilliped; basis without setae.

Pereiopod buds (Fig. 51, j): Only first and second pereiopods present as biramous, unsegmented buds.

Telson (Fig. 51, q): Triangular, process formula 7 + 7, first process smallest, fourth longest; third, fifth and seventh equal, all processes plumose; posterior margin almost straight and spinulose inbetween processes from fourth to seventh.

Chromatophores: Red branched chromatophores on antennal and antennular peduncles, above the eyes, 2 on ventral margin of carapace, a pair each on ventrolateral region of all the abdominal segments and in anal region.

Zoea II
(Fig. 52)
Total length = 2.65 mm; duration of stage = 42 - 46 hrs.

The salient changes over zoea I are:

1) Carapace with epigastric and antennal spines; ii) rostrum hooked ventrally at tip; iii) eyes stalked; iv) fifth abdominal segment with a pair of rather large posterolateral spines; v) antennular peduncle with 1 more long seta and a few small setae; vi) antennal scale with distal segments reduced to 4, marginal plumose setae increased to 14, endopod with a simple seta in place of tooth-like spine of previous stage; vii) basal endite of first maxilla with 1 more tooth; viii) marginal setae
of scaphognathite increased to 9; ix) endopod of third maxilliped 5-segmented, with 1, 1, 0, 1, 1 + 4 setae; exopod terminally 3-segmented, with 4 + 2 + 2 + 2 setae; x) first and second pereiopods functional; xi) endopod of first pereiopod 5-segmented with 1, 0, 2, 1 + 1 setae distally; exopod 2-segmented distally with 4 + 2 + 2 setae, basis with 1 seta; xii) endopod of second pereiopod 5-segmented with 0, 1, 2, 1 + 1 setae distally; exopod segmented at tip with 4 + 2 setae; xiii) telson process formula increased to 8 + 8 with an addition of a median pair of small processes.

**Zoea III**
(Fig. 53)

Total length = 3.10 mm; duration of stage = 45 - 48 hrs.

This stage is characterised by:

i) Epigastric spines increased to 2; ii) antennular peduncle basally dilated (precursor of stylocerite), ventral spine present; iii) antennal scale distally 2-segmented, marginal setae increased to 16, endopod 3-segmented, somewhat flagellar; iv) third pereiopod present as unsegmented biramous bud; v) telson slightly elongated, process formula reduced to 7 + 7; vi) uropods developed, exopod with 10 setae, endopod bud-like without setae.

**Zoea IV**
(Fig. 54)

Total length = 3.35 mm; duration of stage = 46 - 48 hrs.
The advancement over zoea III are:

1) Carapace with pterygostomial angle produced, epigastric spines increased to 3; ii) antennular peduncle faintly 2-segmented, proximal segment longer and distal with a row of 4 long, plumose setae, stylocerite more developed; iii) except for increase in number of marginal setae to 17 and absence of segments on scale, no change in antenna; iv) scaphognathite setae increased to 13; v) third pereiopod functional, endopod 5-segmented with 1, 0, 0, 2, 1 + 1 setae distalwards; vi) fifth pereiopod as small uniramous bud; vii) telson narrower and almost rectangular, process formula further reduced to 5 + 5; viii) uropods well developed, exopod longer than telson and with 14 marginal setae, endopod slightly shorter than telson and with 8 setae.

Zoea V
(Fig. 55)

Total length = 3.5 mm; duration of stage = 44 - 48 hrs.

Characteristic features of this stage are:

1) Pterygostomial spine well developed; ii) inner ramus of antennule developed as a tiny bud with a distal seta; iii) scaphognathite setae increased to 18; iv) first maxilliped with uropod bud and a basal seta on exopod; v) fifth pereiopod longer but still unsegmented; vi) fourth pereiopod unsegmented, biramous bud; vii) telson rectangular with process formula 4 + 4.
Zoea VI
(Fig. 56)

Total length = 3.76 mm; duration of stage = 47 - 49 hrs.

Salient changes over zoea V are:

1) Inner ramus of antennule more developed; ii) setae on scaphognathite increased to 21; iii) basal, outer margin of exopod of first maxilliped slightly broader with 2 outer setae, basis with an epipod; iv) fourth pereiopod still as uniramous bud; v) fifth pereiopods well developed, 5-segmented, terminal segment ending in a strong, fairly long spine.

Zoea VII
(Fig. 57)

Total length = 4.25 mm; duration of stage = 48 - 50 hrs.

Important changes over previous stage are:

1) Rostrum basally with dorsal setae; ii) antennular inner ramus more than half of outer ramus, stylocerite more pointed; iii) endopod of antenna 5-segmented and about 3/4 of scale; iv) teeth on basal endite of first maxilla increased to 10; v) basal setae of exopod of first maxilliped increased to 3; vi) first pereiopods showing chelate nature; vii) fourth pereiopods well developed, endopod 5-segmented, distal segment ending in a strong spine with a basal seta; exopod small with 4 terminal setae; viii) pleopods as small buds; ix) posterior margin of telson narrower than its basal width.
Zoea VIII
(Fig. 58)
Total length = 4.8 mm; duration of stage = 46 - 48 hrs.

Salient features of this stage are:

i) Both rami of antennule almost equal, outer showing traces of segmentation indicated by groups of aesthetasc; ii) endopod of antenna as long as scale, 6-segmented, scale with 23 marginal setae, basal segment with a small sharp spine; iii) setae on scaphognathite increased to 32; iv) basal region of exopod of first maxilliped with 4 setae; v) first and second pereiopods more chelate; vi) fifth pereiopod longer; vii) pleopods as biramous buds; viii) telson more narrower posteriorly, process formula 3 + 3.

Zoea IX
(Fig. 59)
Total length = 5.1 mm; duration of stage = 47 - 49 hrs.

Main changes over the previous stage are:

i) Basal setae of first maxilla increased to 5; ii) marginal setae of scaphognathite increased to 36; iii) exopods only of pleopods with 3 - 4 stumpy setae; iv) uropods longer, overreaching posterior margin of telson.

Zoea X
(Fig. 60)
Total length = 5.35 mm; duration of stage = 46 - 48 hrs.
Important changes over the previous stage are:

i) Endopod of antennal flagellum 10-segmented, overreaching scale; ii) scaphognathite with 44 marginal setae and endopod shorter and broader; iii) fixed finger of first and second pereiopods as long as dactylus; iv) pleopods longer, exopod with 5 - 7 setae, rudiments of appendix interna on pleopods second to fourth; v) telson with its posterior margin more rounded and narrower.

Zoea XI
(Fig. 61)
Total length = 5.5 mm; duration of stage = 48 - 50 hrs.

Characteristic features of this stage are:

i) Inner ramus of antennule longer than outer ramus; ii) antennal endopod longer than scale, with 13 segments; iii) pleopods longer with 8 - 14 marginal setae on exopod.

Zoea XII
(Fig. 62)
Total length = 6.5 mm; duration of stage = 50 - 54 hrs.

This is the last zoeal stage showing following advancements over the previous stage:

i) Inner ramus of antennule 2-segmented; ii) distolateral spine on antennal scale not yet developed, endopod flagellar;
iii) endopod of first maxilliped 2-segmented, basal region of exopod with 7 setae; iv) endopod of pleopods now with 4-5 setae except on first, appendix interna developed on fifth pleopod also.

Postlarva
(Fig. 63)

Total length = 7.1 mm.

Almost resembles adult except for absence of mandibular palp and persistence of exopods though reduced to rudiments, on first to fourth pereiopods.

Rostrum slightly upturned at tip and little longer than antennular peduncle, almost as long as antennal scale, dorsal margin armed with 9 teeth (postorbital 1), distal 1/3 of rostrum without teeth, ventral margin with 2 teeth. Carapace with antennal and branchiostegal spines, but both slightly ventrally placed than in adults.

Antennule (Fig. 63, b): Basal segment with a ventral spine, stylocerite short of reaching middle of basal segment, distolateral margin produced into a spine; second and third segments nearly equal in length; lower flagellum 6-segmented, slightly longer than upper, and upper flagellum with two branches fused for 2 segments, free part of shorter branch not segmented and with 6 aesthetascs, longer branch 2-segmented, tooth on basal segment distinct.

Antenna (Fig. 63, c): Distolateral spine of scale well developed in this stage.
Mandibles (Fig. 63, d): Almost similar, incisor and molar processes well differentiated, palp not yet developed.

Maxillae (Fig. 63, e & f): Almost like in adult but posterior lobe of scaphognathite still long and narrow as in zoeal stages.

Maxillipeds (Figs. 63, g-i): Exopods with only 4-6 setae unlike in adult; endopod of first maxilliped much reduced, unsegmented; third maxilliped more broader and less setose than in adult.

Pereiopods (Figs. 63, k-o): Unlike in adult, exopods still persisting on first to fourth though reduced to small rudiments.

First pereiopod (Figs. 63, k): Chelate, chela broader than in adult; fingers about as long as palm, cutting edges smooth; chela longer than carpus; carpus and merus of almost equal length.

Second pereiopod (Fig. 63, l): Chelate, slightly longer than first; fingers shorter than palm; chela slightly longer than carpus, merus and carpus almost equal.

Third to fifth pereiopods (Fig. 63, m-o): Almost like in adult except for rudimentary exopods which still persist.

Abdomen (Fig. 63, a): All segments smooth with rounded pleura; posterolateral spine of fifth segment of zoeal stages lost in this stage.

Pleopods (Fig. 63, p): Well developed, both exopod and endopod setose (except endopod of first), appendix interna on second to fifth.
Telson (Fig. 63, q): Almost as in adult in shape and structure, with 2 pairs of dorsal spines, tip acute, posterior margin with 2 pairs of spines, second pair about 7-times first, also a pair of feathered setae present inbetween inner pair of spines.

Uropods almost like those of adult, overreaching telson, exopod with accessory subapical spines.

Discussion:

The larvae of the present species *Palaemon (Palaender) semmelinkii* agree with the larval characters given by Gurney (1942) for the subfamily *Palaemoninae*.

The zoea I of the present species has been described by Prasad and Tampi (1957) but their larvae show many differences from the present material as follows:

<table>
<thead>
<tr>
<th>Zoa I as described by Prasad and Tampi (1957) (Mandapam)</th>
<th>Zoa I of the present material (Karwar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tip of rostrum: Neither mentioned nor figured regarding serration.</td>
<td>Serrated ventrally.</td>
</tr>
<tr>
<td>3. Antennal scale: 6 or 7 segments distally, with 9 + 3 marginal setae; inner proximal half figured as having fine setae.</td>
<td>Only 5-segmented, with 9 + 1 marginal setae, fine setae absent.</td>
</tr>
<tr>
<td>endopod: With a long terminal seta.</td>
<td>Ending in a tooth-like spine with a long plumose seta.</td>
</tr>
</tbody>
</table>
The only species in the subgenus *Palaenex* of the genus *Palaemon* in which the complete life history is known is *P. (P.) elegans* in which Hoglund (1943) describes 5 zoeal and a postlarval stages, obtaining stage I from laboratory, rest connected from plankton. Tsunamal (1963) later redescribes the

<table>
<thead>
<tr>
<th>No.</th>
<th>Component</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>First maxilla</td>
<td>Basal endite with a spinous tip surrounded by 3 setae. Basal endite with 2 long large, 2 small incurved teeth + 1 plumose seta.</td>
</tr>
<tr>
<td>5.</td>
<td>First maxilliped</td>
<td>endopod: 2-segmented, distal segment with 5 setae. 3-segmented, more setose. basipod: With one spine-like seta. With 6 simple setae. exopod: Showing faint segmentation and indications of 3 setae. Distally 2-segmented with 4 + 2 setae.</td>
</tr>
<tr>
<td>6.</td>
<td>Second maxilliped</td>
<td>endopod: 3-segmented, subterminal segment with 1 and terminal with 3 or 4 setae. 4-segmented with 0, 0, 3 + 1 + 2 setae distalwards. exopod: Showing faint indications of 4-segmented nature. Of 3-segmented nature.</td>
</tr>
<tr>
<td>7.</td>
<td>Third maxilliped</td>
<td>endopod: 3-segmented with 4, 0, 3, 3 setae distalwards. 4-segmented, terminal segment ending with 1 and subterminal segment with 2 setae. exopod: With 4 + 2 setae. With 4 + 2 + 2 setae.</td>
</tr>
</tbody>
</table>
complete lifehistory of this species comprising 8 zoeal + 1 postlarval stages from laboratory hatchings from the Israel coast, comparing his larvae with those of Hoglund's Swedish material. The larvae of the present material P. (P.) semmelinkii, a tropical species, however, pass through 12 zoeal stages before the postlarva.

The larvae of these above 2 species thus differ as above in respect of number of stages and also the following morphological features, though agreeing in general:

Rostral hook present throughout from zoea I in the present species while in P. (P.) elegans, from second to sixth stages only, also the distal spine of antennal scale is absent throughout larval stages and appears only in postlarva in the present species unlike in P. (P.) elegans wherein it appears as early as zoea IV.

Subgenus Nematopalaemon

The subgenus Nematopalaemon of the genus Palaemon as known today, comprises 4 species. Of these, larvae of only 1 species viz. P. (N.) tenuipes (Stimpson) have been so far known, described by Pillai (1966) from Cannanore along the west coast of India wherein he deals with embryonic development and first 3 zoeal stages as observed in the laboratory.

This subgenus is represented in Karwar by a single species P. (N.) tenuipes. In the present work, larvae of
P. (N.) tenuipes were reared up to zoea V which are adequately described and illustrated and since the larvae show certain important differences from Pillai's account of the first 3 larval stages, it has been felt necessary to redescribe here these stages already described by Pillai.

5. PALAEON (NEMATOPALAEON) TENUIPES (HENDRERSON)

Description of Larval Stages

Zoea I

(Fig. 64)

Total length = 2.2 mm; duration of stage = 24 - 30 hrs.

Eyes sessile. Rostrum not yet formed, carapace smooth. Abdomen 5-segmented, all segments smooth.

Antennule (Fig. 64, b): Outer ramus with 4 aesthetascs and a plumose seta, future inner ramus represented by a long subterminal plumose seta.

Antenna (Fig. 64, c): Biramous, scale 4-segmented distally, with 10 marginal setae; endopod broad, reaching to about 3/4 of scale, ending in a sharp spine with a plumose seta on its outer side.

Mandibles (Fig. 64, d): Slightly asymmetrical, incisor process with minute teeth but molar region rather blunt, no palp.

First maxillia (Fig. 64, e): Coxal endite with only 2 small setae, basal with 5 unequal teeth; palp simple, with a single seta.
Second maxilla (Fig. 64, f) : Coxal endite single-lobed with 3 setae, basal endite bilobed with 2 and 3 setae; endopod characteristic, larger than even scaphognathite, unsegmented with a single terminal seta; scaphognathite with 5 marginal setae but posterior lobe not yet differentiated.

First maxilliped (Fig. 64, g) : Endopod 3-segmented with 0, 1, 2 setae distalwards; exopod with 4 long, terminal, natatory setae; basis with 3 setae.

Second maxilliped (Fig. 64, h) : Endopod 3-segmented, terminal segment with 3 setae; exopod with 4 long terminal and 2 small, subterminal setae; basis with 2 - 3 setae.

Third maxilliped (Fig. 64, i) : Endopod 5-segmented, with 1, 0, 0, 1, 3 setae distalwards; exopod with 4 long terminal and 2 small subterminal setae.

Pereiopod buds (Fig. 64, j) : Only first pereiopod as biramous bud, endopod 5-segmented without any setae.

Telson (Fig. 64, q) : Triangular, with a median notch on posterior margin; process formula 7 + 7, third and fourth processes being longest, small spinules inbetween processes.

Chromatophores : Red branched chromatophores arranged as follows : one each distally on antennular peduncle; one each on eyes anteriorly around mouth, a big one each posterolaterally on carapace and a pair on third abdominal segment.
Zoea II
(Fig. 65)
Total length = 2.45 mm ; duration of stage = 65 - 70 hrs.

This stage differs from the previous stage : 
i) Eyes stalked; ii) a short, acute rostrum present, reaching just upto eyes; pterygostomial spine formed; iii) antennular peduncle faintly 2-segmented; iv) antennal scale distally 3-segmented now; v) coxal endite of first maxilla with 5 setae; vi) scaphognathite with posterior lobe distinctly marked, setae increased to 7; vii) endopod of second maxilliped 4-segmented with 1, 0, 2, 4 setae distalwards; viii) first pereiopods functional, terminal spine-like seta on last segment very long, about as long as endopod; second pereiopods as biramous buds, rest not yet developed; ix) telson process formula increased to 8 + 8, no traces of uropods seen.

Zoea III
(Fig. 66)
Total length = 2.70 mm ; duration of stage = 70 - 74 hrs.

Important changes from stage II are :
i) Rostrum with a small tubercle-like tooth at base; ii) aesthetascos on outer ramus of antenna reduced to 2; inner ramus formed, about 1/2 of outer, bearing a terminal seta, peduncle with setae as in figure; iii) antenna with distal segments of scale reduced to 2, marginal plumose setae increased to 12; endopod reduced to 1/2 of scale and without long terminal seta;
a sharp spine on peduncle near base of endopod; iv) second pereiopods functional, endopod 5-segmented, last segment bearing a very long terminal spine-like seta as in first pereiopod; v) sixth abdominal segment separated from telson; vi) process formula of telson reduced to 7 + 7; vii) uropods developed, exopod with 6 plumose setae, endopod still in bud form.

**Zoea IV**
*(Fig. 67)*

Total length = 2.85 mm; duration of stage = 65 - 70 hrs.

Advancements over previous stage are:

i) Both rami of antennule almost equal, peduncle setation increased; ii) distal segments of antennal scale reduced to 1, endopod about 1/2 scale, with 2 stout, terminal setae; iii) third pair of pereiopods as biramous buds; iv) telson elongated and somewhat rectangular; v) both rami of uropods now functional.

**Zoea V**
*(Fig. 68)*

All larvae died in this stage without moulting further.

Total length = 3.1 mm.

This stage differs from the earlier stages as under:

i) carapace with a pair of tiny, supraorbital spines; ii) antennular peduncle with a ventral spine; iii) antennal scale spine with a small, outer terminal endopod further reduced; iv) third
pereiopod functional, with 5-segmented endopod, last segment with a long seta; v) no pleopod buds as yet; vi) telson more elongated and rectangular, with first 3 pairs of processes now reduced to lateral spines; vii) uropods more elongated and mere setose.

Discussion:

The embryonic development and first 3 laboratory reared larval stages of *P. (N.) tenuipes* have been described by Pillai. The present work wherein larvae of *P. (N.) tenuipes* could be reared up to stage V, therefore, extends the knowledge of the larvae of this species by 2 more stages.

Comparison of the first 3 stages of the present material with the corresponding stages of Pillai's (1966) however, shows considerable differences not only in the development of morphological features but also in chromatophore pattern (as shown in the following table). The rearing experiments were therefore, repeated several times which revealed consistent uniformity of larval characters in the present material.

<table>
<thead>
<tr>
<th>Zoea I</th>
<th>Pillai's (1966) account</th>
<th>Karwar material (present work)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total length</td>
<td>2.04 mm .</td>
<td>2.2 mm .</td>
</tr>
<tr>
<td>Antenna</td>
<td>Scale with proximal inner spine.</td>
<td>No spine on scale.</td>
</tr>
<tr>
<td>First maxilla - palp</td>
<td>Without seta.</td>
<td>With a single seta.</td>
</tr>
<tr>
<td>coxal endite</td>
<td>With 4 teeth.</td>
<td>With 2 small setae.</td>
</tr>
<tr>
<td></td>
<td>Pillai's (1966) account</td>
<td>Karwar material (present work)</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td><strong>basal endite</strong></td>
<td>With 6 teeth.</td>
<td>With 5 teeth.</td>
</tr>
<tr>
<td><strong>Second maxilla - endopod</strong></td>
<td>Bilobed, with a distinct basal lobe as large as scaphognathite, 1 + 2 setae.</td>
<td>Single lobed, larger than scaphognathite with only 1 seta.</td>
</tr>
<tr>
<td><strong>scaphognathite</strong></td>
<td>With 6 marginal setae.</td>
<td>With 5 setae.</td>
</tr>
<tr>
<td><strong>Third maxilliped endopod</strong></td>
<td>3-segmented.</td>
<td>5-segmented.</td>
</tr>
<tr>
<td><strong>Pereiopods</strong></td>
<td>First 2 pairs as rudiments.</td>
<td>Only one pair as buds.</td>
</tr>
</tbody>
</table>

**Zoea II**

<table>
<thead>
<tr>
<th>Total length</th>
<th>2.21 mm</th>
<th>2.45 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraorbital spine</td>
<td>Present</td>
<td>Absent in this stage, appearing only in stage V as small, blunt tubercle.</td>
</tr>
<tr>
<td><strong>Antenna</strong></td>
<td>Endopod segmented, peduncle with spines.</td>
<td>Endopod not segmented, peduncle smooth.</td>
</tr>
<tr>
<td><strong>First maxilla</strong></td>
<td>Palp with 2 setae.</td>
<td>Only one seta.</td>
</tr>
<tr>
<td><strong>Pereiopods</strong></td>
<td>Both first and second functional, next two as buds.</td>
<td>Only first functional, second being only as biramous bud.</td>
</tr>
<tr>
<td><strong>Uropod rudiments</strong></td>
<td>Noticed at the base of telson.</td>
<td>Not seen.</td>
</tr>
</tbody>
</table>

**Zoea III**

<table>
<thead>
<tr>
<th>Total length</th>
<th>2.45 - 2.53 mm</th>
<th>2.7 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antennal endopod</td>
<td>5-segmented, about 1/2 as long as scale.</td>
<td>Unsegmented, about 1/3 of scale.</td>
</tr>
</tbody>
</table>

Also, the adult material (thus accumulated by repeated
rearing experiments) was carefully examined by the author and his senior colleagues and the identity of the present material was confirmed as *P. (N.) tenuipes* (Henderson). This was subsequently reconfirmed by Decapod authority Prof. Dr. L. B. Holthuis of Leiden.

In light of the confirmed identification of the present material and the significant differences in the larval material from that of Pillai's (1966), the possibility that Pillai's material may not belong to *tenuipes* proper but may belong to some other species, can not be ruled out.

Based mainly on the present material, the following may be considered as distinctive features of the subgenus *Nematopalaemon* larvae:

i) Rostrum rather short (reaching only the eye) and acute;

ii) Antennal endopod gradually reduced (at least in later stages);

iii) Second maxilla with endopod large, bearing a single terminal seta and scaphognathite with 7 marginal setae from stage II onwards;

iv) Exopod of maxillipeds with 4 or 4 + 2 (smaller) setae;

v) Abdomen smooth.
GENUS MACROBRACHIUM
GENUS MACROBRACHIUM

Of the family Palaemonidae, the genus Macrobrachium constitutes one of the most important commercial genera, which has attracted many larval workers all the world over: M. rosenbergii (Ling and Merican, 1961; Ling, 1962, 1964, 1969a & 1969b; Uno and Kwon, 1969); M. carcinus (Lewis, 1961; Lewis and Ward, 1965; Choudhury, 1971); M. nipponense (Kwon and Uno, 1969); M. formosense (Shokita, 1970); M. acanthurus (Choudhury, 1970, Dobkin, 1971); M. australiensis (Fielder, 1970); M. niloticum and M. intermedium (Williamson, 1972); M. shokitai (Shokita, 1973).

Considering the lifehistories of the Indian species, though several species (Tiwari, 1955) occur in India, information is available on as many as the following 8 species: M. rudis (= Palaemon rudis, Menon, 1938; Rajyalaxmi, 1960); M. rosenbergii (= Palaemon carcinus, Menon, 1938); M. idella (= Palaemon idae, Aiyer, 1949); M. scabrículum (= P. scabrículus, Rajyalaxmi, 1960); M. mirabile (= P. mirabilis, Rajyalaxmi, 1960); M. lamarrei (Rajyalaxmi, 1961); M. malcolmsonii (Kewalramani et al, 1970); M. idella (Pillai and Mohamed, 1973); M. hendersocayanum (Jalihal and Sankolli, 1975) and M. canarei (Jalihal and Sankolli, 1976).

This genus is represented in Karwar by 3 species viz. M. rosenbergii, M. idella, and M. equidens. Of these, the lifehistory of the first two species has been already described (Ling, 1969a & b and Pillai and Mohamed, 1973 respectively).
only remaining species i.e. *M. equidens*, attempts to work out the metamorphosis met with partial success, only upto Zoea III.

6. **MACROBRACHIUM EQUIDENS** (DANA)

**Description of Larval Stages**

(Based on the larvae of non-striped form)

**Zoea I**

(Fig. 69)

Total length = 2.1 mm; duration of stage = 50 - 54 hrs.

Eyes sessile. Rostrum slender, reaching upto antennular peduncle. Carapace and abdomen smooth.

Antennule (Fig. 69, b): Outer ramus with 4 aesthetascs + 1 plumose seta; in place of future inner ramus, a long plumose seta present.

Antenna (Fig. 69, c): Scale distally 5-segmented and with 9 + 2 (outer) marginal setae; endopod ending in a long spine with a long plumose seta on its outer side.

Mandibles (Fig. 69, d): Slightly asymmetrical, incisor process more pronounced than molar process.

First maxilla (Fig. 69, e): Coxal endite with 4 spine-like setae, basal endite with 3 big + 1 small teeth; palp small with a small terminal seta.

Second maxilla (Fig. 69, f): Coxal endite with a single lobe with 3 setae, basal endite bilobed with 2 + 2 small setae;
endopod with a basal and 2 + 1 setae; scaphognathite with 4 marginal setae.

First maxilliped (Fig. 69, g) : Endopod small, faintly 3-segmented, setation poorly developed, only distal segment with 3 small setae; exopod with 4 terminal setae.

Second maxilliped (Fig. 69, h) : Endopod 3-segmented with 1, 0, 1 + 2 delicate hair-like setae distalwards (last segment ending in a long bristle-like seta); exopod with 4 terminal setae.

Third maxilliped (Fig. 69, i) : Endopod 4-segmented with 1, 0, 1, 1 + 2 setae distalwards, last segment as in second maxilliped; exopod with 4 terminal setae.

Telson (Fig. 69, q) : Triangular, process formula 7 + 7, minute spinules inbetween processes from 4th to 7th.

Chromatophores : Antennular peduncle distally with a red dot; large stellate pinkish red chromatophore at the base of rostrum and on third abdominal segment dorsally, also this segment with a pair of red chromatophores on either lateral side.

Zoea II
(Fig. 70)

Total length = 2.25 mm ; duration of stage = 48 - 52 hrs.

Salient changes from previous stage are :

1) Eyes large, stalked; ii) rostrum with a small tubercle-like dorsal tooth, carapace with a sharp supraorbital
and pterygostomial spines; iii) antennular peduncle 2-segmented but no inner ramus; iv) distal segments of antennal scale reduced to 4; v) mandibles better developed with number of teeth; vi) basal endite of first maxilla with teeth increased to 7; vii) scaphognathite now clearly demarcated posteriorly and setae increased to 6; viii) first pereiopod functional, endopod 5-segmented, with 1, 0, 1, 0, 2 + 1 distal segment drawn into a long seta; exopod with 4 terminal + 2 subterminal setae; ix) second pair of pereiopods functional with 1, 0, 1, 1, 2 + 1 setae distalwards (distal segment drawn into a long seta); x) telson process formula increased to 8 + 8.

**Zoea III**

(Fig. 71)

Larvae died in this stage without moulting further. Total length = 2.55 mm.

Important changes from Zoea II are:

1) Rostrum with a well formed dorsal spine; ii) inner ramus of antennule developed, a ventral spine on peduncle; iii) distal segments on antennal scale reduced to 2; endopod elongated but not reaching scale, 4-segmented, long terminal seta of previous stage absent; iv) scaphognathite marginal setae increased to 7; v) third pereiopods as biramous buds; vi) telson narrower, separated from sixth abdominal segment, process formula reduced to 7 + 7; vii) uropods developed, exopod functional with 5 setae, endopod bud-like, without setae.
Discussion:

The larvae (first 3 stages) of the present species *Macrobrachium equidens* (Dana) agree well with those of other members of the genus showing typical prolonged type of metamorphosis.

The adults of the present species exhibit 2 forms - striped and non-striped, based on the colour pattern. Except for the differences in colour patterns, morphological differences between these two are so minor that the two could not be separated as distinct species, and as such were considered as only 2 coloured forms of one and the same species as discussed earlier in the relevant chapter on adults.

The present larval observations further support the above view when laboratory hatchings were obtained separately of both the striped and non-striped berried females under identical rearing conditions. Even the eggs in both forms agree well in respect of colour, size and number and so also the larvae, both in chromatophore pattern as well as morphological features.
SUBFAMILY PONTONIINAE
In this subfamily, through the works of Holthuis (1952), Bruce (1966 - 1972) and Chace (1972) on adults, we have now information on at least more than 30 genera. Considering the larvae, however, knowledge is restricted to only 6 genera (exclusive of the 2 larval genera, *Mesocaris* and *Retrocaris* discussed by Gurney, 1932 and some unidentified Pontoniid larvae from plankton described by Gurney, 1942; Pillai, 1955; George, 1958 and Williamson, 1967) as under:

**Genus Pontonia**: Gourret, 1884 and Caroli, 1926.

**Genus Typton**: Lebour, 1925 and Caroli, 1926.

**Genus Harpiliopsis**: Gurney, 1938.

**Genus Corallicaris**: Gurney, 1938.

**Genus Anchistiodes**: Gurney, 1938.

**Genus Periclimenaeus**: Gurney and Lebour, 1941, describing the larvae as *Periclimenes* (*Periclimenaeus*).

**Genus Periclimenes**: Most of the Pontoniid larvae known belong to this genus and this being the only genus representing the subfamily in the present work, the details have been given only for this genus.

**GENUS PERICLIMENES**

**Subgenus Periclimenes**

Compared to the other subgenus *Harpilius*, larvae of this subgenus *Periclimenes* are known only in 3 species: *P. scriptus*...
(= P. (P.) scriptus) only stage I described by Caroli (1926); P. longicaudatus ? (= P. (P.) longicaudatus) 5 stages - last zoea upto juvenile III reared from the last zoetal stage collected from Bermuda plankton by Gurney and Lebour (1941) and P. (P.) indicus, 5 larval and postlarval stages (stage I laboratory reared, rest connected from Adyar backwaters) described by Menon (1949).

This subgenus is represented in Karwar by a single species Periclimenes (Periclimenes) obscurus Kemp, of which larvae could be reared upto I stage only.

7. **PERICLIMENES (PERICLIMENES) OBCURUS KEMP**

**Description of Larval Stages**

**Zoea I**

(Fig. 72)

**Totale length = 1.6 mm**.

Eyes sessile. Rostrum reaching half as long as antennular peduncle. Carapace smooth. Abdomen 5-segmented, third segment characteristic, humped, all segments smooth.

Antennule (Fig. 72, b) : Outer ramus with 1 large + 3 slender aesthetasc + 1 plumose seta; a long plumose seta present, representing future inner ramus.

Antenna (Fig. 72, c) : Scale distally 3-segmented, with 10 marginal setae; endopod broad, reaching to about 1/3 length of scale, terminating in a strong spine having a long plumose seta arising from its inner angle.
Mandibles (Fig. 72, d): Slightly asymmetrical, both molar and incisor processes with several teeth, palp absent.

First maxilla (Fig. 72, e): Coxal endite with 3 bristle-like setae, basal with 2 stout + 3 small teeth; palp slightly notched at tip, with 2 small setae as in figure.

Second maxilla (Fig. 72, f): Coxal endite single lobed with 3 setae, basal endite bilobed, with 1 and 2 setae each; endopod rather long, single lobed with a long terminal seta; scaphognathite with 4 marginal setae distributed as 3 distal + 1 posterior.

First maxilliped (Fig. 72, g): Endopod 3-segmented, terminal segment with 3 setae; exopod with 4 terminal setae; short basis with rounded inner margin armed with 4 setae.

Second maxilliped (Fig. 72, h): Endopod 4-segmented with 0, 1, 3, 3 setae distalwards; exopod with 4 terminal setae; basis with 1 seta.

Third maxilliped (Fig. 72, i): Endopod 4-segmented with 1, 1, 3, 3 setae distalwards (setae on propodus being stout); exopod with 4 terminal setae.

Pereiopods (Fig. 72, j): Only first and second pereiopods as biramous buds.

Telson (Fig. 72, q): Almost triangular, with a shallow median notch on posterior margin; process formula 7 + 7, third and fourth process being longest.

Discussion:

Gurney (1942), while dealing with the larvae of
Pontoniinae, expresses difficulty in defining precisely the features which can cover all the known larvae of the family or even at their generic or subgeneric level, owing to the great diversity of larval characters. The larvae of the present species P. (P.) obscurus share majority of the characters listed by Gurney (1942) for the subgenus Ancylocaris (= Harpilius) but no further comment can be made since only the stage I could be studied in the present species.

Subgenus Harpilius

Most of the definitely known Pontoniinae larvae belong to this subgenus. Gurney (1927) describes larvae of Periclimenes calmani (= P. (H.) calmani) from the Suez Canal; in 1936, he deals with P. americanus (= P. (H.) americanus) obtaining the I stage from laboratory and Stage V from plankton from Bermuda; in 1988, he deals with laboratory hatched I stage of 3 species under P. (Ancylocaris) (= Harpilius) viz. grandis, agay, and diversipes; Nair (1947) gives an account of laboratory hatched I stage of P. (= Harpilius) brevicarpalis from Krusadai Islands along the east coast of India and Pillai (1950) describes different larval stages from the Travancore plankton along the west coast of what he refers to P. (Ancylocaris) (= Harpilius) grandis. Williamson (1970), while describing the Decapod larvae from Red Sea plankton, records 7 species of Pontoniid larvae WRS 15 - NRS 21, referring all these to the subgenus Harpilius.
In Karwar this subgenus is represented by 2 species viz. P. (H.) andamanensis Kemp and P. (H.) elegans (Paulson) and lifehistory could be worked out only upto stage II in the former and stage VII in the latter.

S. PERICLIDEMENAE (HARPILIUS) ANDAMANENSIS KEMP

Description of Larval Stages

Zoea I
(Fig. 73)

Total length = 1.60 mm; duration of stage = 48 - 52 hrs.

Eyes sessile. Rostrum slender, reaching upto middle of antennular peduncle. Abdomen 5-segmented, all segments smooth.

Antennule (Fig. 73, b): Outer ramus with 3 slender and 1 thick aesthetascs + 1 plumose seta; in place of future inner ramus a long plumose seta present.

Antenna (Fig. 73, c): Biramous, scale with 5 distal segments and with 11 marginal setae; endopod broad, reaching about 2/3 of scale, ending in a small spine with a long plumose seta at its inner angle.

Mandibles (Fig. 73, d): Slightly asymmetrical, both incisor and molar processes with minute teeth.

First maxilla (Fig. 73, e): Coxlal endite with 3 bristles, basal with 2 stout + 3 small teeth; endopod slightly bilobed at tip with 2 setae (one small) on inner lobe.

Second maxilla (Fig. 73, f): Coxlal endite single-lobed
with 3 setae, basal endite bilobed with 2 setae on each lobe; endopod with a basal lobe and 1 seta each on both lobes; scaphognathite with 4 setae marginally, 3 distal + 1 posterior.

First maxilliped (Fig. 73, g): Endopod 3-segmented, only last segment with 3 setae; exopod with 4 terminal setae; basis with inner margin rounded having 6 setae.

Second maxilliped (Fig. 73, h): Endopod 4-segmented, with 1, 0, 3, 3 setae distalwards; exopod with 4 terminal setae; basis with 2 setae.

Third maxilliped (Fig. 73, i): Endopod 4-segmented with 1, 1, 2, 3 setae distalwards, exopod with 4 terminal setae; basis with 2 setae.

Pereiopod buds (Fig. 73, j): First and second pereiopods as biramous buds.

Telson (Fig. 73, q): Almost triangular with a slight median notch on posterior margin; process formula 7 + 7, third and fourth processes being longer than rest. Minute spinules present between processes from fourth to last, on posterior margin.

Chromatophores: Dark brownish red, highly branched chromatophores as shown in figure (Fig. 73, a).

**Zoea II**
(Fig. 74)

Total length = 1.75 mm.

Advancements over the previous stage are:

1) Eyes stalked; 2) carapace with pterygostomial spine;
iii) abdomen with a pair of posterolateral spines on fifth segment; iv) antennular peduncle 2-segmented; v) antennal scale distally 4-segmented; vi) scaphognathite marginal setae increased to 4 + 1; vii) endopod of third maxilliped 5-segmented; viii) first two pereiopods functional, dactylus and propodus both with 2 setae each; ix) telson process formula 8 - 8.

9. PERICLIMENES (HARPILIUS) ELEGANS (PAULSON)

Description of Larval Stages

Zoea I

(Fig. 75)

Total length = 1.55 mm; duration of stage = 24 - 30 hrs.

Eyes sessile. Rostrum slender, almost straight, reaching to about 1/2 length of antennular peduncle. Carapace smooth. Abdomen 5-segmented, third segment largest, all segments smooth.

Antennule (Fig. 75, b): Outer ramus with 3 slender and 1 large aesthetascs + 1 plumose seta; future inner ramus represented by a long subterminal plumose seta.

Antenna (Fig. 75, c): Scale with 4 distal segments and 11 marginal setae (2 outer); endopod reaching about 2/3 of scale, ending in a small spine with a plumose seta on its inner angle.

Mandibles (Fig. 75, d): Slightly asymmetrical, both incisor and molar processes with minute teeth; no palp.

First maxilla (Fig. 75, e): Coxal endite with 4 setae,
basal with 2 big and 3 small setae; palp slightly notched at tip, inner lobe having 1 long + 1 small setae.

Second maxilla (Fig. 75, f): Coxal endite single lobed with 3 setae, basal endite 2-lobed with 2 setae each; endopod with a small basal lobe with 1 seta on each lobe; scaphognathite with 4 marginal setae, 3 distal + 1 posterior, outer margin being without setae even in subsequent stages.

First maxilliped (Fig. 75, g): Endopod 3-segmented, with 0, 1, 3 setae distalwards; exopod with 4 terminal setae; basis with characteristically rounded inner margin bearing 6 setae.

Second maxilliped (Fig. 75, h): Endopod 4-segmented, with 1, 0, 3, 3 setae distalwards; exopod with 4 terminal setae.

Third maxilliped (Fig. 75, i): Endopod 4-segmented, with 1, 1, 2 + 1, 2 setae distalwards (terminal 2 setae are longer).

Pereiopod buds: First and second pereiopods as small biramous buds.

Telson (Fig. 75, q): Almost triangular with a shallow median notch on posterior margin, process formula 7 + 7, third and fourth being longest processes; posterior margin spinulose between processes fourth to last.

Chromatophores: Larva being transparent, with only a few chromatophores of branched brownish red colour (Fig. 75, a). 2 pairs on carapace dorsolaterally and one each on second abdominal segment dorsally and on anal region.
Zoea II
(Fig. 76)
Total length = 1.65 mm; duration of stage = 40 - 46 hrs.
Salient changes from the previous stage are:

1) Eyes stalked; ii) small supraorbital and pterygostomial spines present; iii) antennal scale distal segments reduced to 3; iv) teeth on basal endite of first maxilla increased to 7; v) endopod of third maxilliped 5-segmented; vi) pereiopods first and second functional, last 2 segments of endopod with 2 setae each; vii) telson process formula increased to 8 + 8; viii) abdomen with a pair of posterolateral spines.

Zoea III
(Fig. 77)
Total length = 1.80 mm; duration of stage = 66 - 70 hrs.

Changes from stage II are:

1) Antennular peduncle 2-segmented; ii) antennal scale without distal segmentation, terminal spine on scale developed, endopod elongated and without distal long plumose setae; iii) telson longer, separated from sixth abdominal segment; iv) uropods present, exopod with 6 marginal setae, endopod bud-like without seta.

Zoea IV
(Fig. 78)
Total length = 2.25 mm; duration of stage = 30 - 36 hrs.
This stage differs from the previous stage in following:

1) A small median hump present posterior to rostrum; ii) inner ramus of antennule 1/2 as long as outer, outer basal margin of peduncle dilated; iii) terminal spine of antennal scale longer than lamella, endopod 2-segmented; iv) basis of first maxilliped starts showing like a protuberance distally on inner margin; v) third pereiopods as biramous buds; vi) telson more elongated and rectangular, with process formula 5 + 5 and also 2 lateral marginal spines; vii) endopod of uropod also setose, both rami almost equal.

Zoea V
(Fig. 79)

Total length = 2.40 mm; duration of stage = 48 - 52 hrs.

Advancements over the stage IV are:

1) Rostrum with a small dorsal spine in place of median hump of previous stage; ii) endopod of antenna 4-segmented; iii) third pereiopods functional, endopod 5-segmented, propodus with a single seta and dactylus with 3 setae; iv) fourth pereiopod functional, very long and strong, without exopod, endopod 5-segmented, dactylus terminating in a long and strong, slightly incurved spine-like seta and this together with similar seta arising from propodus, cross at tip and giving a chelate-like appearance in preserved specimens; fifth pereiopod only as a bud; v) telson more elongated with 2 pairs of lateral marginal spines; vi) a terminal spine on outer margin of exopod of uropod.
Zoea VI
(Fig. 80)
Total length = 2.55 mm; duration of stage = 55 - 60 hrs.
Differences from the earlier stage are:

i) Antennule with small stylocerite precursor with acute tip; ii) endopod of antenna about as long as scale, 6-segmented; iii) scaphognathite setae increased to 6 (5 distal + 1 posterior); iv) fourth pereiopods stouter and longer; v) fifth pereiopod very small (smaller than fourth), without exopod, 4-segmented; vi) telson process formula 5 + 5.

Zoea VII
(Fig. 81)
Total length = 3.10 mm.
All larvae died in this stage.
Important changes from previous stage are:

i) Rostrum with 2 teeth on upper margin; ii) inner ramus of antennule about as long as outer; iii) scaphognathite with a small, additional posterior seta; iv) lobed, protruded appearance of basis of first maxilliped much pronounced in this stage; v) first and second pereiopods showing chelate nature; vi) fifth pereiopod more developed than in previous stage; vii) pleopods as tiny, uniramous buds; viii) uropods overreaching telson.
Remarks:

Gurney (1942) gives a definition for the larvae of the subgenus Ancylocaris (= Harpilius) with which the present 2 species viz. P. (H.) andamanensis and P. (H.) elegans agree fully.
FAMILY HIPPOLYTIDAE
FAMILY HIPPOLYTIDAE

Gurney (1942) in his monumental work on Decapod larvae gives a detailed bibliography of the species then known of this family, belonging to genera: Hippolyte - 6 species, Spirontocaris - 10 species, Thor - 1 species, Caridion - 2 species, Chorismus - 1 species, Saron - 1 species, Tozeuma - 1 species, Latreutes - 1 species, Lysmata - 2 species and Trachycaris - 1 species. He also emphasises the diversity of the Hippolytid larvae leading to the difficulty in framing any definition for the family. Works, therefore, prior to Gurney (1942) have not been included here so as to avoid unnecessary duplication. It may be mentioned here, however, that in his extensive account of Hippolytid larvae from Discovery Report he gives the larval characters of the following genera: Hippolyte, Chorismus, Spirontocaris, Caridion, Lysmata, Hippolysmata, Tozeuma, Saron (and allied forms) and Latreutes.

Following are some of the important works after Gurney:

Kurian (1956) while dealing with the larvae of Decapod Crustacea from the Adriatic Sea, gives an account of stages I to VIII of Spirontocaris cranchii and Lysmata seticauda respectively and stage IV and last stage of Latreutes sp. Broad (1957) describes the development of Thor floridanus. Williamson (1967) in his work on the planktonic Decapoda from the Mediterranean Coast of Israel, gives an account of zoal stages Eualus sp; in 1970 while dealing with Decapod larvae from the northern Red Sea,
describes a single specimen each of 2 species of Eretmocaris viz. MS 8 and 9 and last zoeal stage of Hippolyte sp. NRS 10 and also a juvenile stage of Saron NRS 11. Kurata (1963 a & b) describes the laboratory reared lifehistory, comprising 9 zoeal and a postlarval stages of Heptacarpus futilirostris and H. geniculatus from the Japanese waters. Dobkin (1968) describes abbreviated development of Thor species, consisting of 2 zoeal and a postlarval stages. Ewald (1969) deals with the metamorphosis in the laboratory of Tozeuma carolinensis from Miam. Seridji (1971) describes a number of Hippolytid larvae viz. Caridion gordoni, Lysmata seticaudata and L. nilita and C. steveni, Eualus occultus and E. pusiolus, Thoralus cranchii, Hippolyte varians and Hippolyte sp. from the Mediterranean waters.

In India, very little work has been done on the larvae of Hippolytidae. Menon (1940), while dealing with the larvae from the Madras plankton describes stages I & II of Hippolysmata sp. and IV to VIII stages of Lysmata species and few stages of some unidentified species. Kurien (1951) gives an account of stage I of Hippolysmata vittata obtained in the laboratory. Pillai (1955) in his work on larvae of Decapod Crustacea from the Travancore plankton describes postlarval stage of Hippolysmata vittata, III. and postlarval stages of Eretmocaris A and last larval and a postlarval stages of Eretmocaris B and stage IV of Latreutes sp. Sankolli and Kewalramani (1962) describe the laboratory reared
lifehistory of Saron marmoratus from Bombay. Bansam and Kartha (1965) have described the eggs and early larval stages of Hippolysmata ensirostris. Pillai (1966) describes early 3 stages of Hippolysmata vittata.
GENUS HIPPOLYSMATA
Though this genus is well represented in the Indo-Pacific, information on the larvae, as far as the author is aware, is limited to only early stages of a very few species:

Kemp (1916) describes a postlarval stage from the Orrissa coast (India) which he calls as that of *H. ensirostris*. Gurney (1937) while dealing with the *Eretmocaris* larvae of Atlantic, describes as species A, the larva of which as per him resemble Kemp's *H. ensirostris* but in a earlier stage. In the same work, he also describes first 3 stages of species BST Hippolytus.

Menon (1940) describes first 2 stages from the Madras plankton, referring them to *Hippolytus*. Kurien (1951) gives an account of first stage of *Hippolytus vittata* hatched in the laboratory, from Krusadai along the east coast of India; Pillai (1966) describes the first 3 stages of the same species as observed in the laboratory but along the west coast (Cannanore). Pillai (1955) while describing the *Hippolytus* larvae from the Travancore plankton (India), assigns a postlarva to *Hippolytus vittata* and also mentions the possibility of what he describes as "Eretmocaris" A (his stage III + postlarva) belonging to *H. vittata*.

Thus it is clear that authentically known larvae of the genus are of only 2 Indian species viz. *H. vittata* and *H. ensirostris*; that too only upto III zoeal stages.

In the present work, larvae *Hippolytus* (Hippolytus) vittata Stimpson could be reared upto 9 zoeal stages only, thus...
extending the larval information of the species by 6 more stages.

10. HIPPOLYSMATA (HIPPOLYSMATA) VITTATA STIMPSON

Description of Larval Stages

Zoea I
(Fig. 82)

Total length = 2.00 mm; duration of stage = 46 - 50 hrs.

Eyes sessile; rostrum slender, reaching up to middle of antennule; carapace smooth; abdomen 5-segmented, fifth segment with a pair of posterolateral spines.

Antennule (Fig. 82, b): Outer ramus with 3 (of which 2 stout) aesthetascs, + 1 plumose seta and in place of future inner ramus, a long subterminal plumose seta present.

Antenna (Fig. 82, c): Scale with 5 distal segments with 9 + 1 plumose setae; endopod long, terminating in a plumose seta, about 1/3 of basal region of endopod broad.

Mandibles (Fig. 82, d): Slightly asymmetrical, both incisor and molar processes with minute teeth, no palp.

First maxilla (Fig. 82, e): Coxal endite with 4 bristles, basal with 2 serrated teeth + 1 seta; palp unsegmented, slightly notched distally with 3 terminal + 2 subterminal setae as in figure.

Second maxilla (Fig. 82, f): Coxal endite bilobed with 7 + 2 setae, basal endite bilobed with 2 + 5 setae; endopod
unsegmented, faintly trilobed with 3, 2, 4 setae distalwards. Scaphognathite with 5 setae.

First maxilliped (Fig. 82, g): Endopod 4-segmented with 1, 1, 1, 3 setae distalwards; exopod terminally faintly 2-segmented with 4 terminal and 2 subterminal setae. Basis with 6 and coxa with 3 setae.

Second maxilliped (Fig. 82, h): Endopod 4-segmented with 1, 0, 2, 5 setae distalwards; exopod slender, long, faintly 3-segmented distally, with very long 4 + 2 + 2 setae.

Third maxilliped (Fig. 82, i): Endopod 5-segmented with 1, 1, 0, 3, 3 setae distalwards; exopod slender, long, faintly 5-segmented distally and with 4 + 2 + 2 + 2 very long setae.

Telson (Fig. 82, q): Triangular with a fairly broad median notch, posterior margin concave; process formula 7 + 7 (first and seventh processes smallest, third process longest), posterior margin with minute spinules inbetween processes.

Zoea II
(Fig. 83)

Total length = 2.45 mm; duration of stage = 48 - 52 hrs.

Salient changes from previous stage are:

i) Eyes with long stalk; ii) carapace with supraorbital, a minute antennal, a strong pterygostomial spines and nearly anterior 1/2 of ventral margin serrated broadly; iii) antennal scale with only 4 distal segments and with 11 marginal setae; iv) teeth on basal endite of first maxilla increased to 5; v) no
change in second maxilla except for addition of a few more setae on endites; vi) pereiopods first and second as small buds and vii) telson process formula increased to 8 + 8 with addition of a small, median pair.

**Zoea III**
(Fig. 84)

Total length = 2.55 mm ; duration of stage = 44 - 48 hrs.

Major changes from zoea II are :

1) Rostrum with a postorbital spine followed by a small median hump on carapace; ii) abdomen 6-segmented; iii) antennule with inner ramus as long as outer ramus; iv) antennal scale distal segmentation reduced to 3 and marginal setae increased to 13, endopod much reduced to a stumpy structure; v) teeth on first maxilla increased to 7; vi) marginal setae on scaphognathite increased to 6; vii) first pair of pereiopods functional, endopod 5-segmented with 0, 1, 1, 2, 3 setae distally; exopod shorter than endopod, faintly 3-segmented distally with 4 + 2 + 2 long setae; viii) telson separated from sixth abdominal segment, more elongated; process formula reduced to 7 + 7; ix) uropods functional, exopod with marginal setae and endopod without any setae.

**Zoea IV**
(Fig. 85)

Total length = 2.75 mm ; duration of stage = 48 - 50 hrs.
This stage onward the larva can be distinguished by the characteristic dilated paddle-like propodus with marginal spinulation. Following are the differences over the previous stage:

i) Inner ramus of antennule slightly longer than outer with 1 long + 2 small setae, small stylocerite formed; ii) antennal scale with distolateral spine formed, marginal setae increased to 15; iii) scaphognathite setae increased to 10; iv) second pair of pereiopods functional, endopod 5-segmented; with 0, 1, 0, 3, 2 setae distalwards; v) fifth pereiopod functional with characteristic dilated propodus having 4 denticles on its outer margin; vi) telson elongated, process formula reduced to 6 + 6, third and fourth processes being longer; vii) endopod of uropod with 7 setae.

Zoea V
(Fig. 86)

Total length = 3.10 mm; duration of stage = 45 - 50 hrs.

Advancements over zoea IV are:

i) Third pereiopod functional, endopod 5-segmented with dactylus and propodus having 3 setae each; ii) fifth pereiopod with more denticles on outer margin of propodus and some also on inner margin, a distal outer spine on carpus; iii) telson rectangular, now fourth process longer, 2 pairs of lateral marginal spines developed.
**Zoea VI**

*(Fig. 87)*

Total length = 3.25 mm; duration of stage = 44 - 48 hrs.

Important changes from the previous stage are:

1) Inner ramus of antennule 3-segmented; ii) scale narrower with more setae; iii) both margins of dilated propodus with more denticles, merus with 1 distal spine.

**Zoea VII**

*(Fig. 88)*

Total length = 3.5 mm; duration of stage = 50 - 54 hrs.

Changes over the previous stage are:

1) Inner ramus of antennule 3-segmented; ii) scaphognathite setae increased to 13; iii) fourth pereiopod biramous bud; iv) telson more rectangular; v) setae on uropods increased.

**Zoea VIII**

*(Fig. 89)*

Total length = 3.7 mm; duration of stage = 52 - 54 hrs.

Following are the changes over the VII stage:

1) Inner ramus of antennule 5-segmented, both rami flagellar; ii) endopod of antenna slightly elongated; iii) scaphognathite setae increased to 13; iv) exopod of first maxilliped dilated basally with 2 setae on this part, an epipod
present; v) fourth pereiopod functional, endopod 5-segmented, with 0, 1, 1, 4, 3 setae distalwards.

Zoea IX
(Fig. 90)

Total length = 4.1 mm; duration of stage = died after 60 hrs. in this stage.

Salient features of this stage are:

i) Both rami of antennule more flagellar; ii) antennal endopod longer, about 1/3 of scale; iii) scaphognathite setae increased to 25; iv) setae on basal dilated region of exopod of first maxilliped increased to 4; v) fifth pereiopod with minute serration extending to about distal half of both outer and inner margins of dilated propodus.

Discussion:

In the subgenus Hippolyseta of the genus Hippolyseta, the larvae are known in only one species H. vittata described by Kurien (1951), stage I only and Pillai (1966) upto stage III, reared in the laboratory. The present work describing the laboratory reared 9 stages of H. (H.) vittata, therefore, extends the knowledge of the species by 6 more stages.

Comparison of the stage I of the present material with that of Kurien's (1951), reveals that the two agree well in general with reference to size and absence of: dorsal denticles on carapace, elevations on the anterior margin on either side of rostrum, pterygostomial spines, lateral denticles on carapace.
The first 3 stages of the present material, when compared with the corresponding stages of Pillai's, however, reveal considerable differences which are listed in the following table:

<table>
<thead>
<tr>
<th>Zoea I</th>
<th>Pillai's account (1946)</th>
<th>Present material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>2.17 mm</td>
<td>2.00 mm</td>
</tr>
<tr>
<td>Dorsal tubercle on carapace</td>
<td>Present.</td>
<td>Absent.</td>
</tr>
<tr>
<td>Elevation on anterior margin on either side of rostrum</td>
<td>Present.</td>
<td>Absent.</td>
</tr>
<tr>
<td>Pterygostomial spines</td>
<td>Present.</td>
<td>Absent (Present only from zoea II onwards).</td>
</tr>
<tr>
<td>Supraorbital spines</td>
<td>Present.</td>
<td>Absent.</td>
</tr>
<tr>
<td>Lateral denticles on carapace</td>
<td>Present.</td>
<td>Absent (Present only from zoea II onwards).</td>
</tr>
<tr>
<td>Rostral extension</td>
<td>Reaching upto antennular peduncle.</td>
<td>Reaching 1/2 of antennular peduncle.</td>
</tr>
<tr>
<td>Fifth abdominal segment</td>
<td>A pair of dorsomedian spines.</td>
<td>Posterolateral spines (No dorsal spines).</td>
</tr>
<tr>
<td>Terminal setae on the exopod of maxillipeds</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Setae on endopod of first maxillipeds</td>
<td>2, 1, 2, 4 distalwards.</td>
<td>1, 1, 1, 3 distalwards.</td>
</tr>
<tr>
<td>Endopod of second maxillipeds</td>
<td>3-segmented with 1, 2, 4 setae.</td>
<td>4-segmented with 0, 1, 2, 5 setae.</td>
</tr>
<tr>
<td>Pereiopod buds</td>
<td>First 2 pairs as biramous buds.</td>
<td>Do not appear till stage II.</td>
</tr>
<tr>
<td>Zoea II</td>
<td>Pillai's account</td>
<td>Present material</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Antennal spine</td>
<td>Absent.</td>
<td>A small antennal spine present.</td>
</tr>
<tr>
<td>Second maxilliped endopod</td>
<td>Now 4-segmented with 2, 1, 2, 3 setae distalwards.</td>
<td>2, 1, 2, 5 setae distalwards.</td>
</tr>
<tr>
<td>Pereiopods</td>
<td>4 pairs.</td>
<td>Only first ? as buds.</td>
</tr>
<tr>
<td>Uropod rudiments</td>
<td>Seen.</td>
<td>Not seen.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zoea III</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Antennule</td>
<td>Inner ramus shorter than outer.</td>
<td>Both rami equal.</td>
</tr>
<tr>
<td>Antenna</td>
<td>Distal segments of scale absent; distolateral spine appearing; peduncle with a sharp outer spine (as per his figure).</td>
<td>Distally 3-segmented scale; distolateral spine absent; no peduncular spine present.</td>
</tr>
<tr>
<td>Second maxilla scaphognathite marginal setae</td>
<td>8 setae.</td>
<td>7 setae.</td>
</tr>
<tr>
<td>Second maxilliped endopod</td>
<td>4 setae each on all segments.</td>
<td>Setation 3, 0, 1, 4 distalwards.</td>
</tr>
<tr>
<td>Third maxilliped endopod</td>
<td>3 - 4 setae each on all segments.</td>
<td>Setae 1, 2, 1, 2 and 3 distalwards.</td>
</tr>
<tr>
<td>Telson</td>
<td>With a pair of lateral marginal spines.</td>
<td>Lateral marginal spines absent.</td>
</tr>
<tr>
<td>Uropodal endopod</td>
<td>With 2 setae.</td>
<td>No setae.</td>
</tr>
</tbody>
</table>

The above differences prompted the author to repeat the rearing experiments for confirmation of the uniformity of larval
characters in the present material and the adults were subsequently confirmed by Prof. Dr. L.B. Holthuis, Leiden, as H. (H.) vittata (Stimpson).

The family Hippolytidae, particularly the genera like Hippolysmata show high variability of the members (Kemp, 1914; Holthuis, 1947) and so also the larvae of this family as a whole show high diversity amongst themselves as expressed by Lebour (1940) and Gurney (1942). Thus, the considerable larval differences as discussed above between Pillai's vittata and the present material amply support the possibilities of: i) the variability within the species vittata, as remarked also in adult by Kemp (1914), or ii) that Pillai's material may belong to a variety of vittata (Kemp, 1914, p. 115, creates a variety of vittata based on South (?) Indian material, which is subsequently synonymised by Holthuis, 1947 under the main species vittata) or iii) the larvae of both Pillai's and the present material amply speak for the heterogeneity of the genus Hippolysmata. No further comments, however, can be made until the genus Hippolysmata as a whole and the species group like vittata are properly revised, considering both the larval and adult features.
GENUS HIPPOLYTUS
GENUS HIPPOLYTE

In this genus, larval information is available on 6 species:

- **H. varians**, fully described by Sars (1912) from plankton, Webb (1921) stage I only from Plymouth plankton, Lebour (1931) giving some additional features again based on both laboratory and planktonic material;
- **H. ventricosa** (= **H. orientalis**), complete metamorphosis comprising 4 zoal and postlarval stages described by Gurney (1927) under the name **H. orientalis** and a single specimen of last zoa from Red Sea ascribed to this species by Williamson (1970);
- **H. prideauxiana** - 3 early larval stages from Plymouth by Lebour (1931);
- **H. californiensis** laboratory hatched first stage described by Needler (1933);
- **H. pleuracantha** and **H. acuminata**, larvae from Bermuda waters described by Gurney (1936).

Thus it is clearly seen that no larvae of the genus Hippolyte are so far described from India.

The generic features of Hippolyte based on the then known larvae, have been summarised by Lebour (1931) and Gurney (1937 and 1942).

The genus is represented by a single species viz. **Hippolyte ventricosa** (H. Milne Edwards) in Karwar. The lifehistory of this species, however, has been already described fully by Gurney from the Red Sea (1927). It was, therefore, to find out whether the larvae of the Indian material and those from Red Sea,
showed any differences, only the stage I of the species hatched in the laboratory was studied in the present work, for comparison with Gurney's account.

11. HIPPOLYTE VENTRICOSA (H. MILNE EDWARDS)

Description of Larval Stage

Zoea I
(Fig. 91)

Total length = 1.50 mm.

Eyes sessile. Rostrum distinct, narrow, pointed at tip, slightly enlarged at base, reaching beyond antennal scale. Carapace with a median tubercle behind rostrum, and with minute denticulations on anterior lateral margin. Abdomen 5-segmented, all segments smooth except for fifth bearing a pair of posterolateral spines.

Antennule (Fig. 91, b): Outer ramus with 1 big + 2 small aesthetascs + 1 plumose seta; inner ramus yet to develop but in its place, a long plumose seta present.

Antenna (Fig. 91, c): Scale distally 3-segmented with 7 long plumose setae on inner margin and 1 small hair-like + 2 small outer setae; endopod almost as long as scale, broad at base, terminating in a plumose seta.

Mandibles (Fig. 91, d): Slightly asymmetrical, both incisor and molar processes with minute teeth, no palp.

First maxilla (Fig. 91, e): Coxal endite with 4 bristles,
basal with five serrated teeth; palp unsegmented with 4 setae in 2 groups; an outer seta present.

Second maxilla (Fig. 91, f) : Coxal endite bilobed with 7 + 3 setae; basal endite bilobed with 3 setae each; endopod 4-lobed with 2, 2, 1 & 2 setae distalwards. Scaphognathite with 5 marginal setae.

First maxilliped (Fig. 91, g) : Endopod 4-segmented with 3, 1, 1 & 3 setae distalwards; exopod faintly 3-segmented, with 4 terminal setae. Basis with 9 and coxa with 5 setae.

Second maxilliped (Fig. 91, h) : Endopod 4-segmented, with 3, 1, 1, 4 setae distalwards; exopod faintly 3-segmented, with 4 terminal setae; basis with 3 and coxa with 1 seta.

Third maxilliped (Fig. 91, i) : Endopod 5-segmented with 2, 0, 0, 3 setae; exopod indistinctly 3-segmented with 4 terminal setae; basis and coxa without setae.

Pereiopod buds : Only first and second pereiopods present as small biramous buds.

Telson (Fig. 91, q) : Almost triangular with a median shallow notch; process formula 7 + 7, third, fourth and sixth being largest processes.

Chromatophores (Fig. 91, a) : Brownish branched chromatophores distributed as follows: on antennular peduncle; 3 pairs on lateral sides of carapace, one on base of second maxilliped; one each middorsally of first to third and posterolaterally on third and fifth abdominal segments, a single in anal region.
Remarks:

Gurney (1927) describes the complete metamorphosis of the present species *H. ventricosa* (= *H. orientalis*). The 1st stage of the present material agrees in general with his account except for slightly larger size of the former.

It also agrees with the characters listed by Gurney (1942) for the genus *Hippolyte*.
FAMILY PROCESSIDAE
FAMILY PROCESSIDAE

Information on the larvae of this family is available for only 2 of the 3 genera viz. Mikoides and Processa.

In the genus Mikoides, larvae are known in a single species *M. danae* of which Gurney (1937) describes the 1st and the last zoal stages from the Red Sea; Williamson (1970) describes a single specimen (damaged and stage not known) referred to this species, from the Red Sea plankton.

GENUS PROCESSA

Majority of the species wherein larvae are known, however, belong to the genus Processa. Gurney (1923) describes the complete metamorphosis of *Processa canaliculata*, obtaining stage I in laboratory and remaining 8 stages from plankton off Plymouth; in 1936, he deals with 8 stages of *P. bermudensis*, here too the stage I being obtained in the laboratory and rest from the Bermuda plankton; in 1937, he describes the larvae of *P. aequimana* from the Red Sea but unfortunately this reference being not available to me, details are restricted to as given by Gurney (1942) and Williamson (1970); in 1942, he summarises the characters of the family Processidae based on the then known larvae. Labour (1936) gives a complete account of metamorphosis (8 - 9 zoal + postlarva) of *P. edulis* from the British waters. Williamson (1967) while dealing with decapod larvae from the Mediterranean coast of Israel, records larvae of about 5 species - *Processa EM₄ - EM₇* and *Processa*
canaliculata ?. In this work he also mentions that larvae of 
P. mediterranea and P. parva (larvae of this species are also 
reported from the Mediterranean plankton by Seridji, 1971, but 
no details being given) are known from their parentage but does 
not give any details as to who has reared them and how many 
stages described etc ; in 1970, in his work on the Decapoda and 
Stomatopoda from the northern Red Sea, he deals with one 
specimen and last zoeal stage referred to as Processa HRS12 and a 
single zoea ascribed by him to Nikoides danae.

From India, Pillai (1955) records postlarval specimen of 
what he believes to be Processa australiensis (= P. sulcatus 
Hayashi) from the Travancore plankton, except for which no 
information is available either on the larvae or adult of this 
family.

The family Processidae is represented in Karwar by a 
single species i.e. Processa barnardi Hayashi. Lifehistory of 
this species, as observed in the laboratory, comprises 10 
zoeal + 1 postlarval stages. This also incidentally forms first 
account of completely laboratory reared lifehistory in the 
family.

12. PROCESSA BARNARDI HAYASHI

Description of Larval Stages

Zoea I
(Fig. 92)

Total length = 1.75 mm ; duration of stage = 44 - 48 hrs.

Eyes sessile. Rostrum absent, carapace with a small
dorsomedian hump behind eyes, anteroventral margin serrated with 3 minute denticles, a sharp pterygostomial spine (Fig. 92, a).

Antennule (Fig. 92, b) : Peduncle unsegmented, outer ramus with 3 aesthetascs + 1 plumose seta, future inner ramus represented by a long, subterminal, plumose seta.

Antenna (Fig. 92, c) : Scale unsegmented, with 9 inner and 2 outer marginal setae; endopod short, reaching up to 1/2 of scale, terminating in a stiff seta.

Mandible (Fig. 92, d) : Without palp, both molar and incisor processes with minute teeth.

First maxilla (Fig. 92, e) : With outer setae; coxal endite with 7 bristles, basal with 9 serrated teeth. Palp 2-segmented, distal segment with 3 and proximal with 2 plumose setae.

Second maxilla (Fig. 92, f) : Coxal endite bilobed with 8 + 3 setae, basal endite bilobed and deeply cleft with 3 + 3 setae; endopod 2-segmented, distal segment bilobed with 3 + 1 setae, proximal likewise but with 2 + 2 setae. Scaphognathite with proximal lobe not yet separated, with 5 marginal setae, inner margin fringed with hairs.

First maxilliped (Fig. 92, g) : Endopod 4-segmented with 3, 1, 2, 3 setae distallywards; exopod with 3 terminal and 2 subterminal natatory setae. Basis with 11 and coxa with 5 setae.

Second maxilliped (Fig. 92, h) : Endopod 4-segmented with 2, 1, 2 & 3 setae distallywards. Exopod with 3 terminal + 2
subterminal setae. Basis with 7 and coxa with 5 setae.

Third maxilliped (Fig. 92, i) : Endopod 4-segmented with 2, 1, 3, 2 setae. Exopod as long as endopod with 3 terminal + 2 subterminal setae as in other maxillipeds.

Pereiopod buds (Fig. 92, j) : Only first 2 pairs developed, former as small biramous bud and latter as tiny uniramous bud.

Abdomen (Fig. 92, a) : 5-segmented, fifth with a pair of posterolateral spines.

Chromatophores : Much branched light red chromatophores distributed one on either side above eye, on antenna and maxillipeds; a posterolateral pair each on third and fifth abdominal segments and one dorsomedian on third abdominal segment, large median on anal region extending into telson.

Zoea II
(Fig. 93)

Total length = 1.95 mm ; duration of stage = 40 - 44 hrs.

Salient changes from the previous stage are :

i) Eyes stalked; ii) rostrum short not reaching eyes even in subsequent stages; iii) supraorbital spine present; iv) scaphognathite setae increased to 7; v) second maxilliped with 5-segmented endopod having 4, 1, 0, 0, 3 + 1 setae distally; vi) third maxilliped with endopod 5-segmented and setation 2, 0, 0, 3, 2; exopod with 4 + 2 setae; vii) first pereiopods similar, functional, endopod 5-segmented with 2, 0, 0, 3, 3
setae distalwards; exopod with 4 + 2 setae; viii) telson process formula 8 + 8.

**Zoea III**
(Fig. 94)

Total length = 2.00 mm; duration of stage = 40 - 48 hrs.

This stage can be distinguished from preceding stage by:

1) Antennular peduncle 3-segmented, basal segment with a ventral spine, middle segment with 1 long and 2 small setae, distal segment with 4 setae; inner ramus a small bud with a long seta; outer ramus with 4 aesthetascs; ii) scale with a short terminal spine and outer setae reduced and shifted proximally; iii) second pair of pereiopods functional, endopod 4-segmented, distal segment with 3 setae; oxopod longer than endopod with 4 terminal and 2 subterminal setae; iv) abdomen 6-segmented except for which no change in subsequent stages; v) telson process formula 7 + 7; vi) uropods present, exopods functional with 6 setae, endopod small bud-like.

**Zoea IV**
(Fig. 95)

Total length = 2.15 mm; duration of stage = 48 - 50 hrs.

This stage is characterised by the following advancements over previous stage:

1) Antennal endopod considerably reduced; ii) scaphognathite with 12 setae and posterior lobe fully developed;
iii) second pereiopod endopod 5-segmented with 1, 0, 0, 3, 3 setae distalwards; iv) third pereiopod biramous, endopod unsegmented bud and exopod with 4 terminal setae; v) telson somewhat rectangular, process formula reduced to 5 + 5; vi) both rami of uropod functional, exopod with 7 setae and also with a small lateral spine, endopod with 6 setae.

Zoea V
(Fig. 96)
Total length = 2.25 mm ; duration of stage = 45 - 48 hrs.
Main changes from previous stage are :

1) Antennal scale with 15 + 1 marginal setae, endopod much reduced to less than 3/4 of scale, terminal seta small, hair-like; ii) exopod of third maxilliped, first and second pereiopods with 2 more subterminal setae; iii) endopod of third pereiopod 5-segmented, distal segment with 5 setae, exopod with with 4 + 2 setae; iv) telson narrower, process formula 5 + 5 and with 2 small spinules on lateral margin; v) uropodal setae increased.

Zoea VI
(Fig. 97)
Total length = 3.25 mm ; duration of stage = 46 - 48 hrs.
Advancements over previous stage are :

1) Antennule characteristically bent outwards, both rami almost equal; ii) antennal peduncle with a small spine at base of scale, outer margin of scale with 3 small hair-like setae,
endopod more enlarged than in previous stage and with terminal setae; iii) endopod of third pereiopods 5-segmented with 2, 1, 1, 4, 3 setae; iv) fourth pereiopod functional, exopod small with 4 terminal setae, endopod 5-segmented; v) fifth pereiopod uniramous bud; vi) telson narrower.

**Zoea VII**
(Fig. 98)

Total length = 3.75 mm; duration of stage = 48 - 50 hrs.

Salient changes over previous stage are:

1) Outer basal region of antennule slightly dilated; outer ramus with groups of aesthetascs; ii) scale with 17 marginal setae, endopod 2-segmented, proximal segment smaller, reaching about 1/2 of scale; iii) scaphognathite setae increased to 29; iv) right first pereiopod showing traces of chelate nature, left simple, exopod of both with $4 + 2 + 2 + 1$ setae; v) second pereiopod showing minutely chelate nature; vi) fourth pereiopod longer, exopod nearly half as long as endopod; vii) fifth pereiopod segmented but without exopod; viii) five pairs of small pleopod buds present.

**Zoea VIII**
(Fig. 99)

Total length = 4.40 mm; duration of stage = 46 - 48 hrs.

This stage differs from the preceding stage as under:

i) Inner ramus of antennule 2-segmented; ii) antennal endopod slightly shorter than scale, 4-segmented, flagellar;
iii) setae on scaphognathite increased to 40; iv) chelar part of first and second pereiopods more clearly developed; v) telson more elongated, narrowing posteriorly; vi) pleopods as biramous buds.

**Zoea IX**

(Fig. 100)

Total length = 5.15 mm; duration of stage = 44 - 48 hrs.

Characteristic features of this stage are:

1) Basal segment of antenna more bent, future stylocerite separated and with an acute tip; outer ramus 2-segmented, further segmentation indicated by groups of aesthetascs along inner margin; ii) antennal endopod flagellar, 9-segmented, overreaching scale by distal 3 segments; iii) marginal setae on scaphognathite increased to 47; iv) first right pereiopod (left simple, non-chelate) and second pereiopod more chelate; v) pleopods with a few setae on exopods; vi) telson posterior margin slightly rounded, process formula 6 + 6, 2 pairs of dorsal spines present.

**Zoea X**

(Fig. 101)

Total length = 5.75 mm; duration of stage = 24 - 26 hrs.

This is the last zoeal stage differing from stage IX as follows:

1) Inner ramus of antennule flagellar, 6-segmented, outer ramus 3-segmented with increased number of aesthetascs;
ii) endopod of antenna more flagellar composed of 17 segments, 2.4-times as long as scale; iii) fixed finger of first right pereiopods about 3/4 of dactylus; iv) pereiopod more setose, somewhat adult-like; v) pleopods with setae developing on endopod also.

Postlarva
(Fig. 102)

Total length = 5.90 mm.

Almost like adult except for the following:

Presence of a small spine on stylocerite; less number of carpal and meral subsegments of second pereiopod and absence of spines on merus of third and fourth pereiopods.

Rostrum bifid with a pair of setae (Fig. 102, a). Carapace with a broad projection-like antennal spine, ventral marginal spinules of larval stages lost in this stage.

Antennule (Fig. 102, b): Stylocerite with a small distinct distolateral spine, unlike in adult; outer flagellum only 10-segmented.

Antenna (Fig. 102, c): Peduncle nearly 3/4 of scale, spine on basal segment of zoeal stages absent.

Mandible (Fig. 102, d): Adult like, with only molar process.

Maxillae (Fig. 102, e,f): Almost as in adult.

Maxillipeds (Fig. 102, g-i): Like in adult, except for exopods having only 4 + 2 setae.
First pereiopods (Figs. 102, k,k₁): Stouter than remaining pereiopods, right chelate, left simple like in adults.

Second pereiopod (Figs. 102, l,l₁): Both chelate but unequal; right with carpus 17-, merus 7-, and ischium 3-subsegmented, left with carpus 13-, merus 4-subsegmented (ischium not divided). These subsegments are comparatively less in number than that of adults.

Third to fifth pereiopods (Figs. 102, m - o): Almost like those of adult except that merus of third and fourth without spines; minutely serrated spines distally on propodus found in adult, however, not yet developed in this stage.

Abdomen: Dorsomedian spines of fifth segment lost in this stage, instead pleuron produced into a small posterolateral spine like that of adult.

Pleopods: Endopod of first pleopod (like adult) smaller and without appendix interna.

Telson (Fig. 102, q): Sulcates like in adult with 2 pairs of distinct dorsal spines. Posterior margin with 3 pairs of spines unlike adults.

Remarks:

Gurney (1942) in his comprehensive work on 'Decapod Larvae', has listed the family characters for the larvae of Processidae into which the larvae of the present species Process barnardi fit in. But while Gurney mentions 8 - 9 zoeal stages before postlarva, larvae of the present species pass through 10 zoeal stages. As such, no detailed stagewise
comparison could be made amongst the known species viz. 
P. bermudensis, P. edulis, P. canaliculata and P. barnardi 
(present material) except for zoea I, which revealed the 
following differences (unfortunately, information on 1st stage 
of P. aequimana has not been available to the author, this 
species therefore, has not been included):

<table>
<thead>
<tr>
<th></th>
<th>P. barnardi (present Material)</th>
<th>P. canaliculata (Gurney, 1923)</th>
<th>P. bermudensis (Gurney, 1936)</th>
<th>P. edulis (based on figure, Gurney, 1942)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size of larva</strong></td>
<td>1.75 mm</td>
<td>1.9 to 2.2 mm</td>
<td>1.5 to 1.66 mm</td>
<td>?</td>
</tr>
<tr>
<td><strong>Rostrum</strong></td>
<td>Absent.</td>
<td>Absent.</td>
<td>Absent.</td>
<td>Minute rudiment.</td>
</tr>
<tr>
<td><strong>Carapace</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) pterygostomial spine</td>
<td>Present.</td>
<td>Present.</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>b) denticles on anterolateral margin</td>
<td>3.</td>
<td>2.</td>
<td>Absent.</td>
<td>?</td>
</tr>
<tr>
<td><strong>Antennal scale-number of setae</strong></td>
<td>11.</td>
<td>12.</td>
<td>11.</td>
<td>12.</td>
</tr>
<tr>
<td><strong>First maxilla palp</strong></td>
<td>2-segmented.</td>
<td>Unsegmented.</td>
<td>2-segmented.</td>
<td>Unsegmented.</td>
</tr>
<tr>
<td><strong>Second maxilla a) endopod</strong></td>
<td>2-segmented.</td>
<td>Unsegmented.</td>
<td>Unsegmented.</td>
<td>2-segmented.</td>
</tr>
<tr>
<td>b) scaphognathite setae</td>
<td>5.</td>
<td>Neither figured nor described.</td>
<td>5.</td>
<td>5?</td>
</tr>
</tbody>
</table>

Late larvae of P. aequimana, however, can be 
differentiated from all the rest in having - a median dorsal
spine on third and sixth abdominal segments, large branchiostegal spine and absence of exopods on fourth pereiopods (Gurney, 1942 and Williamson, 1970).
FAMILY CRANONIDAE

Gurney (1942) in his work on the decapod larvae gives a complete bibliography and a brief review of the larval works till 1942 in this family, covering the following genera: Crangon, Sabinea, Scolocrangon, Notocrangon, Pontophilus and Aegeon, as such, to avoid duplication these works are not repeated here. He also summarises the characters of the larvae of the family.

After Gurney, mention may be made mainly of the following works: Kurian (1956) while dealing with the decapod larvae of the Adriatic Sea, describes the stage II of Pontophilus spinosus and stages I and IX of P. norvegicus. Williamson (1960) gives a key to the larvae of 5 genera viz. Sabinea, Pontocaris, Pontophilus, Grangon and Philocheras of this family giving generic features; in 1967, while describing the decapod larvae from the Mediterranean coast of Israel, he deals with the last zoeal stage (single specimen) of Philocheras bispinosus and zoeal stage VI of Pontocaris cataphracta. Kurata (1964), while dealing with the decapod larvae of the Hokkaido plankton (Japan) describes the larvae of 8 species in Crangon affinis, stage I being obtained in the laboratory and stages II to VI and postlarva from plankton, while in remaining 7 species description based entirely on planktonic material; he, based on the above material, gives larval features for the family. Squires (1965) describes stages I and II of Argis dentata (both from plankton) from Ungava bay.
Seridji (1971) describes the larvae of the following species - *Crangon crangon* and *Pontocaris cataphracta* and in the genus *Philocheras* (= *Pontophilus*), *P. bispinosus*, *P. trispinosus* and *P. sculptus*, all from the Mediterranean plankton, no details, however, of larvae have been given for any of the above species except for recording the same.

From the Indian waters, except for the information on first 3 zoeal stages obtained in the laboratory of *Pontocaris pennata* (Sankolli & Shenoy, 1971), no information on the larvae of this family is available.

This family is represented in Karwar by a single genus *Pontophilus* and only one species i.e. *P. parvostris* Kemp, the lifehistory of which could be worked out in the laboratory.

**GENUS PONTOPHILUS**

As seen from above, although development of many a member of the family *Crangonidae* is fairly known, information on the larvae of the genus *Pontophilus* is restricted to only 2 species: stages I and V in *P. spinosus* and stages II, V and postlarva (= megalopa) in *P. norvegicus*, as cited by Williamson (1960). Also no account of complete metamorphosis either from plankton or based on laboratory rearings is available in this genus.

The present work therefore, describes for the first time, laboratory reared lifehistory, comprising 3 zoeal stages and a postlarva of *Pontophilus parvostris* Kemp.
13. POLYTOPHILUS PARVIROSTRIS KEMP

Description of Larval Stages

Zoea I
(Fig. 103)

Total length = 1.75 mm; duration of the stage = 70 - 78 hrs.

Eyes sessile. Rostrum smooth, small, slightly bent downwards, reaching only up to \( \frac{1}{3} \) of antennular peduncle in length. Carapace smooth without supraorbital and dorsal spines; anteroventral margin with 4 denticles behind anterior spine. Fifth abdominal segment with a pair of posterolateral spines.

Antennule (Fig. 103, b): Uniramous, simple; outer ramus with 3 aesthetascs and 2 setae of which one plumose; inner ramus represented by broad-based plumose seta.

Antenna (Fig. 103, c): Scale 2-segmented at tip, distal segment very small with 4 plumose and 1 small setae, proximal with 5 and 2 plumose setae on inner and outer margins; endopod spiniform with swollen base having minute spines at tip; peduncle with a distal spine.

Mandibles (Fig. 103, d): Asymmetrical, both incisor and molar processes present with minute teeth; no palp.

First maxilla (Fig. 103, e): Coxal endite with 6 strong bristles and basal with 4 broad serrated teeth; palp 2-segmented, terminal segment bearing 3 plumose setae and proximal only 2.

Second maxilla (Fig. 103, f): Endites bilobed and
setose, coxal with 3 and 7 and basal with 4 and 2 setae each respectively; endopod unsegmented but 4-lobed and setation 2, 2, 1 & 2 distalwards; scaphognathite with 5 marginal plumose setae and fine hairs on its inner margin.

First maxillipede (Fig. 103, g): Endopod 4-segmented with 3, 1, 2 & 3 setae on segments distalwards; exopod with 3 apical and 2 subapical plumose setae; basis quite large having 2 groups of 3 and 5 setae.

Second maxillipede (Fig. 103, h): Endopod 4-segmented with 3, 1, 3 & 4 setae distalwards as in first maxillipede; basis with two groups of 3 and 5 setae.

Third maxillipede (Fig. 103, i): Endopod 5-segmented with 2, 1, 0, 3 & 3 setae distalwards; exopod like that in first maxillipede; basis with 3 setae.

Pereiopod buds (Fig. 103, j): Appear in this stage as uniramous buds, first and second 2-segmented, rest being unsegmented and small.

Telson (Fig. 103, q): Triangular with a small median notch on its posterior margin. Process formula 7 + 7 with third, fourth and sixth processes almost equal but larger than rest.

Chromatophores: Larvae appear rather brownish black to the naked eye. Brownish black, densely stellate chromatophores are distributed all over the body as shown in (Fig. 103, a). Each of these chromatophores is with a diffused greenish yellow background.
Zoea II
(Fig. 104)

Total length = 2.15 mm; duration of the stage = 46 - 52 hrs.

Larva slightly increased in size and eyes stalked (Fig. 104, a), rostrum straight with acute tip, without any teeth and reaching up to \( \frac{1}{2} \) of antennular peduncle; carapace as in stage I. Fifth abdominal segment with a pair of posterolateral spines.

Antennule (Fig. 104, b): Inner ramus now little broader; peduncle with setae on outer margin.

Antenna (Fig. 104, c): Segmentation of scale disappears, 11 marginal setae on scale; endopod much broader than in I stage, reaching almost to the tip of scale.

Mandibles (Fig. 104, d): As in previous stage.

First maxilla (Fig. 104, e): As stage I except that basal endites now with more serrated teeth.

Second maxilla (Fig. 104, f): Setation of endites and endopod as in previous stage but marginal plumose setae of scaphognathite increased to 7.

First maxilliped (Fig. 104, g): Endopod setation increased to 4, 2, 2 & 3 setae distallywards; exopod with 4 terminal + 2 subterminal plumose setae; basis with two groups of 12 and 6 setae.

Second maxilliped (Fig. 104, h): Endopod now 5-segmented with 3, 2, 0, 2 and 5 setae distallywards; exopod like that of first maxilliped; basis with 8 setae.
Third maxilliped (Fig. 104, i) : Endopod setation increased to 2, 1, 2, 3 & 5; exopod as in first maxilliped; basis with 3 setae.

First pereiopod (Fig. 104, k) : Endopod 5-segmented, distal segment with a terminal small notch (precursor of subchela*), all segments with one seta each; exopod with 3 terminal and 2 sub-terminal setae.

Second pereiopod (Fig. 104, l) : Smaller than first; endopod 4-segmented, terminal segment with 4 long setae and basal with single seta; exopod as in first pereiopod.

Third to fifth pereiopods (Fig. 104, j) : Still in bud stage and without exopods.

Abdomen (Fig. 104, a) : Five pairs of pleopods developed as small buds on segments 1 - 5.

Telson (Fig. 104, q) : Almost as in stage I but with addition of a median pair of processes, formula becoming 8 + 2.

**Zoea III**

(Fig. 105)

Total length = 2.3 mm ; duration of the stage = 92 - 93 hrs.

Increase in size from the previous stage negligible (Fig. 105, a). Abdomen 6-segmented, posterolateral spine on fifth segment now smaller. Uropods present.

Antennule (Fig. 105, b) : As in previous stage.

Antenna (Fig. 105, c) : Scale shorter than endopod with
14 plumose setae and a small distal spine developed in this stage; endopod now 2-segmented, proximal segment much smaller than distal.

Mandibles and first maxilla (Fig. 105, d, e): As in previous stages.

Second maxilla (Fig. 105, f): Scaphognathite setae now increased to 14 in number.

First and third maxillipeds (Fig. 105, g, l): As in previous stage but setation of second maxilliped (Fig. 105, h) now increased to 3, 2, 1, 3 & 5. Exopod as in previous stages; basis with 9 setae.

First pereiopod (Fig. 105, k): Rather stumpy, with characteristic subchela developed; palm as long as carpus, merus and ischium put together; merus longer than carpus and ischium; exopod present with 5 plumose setae.

Second pereiopod (Fig. 105, l): Smaller than remaining pereiopods; chela not yet formed; exopod present, bearing 5 plumose setae terminally.

Last three pairs of pereiopods (Fig. 105, m - o): Without exopods; non-setose; third pair a little shorter than fourth or fifth.

Abdomen (Fig. 105, a): Sixth segment now separated. Five pairs of uniramous pleopod buds without any setae.

Telson (Fig. 105, q): No change.

Uropods (Fig. 105, q): With functional exopod bearing 13 setae and a small bud-like endopod.
Postlarva
(Fig. 106)

Total length = 2.45 mm.

The postlarva survived for 48 - 60 hrs but no further moults could be obtained.

Eyes are now set much closer, resembling those of adult. Rostrum reduced to small triangular structure, reaching below posterior margin of cornea. Carapace with a branchiostegal spine but antennal and hepatic spines not yet developed; anteroventral spinules characteristic of the zoeal stages are, however, lost.

Antennule (Fig. 106, b): Basal segment of 3-segmented peduncle as long as next two segments put together and with its outer distal end projecting anteriorly to about $\frac{1}{2}$ length of next segment, bearing 3 fine setae; broad stylocerite developed; 3 fine setae on both margins of basal segment; second segment with 3 setae. Inner flagellum still unsegmented, bearing 5 terminal setae, while outer 2-segmented with 2 aesthetascs + 2 setae.

Tip of antennule reaching almost to tip of antennal scale.

Antenna (Fig. 106, c): Flagellum of about 30 segments. Outer margin of scale slightly concave, anteriorly ending in a spine, no setae on outer margin, inner and distal margins with 17 plumose setae.

Mandibles (Fig. 106, d): Entirely changed from zoeal
mandible resembling that of adult with only an elongated molar process terminating in 4 large teeth.

First maxilla (Fig. 106, e): Palp slightly bilobed on distal margin with one stout seta; distal endite with 5 bristles, 1 plumose and 1 non-plumose setae, proximal endite with 3 setae.

Second maxilla (Fig. 106, f): Endopod unsegmented, without setae; basal and coxal endites reduced to small knobs without setae. Scaphognathite broad with 20 marginal setae.

Maxillipeds now acquire almost adult form; exopod characteristic, consisting of a non-flagellar basal and an inwardly bent distal flagellar portions.

First maxilliped (Fig. 106, g): Without endites; long, narrow rod-shaped endopod unsegmented, with 3 setae as in figure; broad based exopod with 4 basal and 4 terminal setae.

Second maxilliped (Fig. 106, h): With dactylus articulated diagonally to distal end of propodus and armed with 4 strong bristles and long setae on outer margin; exopod long with 3 terminal setae.

Third maxilliped (Fig. 106, i): Basal segment of endopod as long as next two segments together; exopod reduced with 4 terminal setae.

First pereiopods (Fig. 106, k): Characteristic adult subchela is fully formed, dactylus about \( \frac{2}{3} \) of propodus; carpus very short, spines on ventral surface not yet developed; merus slightly longer than palm with one spine at its outer distal end
of posterior margin as in adult; ischium and basis short. Exopods absent as in adult.

Second pereiopods (Fig. 106, l) : Smallest of all pereiopods. Dactylus slightly shorter than fixed finger; both fingers with claw-like terminal short spines (characteristic of the adult) present; palm twice as long as fingers; carpus as long as palm; outer margins of both chela and carpus with long plumose setae; merus and ischium almost twice as long as carpus. No exopod.

Third to fifth pereiopods (Fig. 106, m-o) : Third smallest and fifth longest; in third, dactylus 1/2 length of propodus; carpus slightly longer than propodus or merus, ischium 1/3 of merus; in both fourth and fifth, dactylus 1/3 of propodus and also merus longer than carpus; ischium 1/3 of merus.

Abdomen (Fig. 106, a) : Almost like in adult, 6-segmented, all segments smooth. 5 pairs of setose pleopods (Fig. 106, p₁ and p₂) projecting laterally, characteristically like in adult, but in this stage they are uniramous, endopod and appendix interna being totally absent.

Telson (Fig. 106, q) : Slightly shorter than sixth abdominal segment in length. Almost resembles adult telson but dorsal spines of adult still lateral in position here; posterior margin with 2 pairs of spines (1 small outer + 1 large inner) and a median pair of plumose setae.

Uropods (Fig. 106, q) : Overreaching telson as in adult. Both endopod and exopod well developed, elongated, narrow as in
adult, with long plumose setae. Outer margin of exopod terminates in a minute tooth.

Discussion:

The larval features of the present material Pontophilus parvirostris Kemp, though agree in general with the list of characters drawn by Gurney (1942) and Kurata (1964) for the Crangonid larvae, differ in the following: 1. antennal scale segmented at the tip (only in stage I); 2. endopod of first maxilla 2-segmented in the present material (unsegmented as per Gurney as well as Kurata); 3. setation of endopod of second maxilla different from that of Kurata's; 4. third to fifth pereiopods without exopod in present material as against second to fifth in Kurata's and 5. anal spine absent.

As far as the genus Pontophilus is concerned, larvae are so far known only in 2 species viz. P. norvegicus and P. spinosus. Seridji (1971) records the larvae of P. bispinosus, P. trispinosus and P. sulcatus from the Mediterranean plankton but since except for recording their occurrence, no other larval information is given by him, these species are not included here. Williamson (1960) while formulating zooplankton key to the larvae of the family Crangonidae, gives a generic key for Pontophilus based on the above 2 species. These two species, however, differ from the larvae of the present material P. parvirostris mainly in respect of the following: P. parvirostris larvae are much smaller, ranging from 1.75 - 2.5 mm in length whereas in the other 2 species the larvae range from 5.5 to 16 mm; rostrum in parvirostris not exceeding 1/3 - 1/2 of antennular peduncle while
in the other two, it is long, reaching almost to the tip of the peduncle; telson in *parviostris* is typical, triangular with a very shallow median notch but in the other two, it is large and deeply forked; no dorsal spine on any (particularly the third) abdominal segments in *parviostris* but with a prominent dorsal spine on third segment in the other two species.

Kemp (1916) based solely on adult characters, divides *Pontophilus* species into 5 different groups. The only 3 species in which the larvae are known, viz. *norvegicus*, *spinosus* and *parviostris* (present work) belong to two widely separated groups, the former two belonging to his group I (supposed to be the most primitive) and the latter to group V (supposed to be highly specialised) within the genus. Kemp's this grouping is now duly supported also in light of the present larval evidence, as seen by the striking differences (discussed above) between *P. norvegicus* and *P. spinosus* on one hand and *P. parviostris* on the other.

Considering the above discussion, it may be mentioned that Williamson's (1960) larval generic key for *Pontophilus* needs to be revised. However, even within the 3 species in which the larvae are known, the differences are so widely distinct that it would be rather premature to define the generic larval features, especially in view of the fact that there are as many as 46 species (as listed by Kemp, 1916 and Yaldwyn, 1960) presently known in the genus *Pontophilus*. 