IV. LARVAL DEVELOPMENT IN ALPHISIDAE
The classification, based solely on adults, of Decapod Crustacea has been a controversial subject and the significance of larval knowledge in solving or understanding the phylogenetic relationships among the various groups or taxa of Decapoda has now been fully accepted (Gurney, 1924; Hart, 1937; Lebour, 1943; Sankolli, 1967; Williamson, 1969; Shenoy & Sankolli, 1971 and Sandifer, 1974). This is particularly true of an intriguing group like the Alpheids.

A review of literature reveals that very little work has been done on the larval development in Alpheids as compared to other Decapods (Brooks, 1882; Brooks & Merrick, 1892; Sars, 1906; Webb, 1929; Lebour, 1932; Gurney, 1938 & 1942 and Knowlton, 1974), which is more so with regards to the Indian Alpheids. Except for the work of Xenon (1940), Pillai (1955) and Prasad & Tampi (1957), no information is available on the Alpheid larvae from India. These works, however, are based mainly on the larvae collected from plankton and therefore of rather uncertain identity.

The larvae obtained from berried females and reared through successive stages in the laboratory (therefore of known parentage) yield authentic information rather than the larvae studied from plankton alone. As such, in the present studies, resort was taken to laboratory cultures.
for studying the larval development.

In Alpheids, larval development is typical, prolonged development as in many of the Carideans, involving a number of larval stages, though in some cases abbreviated metamorphosis is also seen. Rearing of the Alpheid larvae with typical prolonged development is an extremely challenging problem as also experienced by Knowlton (1973) and by the author and his senior colleagues in this laboratory. In such species, in spite of several attempts using various techniques, larvae could be reared only up to IIIrd zoeal stage and not through complete metamorphosis, in the following 11 species: 1. Athanas dimorphus Ortmann, 2. Automate dolicognatha De Man, 3. Synalpheus tumidomanus (Paulson), 4. Alpheus splendidus Coutiere, 5. A. malabaricus Fabricius, 6. A. pacificus Dana, 7. A. lobidens lobidens (De Haan), 8. A. edwardsi (Audouin), 9. A. incipitatus Holthuis & Gottlieb, 10. A. macrodactylus Ortmann and 11. A. banneri n.sp. On the other hand, rearing in species with abbreviated development, is comparatively easier and in the present work, entire metamorphosis of only one species (with abbreviated development) viz. Alpheus santolill n. sp. could be worked out in the laboratory.

Method of Rearing:

Berried females collected from the intertidal zones
were brought to the laboratory in plastic bags containing sea water and kept alive individually in separate glass troughs with about 1000 ml of water until the eggs hatched. It was observed that for obtaining healthy hatchings of larvae, it was essential to simulate as far as possible natural conditions in the glass troughs, by providing small stones, sand, shell pieces etc. When such substratum was not provided, the females either shed their eggs prematurely or the larvae (if at all hatched) were physiologically so weak that most of the larvae generally died before they could moult to IIInd or IIIrd zoeal stages. Also in case of *Synalpheus tumidomanus* (Paulson) which is a rather delicate and highly thigmotactic species, nylon tubings (made of nylon fishing twine coiled around a pencil and then thermatically sealed by singling on sides so that the coil when pulled out from the pencil is in a form of soft and rather springy tubing) were provided which were readily occupied by the shrimps. In this manner the shrimp could be kept alive in the laboratory and the hatchings that were obtained were healthy. In *Athanas dorsalis* (Stimpson), which is a commensal on the sea urchin, both the host and commensal were kept together in the same tank, but unfortunately the host died within about 24 hours polluting the water which resulted in the death of the shrimp also. Though ovigerous females could be collected several times, the shrimps died before giving the larvae, whenever attempts were made to rear
alive the shrimp without its host in the tank.

Rearing techniques:

Larvae were reared in a series of finger bowls, of 100 – 200 ml capacity each, using sea water filtered through glass wool. In each bowl 5 to 10 larvae were used for rearing and the water was renewed every day, after examining the bowl for presence of moults or dead larvae. Individual rearing of the larvae in each bowl was also attempted. Several types of food were used (for details see the later part of this chapter). The larvae were killed and preserved using separate killing solution and preservative (Tnakur, 1960), for subsequent studies. Dissections were made under binocular microscope and drawings with the help of camera lucida.

During the course of the study, the temperature of the sea water varied from 28°C to 30°C and salinity from 30 to 34 ppt.

Failures in Rearing and Different Feeds used (for the species with prolonged life history):

Various techniques were employed to rear the larvae which had prolonged larval phase. Applying the normal laboratory rearing techniques (like using filtered sea water and feeding freshly hatched Artemia nauplii + algal cultures etc.) used quite successfully for rearing the Brachyuran,
Anomuran and Caridean shrimp larvae in this laboratory, the Alpheid larvae could not be maintained alive beyond the II\textsuperscript{nd} zoal stage. This kind of difficulties or failures were also experienced by other workers like Knowlton (1973) and Sobier (as cited by Knowlton, 1973). Indeed, compared to other Decapod larvae, the Alpheid larvae are quite hardy and they easily moult successively till the III\textsuperscript{rd} zoae even when no special care or technique is employed in rearing them, and also even when food or no food being added to the rearing containers. The III\textsuperscript{rd} zoae, apparently remain alive for 20 - 24 hours after which invariably there is a sudden mortality, for which no reasons could be ascribed. It was, therefore, felt that causes for this failure could be possibly improper food, rearing techniques etc. and as such the author and his senior colleagues (who have been working on the laboratory Culture of Decapod Crustaceans) in this laboratory tried several techniques over 3 years using different feeds etc. but with no success beyond the III\textsuperscript{rd} stage.

Food:

Artemia nauplii, either freshly hatched or later nauplii, were not taken by the larvae even in III\textsuperscript{rd} stage.

Bioed egg: Flakes of egg (yolk + albumen beaten together and then steamed over boiling water and then chopped to fine particles of 0.1 - 0.2 mm) were tried for feeding.
The larvae apparently did feed on these egg particles but with no improvement in the rearing results.

**Algal cultures**: When various phytoplankton cultures including those of *Palmelloccocus* species and *Hutzellia* species were tried, the larvae did ingest the green matter (as revealed by examination under microscope of the digestive tract). However, here too, failure beyond IIIrd zoea was inevitable.

**Other feeds**: Various feeds like fine particles of minced meat, beef, sheep liver, clam, oyster, fish roe, live microplankton etc. were tried individually or in mixtures with the above items like *Artemia* nauplii, algal cultures etc. but with no success.

**Rearing techniques**: Alongwith parents: Attempts were made to rear the larvae along with their parents in bigger containers like glass aquaria, glass troughs etc., provided with adult locality sand, mud etc., as a substratum but with no success beyond IIIrd stage.

**Salinity**: It was felt that salinity might be one of the factors for the failure and hence various salinity dilutions were also tried as rearing media.
Live tank: Transparent plastic containers with windows (specially made) on all sides (except on top and bottom) covered with organdy mesh cloth to allow free circulation of sea water were designed wherein live larvae were introduced and the containers were made to float in the shore-waters opposite the Research Station. The containers were rigged as shown in fig. for floating in the sea. But this method had to be abandoned since whenever there was rough weather the containers were lost as they had drifted away in the night or during calm weather were stolen. Similarly this method was tried in the fairly calm portion of the estuarine waters near the Research Station. Here too, the method had to be discarded since the bottles were lost as explained above.

Creating wave action in the rearing tanks: This did not have any effect on the survival or moulting rate of the larvae beyond IIIrd zoal stage.

Terminology:

Gurney (1924 & 1942), Menon (1933, 1937 and 1940) and Lebour (1943) have used the terms setae and long setae or spines to describe the Decapod larval telson. But Pike & Williamson (1960), while working on the Pagurid larvae introduced a general term 'telson process' whether they were spines, setae or hairs, to avoid confusion. This was followed by Sankolli & Shenoy (1967 & 1971) in their studies on
Decapod larvae. Accordingly, in the present study the term 'telson process' is used and processes are numbered from outside in. Thus, the fourth telson process (of the present study) corresponds to the fourth telson spine of Gurney (1924 & 1942), the third spine of MacDonald et al (1957) and fourth process of Pike & Williamson (1960) and of Sankolli & Shenoy (1967 & 1971).

Remarks:

Lebour (1902) and Gurney (1942) have listed the larval characters of the family Alpheidae. The larvae in the present work, belonging to four different genera viz. Automate, Athanas, Synalpheus and Alpheus, also share the characters as listed for the family Alpheidae by the above authors.

Larvae of the above genera, based on present knowledge (inclusive of the present work), offer such a striking similarity and morphological characters that it is difficult to define the characters either at specific level or even at generic level. As such, careful attempts even to frame a satisfactory generic key could not meet with success. This has been so aptly expressed even by larval authorities like Gurney (1942) p. 216 - "Few larvae which can be recognised as Alpheids depart widely from the general form and structure ............. ".
Genus *Automate*

Review of literature shows that there is no information available on the larvae of the genus *Automate*. In the present work, information with regard to laboratory hatched first zoea only of *Automate dolichognatha* De Man is given since subsequent stages could not be obtained.
1. AUTOMATE DOLICHOCNATHA DE MAN
1. Automate dolichognatha De Man

First Zoea
(Fig. 32)

Total length - 1.6 mm; carapace length - 0.8 mm.

Carapace smooth with a distinct dorso-median hump posterior to eyes; rostrum small, pointed, reaching slightly beyond eyes; eyes large and sessile; pterygostomial angle rounded and smooth.

Antennule (Fig. 32, c): Peduncle unsegmented with a long plumose seta distally on inner side; outer ramus separated distinctly and terminally bearing 4 unequal aesthetascs and a short, rather stumpy plumose seta on inner side.

Antenna (Fig. 32, d): Endopod half as long as scale with a long plumose seta and a small tooth-like spine apically; scale with 10 inner marginal and 2 outer setae; peduncle without any spine.

Mandible (Fig. 32, e): Simple, with 2 - 3 teeth on cutting edges.

First maxilla (Fig. 32, f): Coxal and basal endites deeply cleft with a small terminal and a subterminal setae on coxal and 2 tooth-like spines on basal endites; endopod small with 2 setae terminally.
Second maxilla (Fig. 32, g): Both coxal and basal endites bilobed with 1-2 small setae on each of its lobes; endopod fairly large, its basal part enlarged and lobed, with 4 apical setae; scaphognathite broad, bearing 5 marginal plumose setae uniformly along margin.

First maxilliped (Fig. 32, h): Endopod not segmented and with one basal and 4 terminal setae; exopod well developed with 4 terminal natatory setae; basis short with 3 setae on inner margin.

Second maxilliped (Fig. 32, i): Endopod 5-segmented, first segment with a small inner seta and last with 3 apical setae; exopod with 4 terminal + 2 subterminal natatory setae; basis as in first maxilliped but with only 2 setae.

Third maxilliped (Fig. 32, j): Endopod 4-segmented with only last segment bearing 4 terminal setae; exopod a little longer than endopod with 4 terminal + 2 subterminal natatory setae.

Pereiopod buds (Figs. 32, k-o): All pereiopod buds appear at this stage; first biramous and well developed; fifth uniramous and fairly long; second to fourth not yet clearly separated.

Abdomea (Fig. 32, a): 5-segmented, all segments smooth.
Telson (Fig. 32, s) || Triangular, basal portion long and narrow, process formula 7 + 7. Posterior margin with a small median notch, armed with minute serrations at base of each process except first and with 1 - 2 spinules in between processes.

Chromatophores:

Much branched bright orange red chromatophores scattered all over the body including antennule and antenna, giving bright orange appearance to the entire larva. Also, bright golden yellow diffused colouration in carapace region. Cornea black.
Genus Athanas

Information on the larvae of this genus is restricted to only 3 species: Athanas dimorphus, A. djiboutensis (Gurney, 1927 & 1938) and A. nitescens (Sars, 1906; Webb, 1921; Lebour, 1932 and Kurien, 1957).

The present work dealing with the laboratory hatched 3 early larval stages of A. dimorphus Ortmann, extends the knowledge of the species by 2 more stages, the first stage being described by Gurney (1927).

This is the first time that the larvae of this genus from the Indian region are described.

Remarks:

The so far known laboratory hatched larvae of this genus viz. A. dimorphus, A. nitescens and A. djiboutensis, resemble each other so closely that base on morphological features, it is rather difficult to separate them from one another, as also suggested by Gurney (1938), and it is only the chromatophore pattern of each which probably can be a diagnostic feature.
FIGURE 33. Athanas dimorphus Ortmann - First Zoea.

a - entire larva, c - antennule, d - antenna, e - mandible,
f - first maxilla, g - second maxilla, h - first maxilliped,
i - second maxilliped, j - third maxilliped, k - first pereiopod,
o - fifth pereiopod, s - telson.
2. **Athanaes dimorphus** Ortmann

**First Zoea**

(Fig. 33)

Total length - 1.4 mm; carapace length - 0.3 mm.

Rostrum indistinct; carapace smooth with a dorso-median hump behind eyes; eyes large, sessile; abdomen nearly 4-times carapace, smooth, 5-segmented and peculiarly bent at third segment.

**Antennule** (Fig. 33, c): Peduncle unsegmented. Inner ramus represented by a long plumose seta; outer ramus clearly demarcated from peduncle bearing one large and 2 thinner aesthetasos and 2 unequal setae terminally.

**Antenna** (Fig. 33, d): Peduncle with a distal spine on inner margin; endopod small, broad, ending in a point; scale 3-segmented, distally, about 3-times longer than endopod with 10 inner (terminal seta very small) and 2 outer marginal setae.

**Mandible** (Fig. 33, e): Poorly developed, its processes not clearly differentiated.

**First maxilla** (Fig. 33, f): Rather rudimentary; basal endite and endopod bearing 2 spine-like teeth.
Second maxilla (Fig. 33, g) : Only 3 endites present and demarcated by shallow notches, distalmost bearing 2 setae; endopod fairly large with 2 terminal setae; scaphognathite with 5 marginal setae.

First maxilliped (Fig. 33, h) : Endopod rather rudimentary, unsegmented, bearing 2 small terminal setae; exopod with 4 terminal natatory setae; basis unarmed.

Second maxilliped (Fig. 33, i) : Endopod about half the length of exopod, 4-segmented, last segment drawn into a slightly curved spine and bearing 2 small setae; exopod with 4 natatory setae; basis unarmed.

Third maxilliped (Fig. 33, j) : Almost like second maxilliped but endopod being 3/4 exopod in length and exopod with one small subterminal outer seta.

Pereiopod buds (Figs. 33, k - o) : First large biramous; fifth also large but uniramous while other pereiopods not yet appeared.

Telson (Fig. 33, s) : Triangular, with a slight median notch on posterior margin; process formula 7 + 7, 3 - 4 small spinules present inbetween processes from fourth to seventh.

Chromatophores :

Larva almost transparent except for red branched
FIGURE 34. _Athanas dimorphus_ Ortman - Second Zoea.

- a - entire larva, c - antennule, d - antenna, e - mand.bis.
- f - first maxilla, g - second maxilla, h - first maxilliped.
- i - second maxilliped, j - third maxilliped, k - first pereiopod.
- l - fifth pereiopod, s - telson.
chromatophores which are distributed as follows: as seen in dorsal view, a single tiny one distally on antennule; one prominent large on the eye; one on either side at the base of rostrum; 3 pairs on carapace (one anterior and 2 posterior). 2 pairs each arranged horizontally on second and third abdominal segments; another set of 2 pairs at the junction of third and fourth abdominal segments; fourth abdominal segment with one pair on either side and fifth with a single pair; telson with a rather large chromatophore. Similar but small chromatophore at base of first and second maxillipeds. Also, diffused yellow patch with branched red chromatophore proximally on antennule, antero-laterally on eyes; a single patch just below the rostrum; middorsally on fourth abdominal segment and a horizontal patch along the posterior margin of fifth abdominal segment and a lateral patch on telson.

Ventrally, first and fourth abdominal segments, with red branched chromatophores with diffused yellow patches.

Second Zoa (Fig. 34)

Total length - 1.7 mm; carapace length - 0.4 mm.

This stage is characterised by a distinct but small rostrum, eyes stalked, dorso-median hump of carapace now shifted posteriorly; antennular peduncle segmented; telson
process formula 8 + 8; uropod buds seen through cuticle.

**Antennule** (Fig. 34, c): Peduncle indistinctly 3-segmented, proximal segment indicated by only a notch while the distal clearly separated, bearing 4 - 5 delicate setae distally; inner ramus represented by a single seta; outer ramus now with 5 aesthetascos and one seta terminally.

Antenna to first maxilla (figs. 34, d - f) practically no change.

**Second maxilla** (Fig. 34, g): Endites now more clearly differentiated with 1, 2 and 2 setae respectively distally.

**Maxillipeds** (Figs. 34, h - j): Not much changed except for an addition of a small seta on endopod segments - on second segment in second maxilliped and on third in third maxilliped.

**Pereiopod buds** (Figs. 34, k - o): Except for increase in size, no change.

**Telson** (Fig. 34, s): Process formula 8 + 8, with an addition of a median pair of small processes. Uropod buds seen through cuticle in this stage.
FIG. 35. *Atuanae dimorpha* Ortmann - Fair. Zone.

1 - entire larva, c - antennule, d - antenna, e - mandible,
f - first maxilla, g - second maxilla, h - first maxilliped,
i - second maxilliped, j - third maxilliped, k - postabdomen,
l - first peraeon, s - telson.
Third Zoea
(Fig. 35)

Total length - 1.7 mm; carapace length - 0.5 mm.

Salient features of this stage are: Rostrum acute, longer than in previous stage and slightly upturned; pterygostomial margin angular; first and fifth pereiopods functional, fifth with characteristically produced dactylus; abdomen with 6 segments; telson almost quadrangular; process formula reduced to 7+7; biramous uropods with functional exopod.

Antennule (Fig. 35, c): Peduncle 3-segmented; first segment distally with 2 small outer and a long inner setae, second with 3 short thin, hair-like and 2 long plumose setae at base of inner ramus; inner ramus represented by a long seta; outer ramus with 2 aesthetacs and a seta.

Antenna (Fig. 35, d): Scale now with 11 inner marginal and one outer setae (instead of 2 of previous stage).

Mandible (Fig. 35, e): Incisor process with 3 spine-like teeth.

First maxilla (Fig. 35, f): Now setose, coxal endite with 3 setae, while basal with 2 large, nonserrated teeth and a simple seta; endopod with a characteristic large, thick and a delicate setae.
Second maxilla (Fig. 35, g) : Setation increased by one seta each on all endites and endopod.

Maxillipeds (Figs. 35, h - j) : Only change - exopod of second with a small subterminal seta.

Pereiopods (Figs. 35, k - o) : Second to fourth pairs not yet developed; first pair now functional, endopod indistinctly 3-segmented, last segment ending in a drawn out spine and with 2 small setae; exopod with 4 natatory setae; fifth pair segmented and with characteristically elongated dactylus bearing a small seta near base.

Telson and uropods (Fig. 35, s) : Telson roughly quadrangular, with process formula 7 + 7 (first process of previous stage now reduced).

Uropods well developed with only exopod functional, bearing 6 long plumose setae distally; endopod buds narrow and elongated; protopod not yet demarcated.
Genus Synalpheus

A review of literature on Alpheid larvae reveals that the larvae of this genus are somewhat better known as in allied genus Alpheus and mention may be made particularly of the following works: Brooks & Herrick (1892) described larvae of Synalpheus brevicarpus and S. longicarpus; Coutiere (1896, 1899 & 1909) described larvae of S. laevimanus, S. spinifrons, S. brooksi and S. minus; Gurney (1927, 1938 & 1949) dealt with larvae of S. gravieri (= S. neomeris), S. triunguiculatus and entire metamorphosis consisting of 3 stages of S. goodei; Dobkin (1965) dealt with the direct development in S. brooksi and extended development in S. apioceros. For further details, please see Knowlton (1973, p. 275).

As far as the larvae of the Indian region are concerned, no information whatsoever is available of this genus. The present thesis, describing the first 3 zoeal stages of S. tumidomanus, therefore, adds to the knowledge of the larvae of this genus by one more species and also forms the first account of the larvae of the genus from the Indian waters.
Discussion:

Gurney (1949) while describing the development of *Synalpheus goodei*, lists the species of this genus wherein larvae were known till then, viz. *S. brevicarpus*, *S. longicarpus*, *S. triunguiculatus* and *S. gravieri*, in all of which, including his *S. goodei*, the larvae hatching in more or less advanced form.

Knowlton (1973), while listing the species of *Synalpheus* in which larvae are supposed to be known, mentions *S. guerini*, *S. hemphili* and *S. apiceros* as having extended development. Unfortunately, there is no published account of these three species.

Besides, the larvae of the present species, *S. tumidomanaus* indicate a normal, typical development, thus rendering comparison with known larvae (with abbreviated metamorphosis) rather difficult. *S. triunguiculatus* is the only species of which the larvae, described by Gurney (1938), are somewhat comparable with those of present species, in degree of development but here too Gurney's so called first stage is actually the second stage (as also suggested by him). The two species can, however, be easily distinguished by
the presence in *S. triumguiculatus* larvae, of characteristically enlarged second abdominal pleura and other morphological features such as more developed, large rudiments of pereiopods etc.
3. SYNALPHEUS TUMIDOMANUS (PAULSON)
Fig. 36. *Synalpheus tumidomanus* (Paulson) - First Zoea.

- entire larva, c - antennule, d - antenna, e - mandible,
  f - first maxilla, g - second maxilla, h - first maxilliped,
  i - second maxilliped, j - third maxilliped, k - o - Parapodi
  l - n - telson.
3. *Synalpheus tumidomanus* (Paulson)

**First Zoea**

(Fig. 36)

Total length - 2.1 mm; carapace length - 0.7 mm.

Body somewhat flattened; rostrum broad basally, tapering acutely and reaching slightly beyond eyes; a distinct medio-dorsal hump on carapace; eyes sessile; all pereiopod buds present; abdomen 5-segmented; telson rounded.

**Antennule** (Fig. 36, c): Peduncle 2-segmented, basal segment longer with 3 small, outer and a long inner setae; second segment short with 4 short, distal setae at base of inner ramus and a single outer seta. Both rami well developed, almost of same size, inner ramus terminating into a long spine-like seta and a shorter slender seta besides it; outer at its apex with one broad and 4 slender aesthetascs and a seta.

**Antenna** (Fig. 36, d): Endopod quite large, a little shorter than scale, gradually tapering into an acute point with a small seta near apex; scale elongated, slender, almost with parallel sides, bearing 10 setae along proximal half of inner margin and one outer marginal seta.
Mandible (Fig. 36, e): Incisor and molar processes somewhat differentiated, incisor with a large tooth and 3 tubercle-like small teeth while molar without any armature except for 2 blunt tooth-like projections on either extremities.

First maxilla (Fig. 36, f): Endopod terminating into a long spine-like seta with a small seta at its base; basal endite with 4 small blunt teeth, coxal with 3 plain bristles.

Second maxilla (Fig. 36, g): Both coxal and basal endites represented by only 3 lobes (as in Alphens) armed with 3, 4 and 4 setae respectively; proximalmost lobe with a slight notch distally; endopod with a well developed basal lobe and with 3 terminal setae + 2 setae on basal lobe; scaphognathite with 7 setae of which 5 on distal margin and 2 on proximal lobe posteriorly.

First maxilliped (Fig. 36, h): Endopod small, unsegmented and poorly developed with 3 apical and a basal setae; exopod well developed with 4 terminal setae. Basis with a row of stiff, plain setae.

Second maxilliped (Fig. 36, i): Endopod unsegmented, ending in a point and bearing 1, 1 and 2 setae as in figure; exopod with 4 terminal + 1 subterminal, long plumose setae. Basis smooth.
Third maxilliped (Fig. 36, j): Endopod equal to exopod in length, 2 segments faintly marked, distal segment bearing $1+1+2$ setae, tip ending in a spine; exopod with $4+2$ setae.

Pereiopod buds (Figs. 36, k-o): All pereiopod buds present in this stage, first 4 pairs biramous (third and fourth small), fifth long and uniramous.

Telson (Fig. 36, s): Rather narrow and elongate, almost rounded posteriorly, with a shallow median notch on posterior margin. Process formula $7+7$, fifth process longest, seventh smallest.

Chromatophores:

Larva densely covered with branched chromatophores - red, yellow and yellowish brown: Inner ramus of antennule with a longitudinal red and its peduncle along its inner margin with much branched reddish brown; rostrum basally with a reddish brown and eye along antero-internal angle with a similar chromatophore. Carapace - with 3 dorsal pairs of reddish brown and all along its ventral margin with about 6 reddish brown with golden yellow and with a larger reddish brown at postero-lateral angle. Abdomen - first segment dorsally with one reddish brown pair and posteriorly with another pair which is much branched transversely (often merging into each other), a single golden yellow on pleural region; second to fourth.
FIGURE 37. *Synalpheus tumidomanus* (Paulson) - Second Zoea.

a - entire larva, c - antennule, d - antenna, e - mandible,
f - first maxilla, g - second maxilla, h - first maxilliped,
i - second maxilliped, j - third maxilliped, k - o - Per.104
risc, s - telson.
segments each with a dorsal pair of red and with a golden yellow on each pleuron; fifth segment with a dorsal pair of golden yellow with a single median red in between and also a golden yellow on pleuron. Telson at its base with a prominent yellowish brown and each uropodal bud with a longitudinal red.

Second Zoea
(Fig. 37)

Total length - 2.2 mm; carapace length - 0.8 mm.

Rostrum and hump on carapace distinct; eyes stalked; abdomen still 5-segmented; telson process formula 8–8.

Antennule (Fig. 37, c): Peduncle incompletely 3-segmented; first segment with 3+1, second with a single and third with 5 short setae (as in figure); inner ramus with a long plumose and a short plain setae; outer with 2 broad + 3 slender aesthetascs and a short inner seta.

Antenna (Fig. 37, d): Almost as in first stage.

Mandible (Fig. 37, e): 3–4 blunt, short tubercle-like teeth on both incisor and molar portions.

First maxilla (Fig. 37, f): General setation now increased—endopod with 2 unequal, spine-like setae; basal endite with 4 non-serrated teeth, longer than in previous stage; coxal endite with 4 prominent setae.
FIG. 38. *Synalpheus tumidomans* (Paulson) - third larva

a - entire larva, c - antennule, d - antenna, e - antennula
f - first maxilla, g - second maxilla, h - first maxilliped
i - second maxilliped, j - third maxilliped, k - c - telson's buds, s - telson.
Second maxilla (Fig. 37, g): Not much changed over previous stage.

Maxillipeds (Figs. 37, h - j): Major change over first stage is only a slight increase in number of setae - endopod of second and third maxillipeds now with one fairly long, minute serrated subterminal bristle: basis of the two with 2 setae each.

Pereiopod buds (Figs. 37, k - o): Slightly increased in size but not yet segmented.

Telson (Fig. 37, s): Posterior margin divided by median notch into two distinct rounded halves. Process formula 8 + 8, eighth process very small and situated on median notch.

Third Zoea
(Fig. 38)

Total length - 2.2 mm; carapace length - 0.9 mm.

Rostrum now reaching well beyond eyes; pterostomial angle not produced; abdomen 6-segmented, sixth segment separated from telson; uropods present.

Antennule (Fig. 38, c): Peduncle 3-segmented, with following setation: 3 short outer distally, 2 short outer and 1 long + 1 short inner, and 4 - 5 short outer and 4
long on distal margin in inner half, from first to third segments respectively. Inner ramus about twice as long as outer, bearing 3 delicate setae. Outer ramus with 2 broad and 2 thinner aesthetascs terminally.

Antenna (Fig. 38, d) : Scale now with outer seta lost and inner marginal setae increased to 14. Endopod elongated but not reaching tip of scale.

Mandible (Fig. 38, e) : Well developed incisor part with a sharp, broad tooth and 3 additional blunt long teeth; molar with 4 - 5 blunt teeth.

First and second maxilla (Figs. 38, f & g) : Not much changed except for a slight increase in setation - coxal endite of first maxilla with 5 setae; lobes of endites of second maxilla with 4, 4 and 5 setae respectively distally.

Maxillipeds (Figs. 38, h - j) : Though endopod of second and third maxillipeds now 3-segmented, no other appreciable change.

Pereiopods (Figs. 33, k - o) : First two pairs now functional, endopod 4-segmented, ending in a point, exopod with 4 terminal + 2 subterminal long, plumose setae; third and fourth still small, biramous buds; fifth now 3-segmented with its tip produced into usual long, styliform process.
Telson and Uropods (Fig. 38, s): Telson quadrangular in shape with the median notch of posterior margin still persisting but without lobed appearance. Process formula $7+7$, median (seventh) process being very small.

Uropods biramous, protopod not yet differentiated, only exopod with 6 plumose setae, while endopod still bud-like without any setae.
Genus *Alpheus*

The earliest work on the development in this genus is as far back as 1882 when Brooks observed abbreviated development in *Alpheus heterochaelis*, the life history, however, later on accurately described by Brooks & Herrick (1892), from the Atlantic. In 1888, Herrick described abbreviated metamorphosis in *A. praccox*, a commensal on sponges. Later works in the genus are rather scattered, of which mention may be made of the following: Coutiere (1899) described 'egg-larva' of *A. laevis* from the Red Sea; Webb (1921) dealt with larval stages of *A. glaber* (= *A. ruber*), she evidently mixed the larvae of *A. macrochelis*, from the Plymouth plankton. Gurney (1927 & 1938) gave an account of larval stages of *A. audouni* (= *A. edwardsi*), *A. pacificus* and *A. ventrosus* from the Red Sea; Lebour (1932) described larvae of *A. glaber* (= *A. ruber*) and *A. macrochelis*, obtaining the first 3-4 zoeal stages in the laboratory and connecting the subsequent stages from plankton from the British waters. Miyazaki (1937) described the larvae of *A. brevirostratus* from Japan; Bourdillon-Casanova (1960) dealt with the larvae of *A. dentipes* - a Mediterranean form; Gooar & Al-Kholy (1957) gave an inadequate account of larvae of
A. pacificus? from the Red Sea plankton; Kurien (1956) while dealing with the decapod larvae of the Adriatic plankton, described the larvae of A. ruber; Al-Kholy (1960) gave an account of larvae of A. villosus and A. ventrosus from the Red Sea; Kurata (1965) described the larvae of 2 species of alpheids from the Japanese waters and Knowlton (1973) gave a detailed account of the abbreviated development in A. heterochaetis.

Among the Indian works, Menon (1940) dealt with the larvae of 2 species of Alpheus from the Madras plankton; Pillai (1955) gave an account of postlarva of what he doubtfully referred as A. pacificus from the Travancore plankton and Prasad & Tampi (1957) described the first zoeae of A. rapacida and A. strenuus, based on laboratory hatchings.

In the present work, first 3 larval stages, based on laboratory hatchings, of the following 8 species and the complete lifehistory of only one species viz. A. A. sankollii n. sp., are described: 1. A. splendidus, 2. A. malabaricus, 3. A. pacificus, 4. A. bangeri n. sp., 5. A. lobidens lobidens, 6. A. edwardsi, 7. A. inopinatus, 8. A. macrodactylus and 9. A. sankollii n. sp.

Of the above 9 species, larvae are already known in
2 species viz. *A. pacificus* (Gurney, 1938) and *A. edwardsi* (= *A. audouini* Coutière of Gueney, 1938) and hence, the necessary comparisons could be made of the present material with the earlier account of these 2, while in the remaining 7 species, larvae are described for the first time.

a - entire larva, c - antennule, d - antenna, e - mandible, 
f - first maxilla, g - second maxilla, h - first maxilliped, 
i - second maxilliped, j - third maxilliped, k - first pereiopod,  
o - fifth pereiopod, s - telson.
4. *Alpheus splendidus* Coutiere

**First Zoea**
(Fig. 39)

Total length - 2.1 mm; carapace length - 0.6 mm.

Carapace smooth without a distinct rostrum (Fig. 39, a) but a slight dorsomedian hump present posterior to eyes; eyes large and sessile; abdomen 5-segmented, sixth segment still fused with telson; telson process formula 7 + 7.

**Antennule** (Fig. 39, c): Peduncle unsegmented, long and slender; inner ramus represented by a long plumose seta; outer ramus distally bearing a thin and 2 broad aesthetases and a short plumose seta.

**Antenna** (Fig. 39, d): Peduncle with a spine medio-ventrally; endopod half as long as exopod terminating into a fairly long tooth-like spine and bearing apically a long plumose seta on inner side of this spine; scale with 10 marginal setae (terminal the smallest) and 2 setae subterminally on outer margin.

**Mandible** (Fig. 39, e): Poorly developed without distinct demarcation of processes, no teeth.

**First maxilla** (Fig. 39, f): Coxal and basal endites
armed with 4 setae and 2 non-serrated teeth respectively; endopod with a large, broad apical process (non-plumose).

**Second maxilla** (Fig. 39, g) : With only 3 endites clearly marked, bearing 3, 4 and 5 setae distalwards; endopod elongated with basal part slightly lobed and with 2 apical and a basal setae; scaphognathite with 5 - 6 setae distributed all along margin.

**First maxilliped** (Fig. 39, h) : Endopod small, unsegmented with 5 apical and a basal setae; exopod with 4 terminal natatory setae. Basis short with 5 stumpy setae.

**Second maxilliped** (Fig. 39, i) : Endopod 4-segmented, with following setation distalwards: one on first segment; 1 inner and 1 outer on third and 1 inner + 1 broad, pointed terminal on last segments; exopod with 4 terminal + 2 subterminal natatory setae. Basis short with 3 setae.

**Third maxilliped** (Fig. 39, j) : Endopod as long as exopod, 5-segmented, fourth segment with a stumpy seta and last segment as in second maxilliped, terminating in a broad spine-like seta + 2 small setae, rest of segments and basis smooth.

**Pereiopod buds** (Figs. 39, k - o) : A biramous first and a uniramous fifth pereiopod buds well developed while second to fourth not yet clearly separated.
FIGURE 40. *Alpheus splendidus* Colebrooke - larva.

a - entire larva, c - antenna;

f - first maxilla, g - second maxilla;

i - second maxillipede, j - telson;

k - second pereiopod, l - fifth maxillipede.
Telson (Fig. 39, s): Triangular with long narrow basal part, and its posterior margin spinulose and with a shallow median notch. Process formula 7 + 7, all processes plumose, fourth longest while seventh short; part of posterior margin bearing second to fourth processes lobed as in figure. No uropod buds.

Second Zoa (Fig. 40)

Total length - 2.5 mm; carapace length - 0.8 mm.

Carapace now with a distinct, acute and fairly long rostrum and its hump well developed; eyes stalked.

Antennule (Fig. 40, c): Peduncle now 2-segmented, basal segment with 3 short setae distally on outer side, second with similar setae at base of outer ramus; inner ramus small not fully separated from peduncle and with a long plumose seta; outer ramus with 3 aesthetascs and a seta.

Antenna (Fig. 40, d): Not much changed over previous stage except for segmentation of scale becoming indistinct to absent.

Mandible (Fig. 40, e): Cutting edges now with 2 longer + 4 - 6 smaller teeth as in figure.
FIGURE 41. *Alpheus splendidus* Coutiere - Third Larva.

- **a**: entire larva, **c**: antennule, **d**: antenna, **f**: first maxilla, **g**: second maxilla, **h**: first maxillipede, **i**: second maxillipede, **j**: third maxillipede, **k**: first pereiopod, **l**: second pereiopod, **o**: fifth pereiopod, **s**: telson.
First and second maxillae (Figs. 40, f - g): Almost as in previous stage.

Maxillipeds (Figs. 40, a - j): First maxillipeds as in previous stage; second and third both with 5-segmented endopod, the last segment of third produced into a characteristic long terminal spine; exopod of second with 4 terminal and 2 smaller but unequal subterminal setae while that of third with 3 subterminal setae.

Periopod buds (Figs. 40, k - o): First and fifth most much elongated; second and third as small buds.

Telson (Fig. 40, a): Process formula increased to 2 - 3 with addition of a small median pair, no other change.

Third Zone
(Fig. 41)

Total length - 2.6 mm; carapace length - 0.8 mm.

Salient features of this stage are: Perigonostomial angle produced; fifth periopod characteristically developed; abdomen 5-segmented; uropods present.

Antennule (Fig. 41, c): Peduncle 3-segmented, first and second segments with a long inner and a short outer setae distally; third with 4 short outer, 2 short middle and 1 long setae at base of inner ramus. Both ram almost as in previous stage.
Antenna (Fig. 41, d): Endopod now with only terminal tooth-like point, seta being absent; scale with 11 inner marginal and a single outer setae.

Mandible (Fig. 41, e): Incisor process with 4 well developed + 1 slender pectinate teeth and molar with 4 - 5 small teeth.

First and second maxilla (Figs. 41, f & g): Except for increase in number of setae, no major change - coxal endite of first maxilla with one more seta while scaphognathite with 7 marginal setae instead of 5 of previous stage.

Maxillipeds (Figs. 41, h - j): Practically no change.

Pereiopods (Fig. 41, k - o): Both first and fifth pereiopods now functional, first with small unsegmented endopod and its exopod with 4 terminal + 2 subterminal natatory setae; fifth uniramous, 5-segmented, fifth segment characteristically styliform, drawn into a long tapering process bearing a small basal seta; rest still rudimentary.

Telson and Uropods (Fig. 41, s): Telson now roughly quadrangular, process formula 8 + 8.

Uropods as biramous buds; exopod longer than endopod with 6 plumose setae distally; endopod elongated but nonfunctional; protopod not yet clearly separated.
5. ALPHIEUS MALABARICUS FABRICIUS
FIG. 49. *Alpheus malabaricus* Fabricius - First Zoea.

a - entire larva, c - antennule, d - antenna, e - mandible,
f - first maxilla, g - second maxilla, h - first maxilliped,
i - second maxilliped, j - third maxilliped, k - first pereiopod,
o - fifth pereiopod, s - telson.
5. *Alpheus malabaricus* Fabricius

**First Zoea**

(Fig. 42)

Total length - 2.1 mm; carapace length - 0.5 mm.

Body long, slender and smooth; rostrum rather reduced; dorsal carapace hump not so distinct; eyes sessile; abdomen 5-segmented, sixth segment fused with telson; telson process formula 7 + 7.

**Antennule** (Fig. 42, c): Peduncle unsegmented; inner ramus represented by a single, long plumose seta; outer ramus with one broad and 3 slender aesthetascs and a plumose seta distally.

**Antenna** (Fig. 42, d): Peduncle with a distal spine on inner margin; endopod short, 1/3 of scale, unsegmented and distally ending in a tooth and a long plumose seta on outer angle of this tooth; scale well developed with 10 inner marginal and 2 outer setae.

**Mandible** (Fig. 42, e): Rather poorly developed with 2 small tubercle-like projections on cutting edge.

**First maxilla** (Fig. 42, f): Coxal endite with 2 thick, plain, spine-like setae, basal with 2 large, non-serrated spines; endopod unsegmented with a thick spine-like seta.
Second maxilla (Fig. 42, g): Only 3 endites distinct, bearing 2, 2' and 2 setae distalwards; endopod with a slightly bulged basal part and 2 apical and one basal setae; scaphognathite with 5 plumose setae.

First maxilliped (Fig. 42, h): Endopod short, unsegmented, bearing 3 terminal setae; exopod long (4-times endopod), with 4 terminal natatory setae; basis short with 4 short, spine-like setae.

Second maxilliped (Fig. 42, i): Endopod well developed but indistinctly segmented, bearing a basal and a subdistal spine-like thick setae and a thin seta distally on outer side of drawn out pointed tip; exopod unsegmented with 4 terminal + 1 subterminal natatory setae. Basis with 3 setae.

Third maxilliped (Fig. 42, j): Endopod long without clear segmentation and ending in a long point with 3 setae - 2 apical + 1 subapical; exopod with 4 + 2 natatory setae.

Pereiopod buds (Figs. 42, k - o): First a biramous short bud, and fifth uniramous but long bud, remaining pereiopods not yet developed.

Telson (Fig. 42, s): Triangular, elongated with a shallow median notch on posterior margin. Process formula 7 + 7. 2, 2, 3 and 1 spinules present in between processes from fourth to seventh. Fourth process longest, second to fourth processes borne on posterior lobe.
FIGURE 43. Alpaeus malabaricus Fabricius - Second Zoa.

a - entire larva, c - antennule, d - antenna, e - maxilla,
f - first maxilla, g - second maxilla, h - first maxillipede,
i - second maxillipede, j - third maxilliped, k - first pereiopod,
o - fifth pereiopod, s - telson.
Chromatophores:

Larva is transparent except for the few branched chromatophores as follows: antennular peduncle with a single distal reddish brown; eye at its antero-inner angle with a reddish brown mixed with violet and its proximal inner portion with diffused yellow; carapace posteriorly (at junction of carapace and abdomen) with a transverse band of reddish brown with violet; telson at its base with a reddish brown transverse band. Mandibular region with diffused yellow.

Second Zoea

(Fig. 43)

Total length - 2.2 mm; carapace length - 0.6 mm.

Rostrum and carapace hump distinct; eyes stalked; abdomen still 5-segmented.

Antennule (Fig. 43, c): Peduncle now 2-segmented, first segment with 3 setae distally on outer side; second segment with a long, plumose seta at base of outer ramus; inner ramus not yet clearly separated, represented by a long plumose seta; outer ramus with one broad and 5 slimmer aesthetascs distally.

Antenna (Fig. 43, d): Not much changed over previous stage.
FIGURE 44. *Alpheus malabaricus* Fabricius - Third instar.

a - entire larva, c - antennule, d - antenna, e - second antennal flagellum, f - first maxilla, g - second maxilla, h - third maxilliped, i - second maxilliped, j - third maxilliped, k - fourth maxilliped, l - fifth maxilliped, m - fifth maxilliped, n - fifth pereiopod, o - fifth pereiopod, p - telson.
Mandible (Fig. 43, e): Incisor and molar processes now differentiated, former with 2 sharp teeth, latter with 2 bigger and 2 - 3 smaller teeth.

First maxilla (Fig. 43, f): Except for coxal endite now bearing 2 setae, no other change.

Second maxilla (Fig. 43, g): Endites now with 2, 3, and 3 setae distalwards; endopod with 2 apical setae only; scaphognathite with 5 marginal, uniformly distributed setae as in previous stage.

Maxillipeds (Figs. 43, h - j): Third maxilliped with its endopod terminating into a long spine-like process but for which maxillipeds remain almost same as in earlier stage.

Pereiopod buds (Figs. 43, k - o): Except for increase in size in first and fifth pair of buds, no change.

Telson (Fig. 43, s): Process formula 8 + 8, with an addition of a small, median pair. No other change.

Third Zoea
(Fig. 44)

Total length - 2.2 mm; carapace length - 0.6 mm.

Rostrum now sharp and well developed, carapace hump
distinct; fifth pereiopod with characteristic tip; abdomen now 6-segmented; uropods present.

**Antennule** (Fig. 44, c): Peduncle 3-segmented, segmentation between first and second segments not complete; first segment with a long seta distally on inner side; second with a long inner and 2 short outer setae; third with one outer and 3 long plumose and 3 short hair-like setae at base of inner ramus with its single apical seta; outer ramus with 3 aesthetascs and a long seta terminally.

**Antenna** (Fig. 44, d): Endopod now without seta of previous stage; scale with 11 inner marginal and only one outer setae.

**Mandible** (Fig. 44, e): Incisor process with 3 and molar with 4 – 5 teeth.

**First and second maxilla** (Figs. 44, f & g): Almost as in stage II, but distalmost endite of second maxilla with 5 setae.

**Maxillipeds** (Figs. 44, h – j): First maxilliped not much changed and so also second, in which endopod setae increased in number to 1 basal and 5 distal; third maxilliped with endopod 5-segmented, its long drawn out tip now reduced.

**Pereiopods** (Figs. 44, k – o): First biramous pereiopod now with functional exopod carrying 4 terminal + 2 subterminal
natatory setae, endopod small rudimentary bud. Fifth pereiopod uniramous, 5-segmented with its last segment drawn out into a typical styliform process.

Telson and Uropods (Fig. 44, s): Telson now quadrangular, median notch of posterior margin still present, process formula $7 + 7$, first process of earlier stages being reduced.

Uropods biramous with well developed exopod bearing 6 long plumose setae distally while endopod non-functional and much smaller.
6. *ALPHEUS PACIFICUS DANA*
FIGURE 45. Alpheus pacificus Dana - First Zoea.

a - entire larva, c - antennule, d - antenna, f - first maxilla, g - second maxilla, i - second maxilliped, j - third maxilliped, o - fifth pereionpod, s - telson.
6. **Alpheus pacificus** Dana

**First Zoea**

(Fig. 45)

Total length - 2.2 mm; carapace length 0.5 mm.

Carapace smooth, with a slight hump; rostrum indistinct; eyes sessile; abdomen 5-segmented, smooth.

**Antennule** (Fig. 45, c): Peduncle unsegmented; inner ramus represented by a single plumose seta; outer ramus with 3 unequal aesthetascs and a long plumose seta apically.

**Antenna** (Fig. 45, d): Endopod small, just more than 1/3 scale, bearing a long seta and a tooth terminally; scale with one distal segment and bearing 10 setae on inner and 2 setae on outer margins. Peduncle with a small, not so sharp spine.

**Mandible** (Fig. 45, e): Poorly developed without demarcation of processes or teeth.

**First maxilla** (Fig. 45, f): Endopod with usual terminal seta; basal endite with 2 smooth teeth and coxal with a single seta.

**Second maxilla** (Fig. 45, g): Lobes of endites bearing 2, 2 and 3 setae from proximal to distal; endopod with 2 setae apically; scaphognathite with 5 marginal setae.
First maxilliped (Fig. 45, h): Endopod short unsegmented, bearing 3 terminal setae; exopod long, well developed with 4 terminal setae.

Second maxilliped (Fig. 45, i): Endopod 3-segmented, first segment with a basal, second with 2 distal setae and last ending in a point; exopod with 4 + 2 setae. Basis with 2 small setae.

Third maxilliped (Fig. 45, j): Endopod 4-segmented, longer than exopod, last segment ending in a point bearing a single seta; exopod with 4 + 2 setae terminally.

Pereiopod buds (Figs. 45, k-o): First and fifth pereiopods present as biramous and uniramous buds respectively.

Telson (Fig. 45, s): Triangular with a small posterior notch in middle; process formula 7 + 7, posterior margin finely spinulose between fifth to seventh processes.

Chromatophores:

Larva almost colourless except for the following reddish brown branched chromatophores and a few yellow diffused patches distributed as follows: Antennular peduncle with red; eye at its antero-internal angle with a much prominent reddish brown and a smaller golden yellow posterior patch. Carapace with a distal pair of red on golden yellow patch with a gastric patch of yellow behind
FIGURE 46. Alpheus pacificus Dana - Second Zoa.

a - entire larva, c - antennule, d - antenna, e - mandible.
f - first maxilla, g - second maxilla, n - first maxilliped.
i - second maxilliped, j - third maxilliped, k - first pereiopod.
o - fifth pereiopod, s - telson.
this pair, and with 2 distinct posterior pairs of reddish brown around but in front of cardiac region, a transverse much branched reddish brown band at the junction of carapace and abdomen. Abdomen - only second and third segments with a single medio-dorsal reddish brown of which the one on third is rather prominent. Telson - near its base with a pair of reddish brown whose branches spread into almost more than anterior half as shown in figure.

Second Zoea
(Fig. 46)

Total length - 2.4 mm; carapace length - 0.6 mm.

Rostrum and carapace hump now distinct; eyes stalked; pterygostomial margin angular; abdomen still 5-segmented.

Antennule (Fig. 46, c): Peduncle 2-segmented, both segments with a long plumose outer seta each; inner ramus with a long plumose seta but not separated clearly; outer ramus with 3 aesthetasc and a long plumose seta.

Antenna (Fig. 46, d): As in previous stage.

Mandible (Fig. 46, e): With 4 teeth on incisor and 4 - 5 small on molar process, teeth being long and sharp.

First and Second maxilla (Figs. 46, f & g): Coxal endite
FIGURE 47. *Alpheus pacificus* Dana - *Third Zone.*

- **a** - entire larva,
- **c** - antennule,
- **d** - antenna, **e** - mouth,
- **f** - first maxilla,
- **g** - second maxilla,
- **h** - third maxilla,
- **i** - second maxilliped,
- **j** - third maxilliped,
- **k** - fifth pericaridium,
- **l** - telson.
now with 3 setae and endopod with an additional basal seta respectively in first and second maxilla.

Maxillipeds (Figs. 46, h - j): Endopod of third maxilliped drawn out into a long tapering point as in other species, no other change.

Pereiopod buds (Fig. 46, t): But for increase in size, no other change from previous stage.

Telson (Fig. 46, s): Process formula, with addition of a small, median pair, increased to 8 + 8.

**Third Zose**

(Fig. 47)

Total length - 2.4 mm; carapace length - 0.6 mm.

Rostrum now longer and sharper; pterygostomial spine developed; abdomen 6-segmented, uropods present.

Antennule (Fig. 47, c): Peduncle though 3-segmented, segmentation not clear between first and second; all segments with a long inner seta each and last with a similar outer seta besides small setae as in figure; inner ramus with a long plumose seta; outer with 2 aesthetascs and a seta apically.

Antenne (Fig. 47, d): Endopod now without apical seta
and scale with 11 inner marginal and a single outer marginal setae.

Mandible (Fig. 47, e): Incisor process with 3 long, sharp, teeth; molar with 5 - 6 sharp but shorter teeth.

First maxilla (Fig. 47, f): Endopod seta increased in size and coxal endite now with 4 setae.

Second maxilla (Fig. 47, g): No appreciable change.

Maxillipeds (Figs. 47, h - j): Except for tip of exopod of third maxilliped reducing to normal, not much of change over previous stage.

Pereiopods (Fig. 47, t): First pereiopod biramous, its endopod, a small bud and exopod well developed with 4 + 2 setae terminally. Fifth 4-segmented and typical styliform process at tip; other pairs indistinct buds.

Abdomen (Fig. 47, a): Now 6-segmented, sixth segment having separated from telson.

Telson and Uropods (Fig. 47, s): Telson roughly quadrangular, somewhat slender. Process formula 7 + 7, first process of earlier stages being totally reduced.

Uropods with exopod well developed bearing 6 plumose setae; endopod smaller, bud-like and without any setae.
Remarks:

Though larvae from plankton have been ascribed to this species by Gurney (1938) from the Red Sea, no comparison can be made here since he deals with only the last zoeal and postlarval stages whereas the present account is of early larval stages only.

Also, though Gohar and Al-Kholy (1957) tentatively refer their Red Sea plankton larvae to A. pacificus, their description and illustrations are rather inadequate to be of any comparative value.
7. Alpheus Sankollii n.sp.
FIGURE 48. Alpheus sankollii n.sp. - First Zoa.

a - entire larva, b - front enlarged, (dorsal view),
c - antennule, d - antenna, e - mandible, f - first maxilliped,
g - second maxilla, h - first maxilliped, i - second maxilliped,
j - third maxilliped.
7. *Alpheus sankollii* n. sp.

**First Zoea**

(Figs. 48 & 49)

Total length - 2.2 mm; carapace length - 1.0 mm.

Larva fairly advanced compared to normal first zoea, robust and fairly large; carapace smooth; rostrum very small; eyes stalked and not covered by carapace; abdomen smooth, pleura rounded, sixth abdominal segment separated from telson and 5 pairs of biramous pleopods present on first to fifth segments.

**Amennule** (Fig. 48, c): Peduncle 3-segmented, first segment twice as long as broad, with a small lobe-like stylocerite not yet clearly separated; second segment broader than long bearing 3 inner, 6 small fine outer and 2 similar antero-dorsal setae; third segment short with 5 short, delicate setae on outer and 5 long plumose on inner-distal margins. Inner ramus 2-segmented, basal segment long with 4 + 1 + 1 setae on its distal and 2 outer setae on proximal segments; outer ramus with 3 small distal and a large proximal segments and with 5 aesthetascs at tip besides 2 delicate hairs on second and third segments.

**Antenna** (Fig. 48, d): Endopod much longer than scale, distally segmented into 4 small segments representing future flagellar part and bearing 5 small setae. Scale
narrow, long with 21 - 22 marginal plumose setae.

**Mandible (Fig. 48, e)**: Well developed, with incisor and molar processes differentiated, former with 3 teeth while latter with blunt, ridged cutting edge. No palp.

**First maxilla (Fig. 48, f)**: Both endopod and coxal endite smooth but basal endite armed anteriorly with a row of 6 - 7 short spines and almost twice as large as coxal endite.

**Second maxilla (Fig. 48, g)**: Of the two endites, coxal single lobed with 2 small setae and basal bilobed (with a shallow median notch) but without setae; endopod small with a single terminal seta; scaphognathite fringed along entire margin with 35 - 40 setae.

**First maxilliped (Fig. 48, h)**: Endopod much smaller than exopod, unsegmented, bearing 3 apical setae; exopod with 4 terminal setae; protopod simple, unarmed, bearing a large, bilobed epipod.

**Third maxilliped (Fig. 48, i)**: Endopod 3-segmented and about 1/2 length of exopod with 2 spine-like setae at tip and one 'outer' at base of last segment. Exopod with 4 terminal setae as in first maxilliped + 1 subterminal seta. A small rounded epipod present.

**Third maxilliped (Fig. 48, j)**: Endopod indistinctly
FIGURE 49. Alpheus sankuli! n. sp. - F1.: -

k - First pereiopod (right), k₁ - first pereiopod,
l - second pereiopod, m - third pereiopod,
o - fifth pereiopod, a - first pleopod, r - second pleopod,
s - telson.
4-segmented, longer than exopod, with setation 1, 1, 1 & 4 from first to last segments. Exopod with 4 terminal + 2 subterminal setae. A small epipod bud present.

Pereiopods: All pairs present and partially functional; first to fourth biramous.

First cheliped (Fig. 49, k): Slightly asymmetrical. Endopod segmented with 3 - 4 setae as in figure; fingers almost equal or little shorter than palm; exopod with 4 + 2 setae; epipod bud-like.

Second cheliped (Fig. 49, l): Without any setae on segmented endopod; fingers equal to palm; carpus apparently not subdivided; exopod with 4 terminal + 2 subterminal setae.

Third pereiopod (Fig. 49, m): Endopod partially 4-segmented, basal segment with incomplete partition; setation of endopod being 1, 2 & 1 on first three segments; exopod with 4 terminal + 2 subterminal setae.

Fourth pereiopod (Fig. 49, n): Similar to third but with endopod 5-segmented and setation 1, 1 & 2 on first three segments.

Fifth pereiopod (Fig. 49, p): Uniramous, indistinctly 5-segmented, with no setae on any segments.

Pleopods (Figs. 49, q & r): Five pairs on first to fifth
Alohaes sankollii n.sp. - Second instar.

- a - first instar, c - antennula, d - antenna, e - mandible
- f - first maxilla, g - second maxilla, h - first maxilliped
- i - second maxilliped, j - third maxilliped.
abdominal segments, biramous (non-functional), first with 2 setae distally on protopod, endopod short, exopod well developed but without any setae. In remaining pleopods, endopod large (as in adult) but with no setae, appendix interna present and protopod with a single outer seta.

Telson (Fig. 49, s): Elongatedly rounded in outline, process formula 7+7 (as in normal first zoea) with a shallow median notch on posterior margin.

No uropods.

Second Zoea
(Figs. 50 & 51)

Total length - 3.0 mm; carapace length - 1.2 mm.

No difference from first zoea except for the following:

1. Rudimentary palp on mandible.
2. Exopod of pereiopods with their setae lost.
3. Carpus of second pereiopod with a clear distal subsegment and a faintly divided (4 subsegments) proximal part.
4. Uropod buds within telson cuticle.
FIG. 57. _Alpheus sankollii_ n. sp. — Second out.

k - first pereiopod (right), k₁ - first pereiopod
l - second pereiopod, m - third pereiopod, n - third
o - fifth pereiopod, q - first pleopod, r - second
s - telson.
Postlarva (Figs. 52 & 53)

Total length - 3.2 mm; carapace length - 1.4 mm.

Resembles adult. Carapace smooth with orbital hoods anteriorly covering eyes; rostrum much reduced; abdomen smooth with a gradual curve.

Antennule (Fig. 52, c): Peduncle 3-segmented with setae as in figure, first segment longest and longer than sum of remaining 2 segments; stylocerite distinct with a few setae and its spine not reaching end of first segment; upper flagellum bifid with 3 basal segments fused and lower flagellum with about 11 segments.

Antenna (Fig. 52, d): Scaphocerite or scale well developed, its lateral spine not reaching tip of lamellar part; peduncle 4-segmented; flagellum of about 29 - 31 segments.

Mandible (Fig. 52, e): Well developed, incisor process with 3 - 4 teeth; palp 2-segmented bearing a single, terminal seta.

First maxilla (Fig. 52, f): Endopod slightly notched distally and with a single spine-like seta; basal endite with 5 short, non-serrated, conical teeth and 4 delicate setae in between teeth; coxal endite with 7 - 8 bristles.
FIGURA 52. Alpheus sankollii n.sp. - Post larv.
a - entire larva, c - antennule, d - antenna, e = max.
f - first maxilla, g - second maxilla, h - third max.
i - second maxilliped, j - third maxilliped.
Second maxilla (Fig. 52, g): Endopod reduced and with no setae; coxal endite with a single lobe, basal bilobed.

**First maxilliped (Fig. 52, h):** Endopod with 1 long terminal and a number of small setae on inner margin; exopod with 4 terminal and 2 basal setae on outer side on proximal part. Protopod bilobed and setose, with a bilobed epipod.

Second maxilliped (Fig. 52, i): Endopod of usual incurved shape of adult, with fringe of setae on dactylus and a few setae on propodus. Flagellar exopod with 4 terminal + 1 subterminal setae. A small oval epipod present.

Third maxilliped (Fig. 52, j): Endopod with 3 distinct segments, terminal covered with short setae as in adult. Exopod with 4 terminal + 1 subterminal setae, reaching to end of basal segment of endopod. A small epipod present.

Pereiopods: First to fourth pairs with rudimentary exopods still persisting unlike in adult.

**First chelipeds (Fig. 53, k):** Unequal, either right or left being larger as in adults, no traces of future grooves or depressions of adult, also hammer-shaped tooth of adult not yet developed.

Second chelipeds (Fig. 53, l): Fingers crossing at tip,
FIGURE 53. Alpheus sankollii n.sp. - Post Larva.

k - first pereiopod, l - second pereiopod, m - third pereiopod,
n - fourth pereiopod, o - fifth pereiopod, p - first pleopod,
r - second pleopod, s - telson and uropod.
slightly longer than palm as in adult, fringed with setae at their tips; carpus 5 - subsegmented as in adult. All segments smooth.

Third to fifth pereiopods (Figs. 53, m - o) : Resemble those of adult but for fewer spines on propodus (2, 2 & 5 from third to fifth pereiopods). Brush of setae on fifth pereiopod propodus not yet developed.

Abdomen (Fig. 52, a) : All pleura smooth and rounded, sixth segment longer than fifth.

Pleopods (Figs. 53, p - q) : 5 pairs of pleopods; endopod of first reduced while those of remaining with 8 - 10 setae and with appendix interna; exopod with 6 setae on first and 8 - 10 on remaining pleopods.

Telson (Fig. 53, s) : With parallel sides and without dorsal spines unlike in adult; posterior margin rounded, fringed with 8 + 8 setae as in figure.

Uropods (Fig. 53, s) : Almost as long as telson unlike in adult; endopod about 1/2 exopod, with 5 - 6 small setae; exopod with a single terminal spine, subapical spine of adult yet to develop, also suture of adult not yet developed.

Discussion:

A review of literature on larval development in the
family Alpheidae reveals that these shrimps exhibit 3 types of developmental patterns viz. 1. normal type with prolonged life history involving number of stages, 2. abbreviated type with 1 or more larval stages before postlarva, as also observed in some of the Palaemonids (Jalihal and Sankolli, 1975) and 3. direct type with no larval stages but directly hatching into postlarva or young.

The life history of the present species Alpheus sankollii n.sp. comprising 2 larval stages + postlarva, fits into second type or the abbreviated type mentioned above.

The only other species of the genus in which the entire life history, based on laboratory hatchings is known is A. heterochaelis Say (Knowlton, 1972) from the Atlantic waters wherein there are 3 larval stages before the postlarva. Comparison of the larvae of present material with those of A. heterochaelis reveals that first stage of present species is comparable with the third stage of heterochaelis revealing thereby greater degree of abbreviation of development in the present species. Hence comparisons could be made only between first stage of present species with third stage of heterochaelis as shown in Table I.
Also the postlarval comparisons between the 2 species reveals that the 2 postlarvae are of about same level of development but with differences as shown in Table II.

Knowlton (1972) while working on heterochaelia development, observed that about 6 hours were required for the first stage larva to moult to second stage and he stated that in few instances, stage I was apparently skipped and the larvae hatched as stage II. It is possible that the first stage might have been overlooked by Knowlton since as observed in present species the larva hatching from the egg as first zoea, immediately mouls to second stage in few seconds.
Table I

Comparison of characters between first stage of *Alpheus sankollii* n.sp. (present work) and third stage of *A. heterochaelis* Say (after Knowlton, 1973).

<table>
<thead>
<tr>
<th>Appendages</th>
<th><em>A. heterochaelis</em> Say</th>
<th><em>A. sankolli</em> n.sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antennule -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>outer flagellum</td>
<td>4 aesthetascs</td>
<td>5 aesthetascs</td>
</tr>
<tr>
<td>inner flagellum</td>
<td>unsegmented</td>
<td>2-segmented</td>
</tr>
<tr>
<td>stylocerite</td>
<td>pointed</td>
<td>blunt-like</td>
</tr>
<tr>
<td>Antenna -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scale</td>
<td>3-segmented distally</td>
<td>unsegmented distally</td>
</tr>
<tr>
<td>endopod</td>
<td>3-segmented</td>
<td>7-segmented</td>
</tr>
<tr>
<td>Mandible -</td>
<td>with incisor process only</td>
<td>with both processes</td>
</tr>
<tr>
<td>First maxilla -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>endopod and basal endite</td>
<td>with setae</td>
<td>without setae</td>
</tr>
<tr>
<td>Second maxilla -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>endopod</td>
<td>large</td>
<td>small</td>
</tr>
<tr>
<td>scaphognathite</td>
<td>9 - 10 setae</td>
<td>35 - 40 setae</td>
</tr>
<tr>
<td>Appendages</td>
<td><em>A. heterochaelis</em> Say</td>
<td><em>A. sankollii</em> n.sp.</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>First &amp; maxillipeds</td>
<td>epipod absent</td>
<td>epipod absent</td>
</tr>
<tr>
<td>Second</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First cheliped</td>
<td></td>
<td></td>
</tr>
<tr>
<td>endopod</td>
<td>4-segmented</td>
<td>5-segmented</td>
</tr>
<tr>
<td>Second cheliped</td>
<td></td>
<td></td>
</tr>
<tr>
<td>carpus</td>
<td>not subdivided</td>
<td>indistinctly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>subdivided</td>
</tr>
<tr>
<td>Fifth pereiopod</td>
<td>distal segment</td>
<td>distal segment of</td>
</tr>
<tr>
<td></td>
<td>tapering with a</td>
<td>normal thickness</td>
</tr>
<tr>
<td></td>
<td>spine</td>
<td>and without a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>spine</td>
</tr>
<tr>
<td>Pleopods</td>
<td>rudimentary</td>
<td>well developed with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>appendix interna</td>
</tr>
<tr>
<td></td>
<td></td>
<td>from second to fifth,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>but without setae</td>
</tr>
<tr>
<td>Telson</td>
<td>rectangular,</td>
<td>rounded, 7 + 7</td>
</tr>
<tr>
<td></td>
<td>6 + 6</td>
<td></td>
</tr>
<tr>
<td>Uropods</td>
<td>well developed,</td>
<td>absent</td>
</tr>
<tr>
<td></td>
<td>without setae</td>
<td></td>
</tr>
</tbody>
</table>
### Table II

Comparison of characters between postlarvae of *Alpheus sankollii* n. sp. (present work) and *A. heterochaelis* Say (after Knowlton, 1973).

<table>
<thead>
<tr>
<th>Appendages</th>
<th><em>A. heterochaelis</em> Say</th>
<th><em>A. sankollii</em> n. sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antennule -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>outer flagellum</td>
<td>- 4 aesthetascs and</td>
<td>no aesthetascs</td>
</tr>
<tr>
<td></td>
<td>- not bifid</td>
<td>and bifid</td>
</tr>
<tr>
<td>inner flagellum</td>
<td>- 5-segmented</td>
<td>12-segmented</td>
</tr>
<tr>
<td>Antenna -</td>
<td>- not so developed</td>
<td>- almost as in</td>
</tr>
<tr>
<td></td>
<td>- as in adult</td>
<td>- adult</td>
</tr>
<tr>
<td>Mandible -</td>
<td>- palp absent (no</td>
<td>- palp present</td>
</tr>
<tr>
<td></td>
<td>mention and no</td>
<td></td>
</tr>
<tr>
<td></td>
<td>figure)</td>
<td></td>
</tr>
<tr>
<td>Third maxillipede</td>
<td>- exopod -</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- with long apical</td>
<td>- with short stumpy,</td>
</tr>
<tr>
<td></td>
<td>setae</td>
<td>apical setae</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telson -</td>
<td>- posterior border</td>
<td>- posterior border</td>
</tr>
<tr>
<td></td>
<td>- straight with</td>
<td>- convex</td>
</tr>
<tr>
<td></td>
<td>- slight</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- indentation</td>
<td></td>
</tr>
</tbody>
</table>
5.  ALPHEUS LOBIDENS LOBIDENS DE HAAN
FIGURE 54. Alpheus lobidens lobidens De Haan - First Zoea.

- a - entire larva, c - antennule, d - antenna, e - mandible,
- f - first maxilla, g - second maxilla, h - first maxilliped,
- i - second maxilliped, j - third maxilliped, k - first pereiopod,
- l - second pereiopod, o - fifth pereiopod, t - tail
8. **Alpheus lobidens lobidens** De Haan

**First Zoea**
(Fig. 54)

Total length - 2.1 mm; carapace length - 0.5 mm.

Carapace smooth with a small mid-dorsal hump; rostrum indistinct; eyes sessile, slightly narrowing anteriorly; abdomen 5-segmented.

**Antennule** (Fig. 54, c): Peduncle long and unsegmented. Inner ramus represented by a long plumose seta; outer ramus with 4 unequal aesthetascs and a small plumose seta.

**Antenna** (Fig. 54, d): Endopod small reaching less than 1/2 scale and ending in a tooth besides bearing a long plumose seta apically; scale without distinct segmentation and with 10 inner marginal and 2 outer marginal setae.

**Mandible** (Fig. 54, e): Rather poorly developed, armed with a single blunt, tubercle-like tooth.

**First maxilla** (Fig. 54, f): Endopod with a long, thick non-plumose seta; basal endite with 2 non-serrated teeth; coxal endite with 3 unequal setae.

**Second maxilla** (Fig. 54, g): Endites with 2, 2 and 3 setae respectively; endopod with 2 terminal and one basal setae; scaphognathite with 5 marginal setae.
Maxillipeds (Figs. 54, h - j): Endopods of all maxillipeds unsegmented, that of first small with 3 terminal setae, of second with 2 subterminal setae and tapering tip while third long, distal part separated and tip produced. Exopod of first maxilliped with 4 terminal, of second with 4 terminal + 2 subterminal and of third 4 terminal + 3 subterminal setae respectively.

Pereiopod buds (Fig. 54, t): First pair biramous, second small uniramous, and fifth long and uniramous, buds.

Telson (Fig. 54, s): Triangular with a distinct posterior notch in middle; process formula 7 + 7, posterior margin armed with spinules as in figure.

Chromatophores:

Larvae almost colourless except for a few reddish brown branched and yellow diffused chromatophores as follows: Antennular peduncle distally with orange red mixed with yellow; ocular peduncle with a reddish brown at antero-inner angle with a yellow coloration behind it. Carapace with an anterior pair of very light reddish brown and rather a prominent posterior pair but of brighter reddish brown, with a rather transverse band of orange red with yellow behind cardiac region. Abdomen - first segment with a single tiny medio-dorsal orange red; second segment posteriorly with one pair of diffused
Fig. 55. Alpheus lobidens lobidens De Haan - Second Zyg.  
- - entire larva, c - antennula, d - antenna, e - mandible, f - first maxilla, g - second maxilla, h - first maxillipede, i - second maxillipede, j - third maxillipede, k - first pereiopod, l - second pereiopod, o - fifth pereiopod, s - s.p.
yellow and one pair of smaller orange yellow; third segment with a pair of orange yellow and a posterior pair of yellow patch. Telson at its base with a reddish brown intermingled with yellow giving orange yellow colouration.

Second Zona
(Fig. 55)

Total length - 2.4 mm; carapace length - 0.7 mm.

Rostrum fairly long and sharp; carapace hump more distinct; eyes stalked; abdomen still 5-segmented.

Antennule (Fig. 55, c): Peduncle 2-segmented; first segment with 2 small distal setae on outer side, second segment with a plumose seta at base of outer ramus; inner ramus not yet fully separated and with a long plumose seta; outer ramus with 4 aesthetascs and a long seta.

Antenna (Fig. 55, d): Not much changed.

Mandible (Fig. 55, e): Two larger and 4 - 5 smaller blunt teeth on incisor and molar parts respectively.

First maxilla (Fig. 55, f): Coxal endite with a rather large and 2 slender, delicate setae but for which no other change.

Second maxilla (Fig. 55, g): Setation of endites now 2, 3 and 3 distalwards, rest as in previous stage.
FIGURE 56. *A. lobidens lobidens* De Haan - Third Zc.

a - entire larva, c - antennule, d - antenna, e - mandible.

f - first maxilla, g - second maxilla, h - first maxilliped.

i - second maxilliped, j - third maxillipede, k - unsegmented buds, s - telson.
Maxillipeds (Figs. 55, h - j) : Segmentation of endopod in second and third maxillipeds now clear, that of third terminating in a long spine. No other appreciable change.

Pereiopod buds (Fig. 55, t) : First and second pair biramous and fifth uniramous but now more elongated.

Telson (Fig. 55, s) : Process formula 8 + 8, eighth process small.

**Third Zoea**
(Fig. 56)

Total length - 2.4 mm ; carapace length - 0.7 mm.

Pterygostomial margin with a spine; sixth abdominal segment separated from telson; uropods present.

Antennule (Fig. 56, c) : Peduncle 3-segmented (segmentation indistinct between first and second); first segment with a long distal seta on inner side; second segment with a similar inner and 2 short outer setae distally while third segment with a long and 2 short setae at base of inner ramus and a short at base of outer ramus; inner ramus now with a long seta; outer ramus with 2 aesthetascos and a short seta.

Antenna (Fig. 56, d) : Endopod short, about 1/3 scale in length, ending in a tooth but long plumose seta being lost;
scale with 12 inner marginal and a single outer marginal setae.

**Mandible** (Fig. 56, e) : With 3 - 4 teeth on incisor and 4 - 5 small teeth on molar parts.

**First maxilla** (Fig. 56, f) : Endopod seta serrated in its distal half; coxal endite with 3 + 1 setae of which one larger.

**Second maxilla** (Fig. 56, g) : Three endites with 2, 3 and 4 setae respectively; scaphognathite still with 5 marginal setae.

**Maxillipeds** (Figs. 56, h - j) : Long process of endopod of third maxilliped reduced to normal, no other major change.

**Pereiopods** (Fig. 56, t) : First pair of pereiopods with their endopod as small bud and exopod functional with 4 terminal + 2 subterminal setae; second and third pairs as buds, former biramous and latter uniramous. Fifth pereiopod (Fig. 56, k - o) 5-segmented, last segment ending in very long process styliform and with a basal seta.

**Abdomen** (Fig. 56, a) : Now 6-segmented, sixth segment being separated from telson.

**Telson and Uropods** (Fig. 56, s) : Telson rather quadrangular with a slight median posterior notch; process formula 7 + 7 first process of previous stage being absent.
Uropods biramous, exopod longer than endopod and with 6 setae; endopod small bud-like without any setae, protopod not separated.
FIGURES 57. Alpheus edwardsi (Audouin) - first zoea.

a - entire larva, c - antennule, d - antenna, e - mandible,
f - first maxilla, g - second maxilla, h - first maxilliped,
i - second maxilliped, j - third maxilliped, k - first larva,
o - fifth perionep, s - telson.
9. **Alpheus edwardsi** (Audouin)

**First Zoea**

*(Fig. 57)*

Total length - 2.3 mm; carapace length - 0.5 mm.

Carapace smooth; rostrum not distinct; eyes large and sessile; abdomen smooth, 5-segmented.

**Antennule** *(Fig. 57, c)*: Peduncle unsegmented; inner ramus represented by a long plumose seta; outer ramus with 3 aesthetascs and a rather broad plumose seta.

**Antenna** *(Fig. 57, d)*: Endopod less than half as long as scale bearing at its tip a long seta and a tooth; scale 4-segmented distally and with 10 setae on inner and 2 small setae on outer margins. Peduncle with a sharp spine as in figure.

**Mandible** *(Fig. 57, e)*: Poorly developed though both incisor and molar processes somewhat differentiated with 2 blunt projections on incisor part.

**First maxilla** *(Fig. 57, f)*: Endopod with a large terminal seta-like process. Basal endite with 2 non-serrated teeth while coxal with 3 setae.

**Second maxilla** *(Fig. 57, g)*: All 3 lobes of endites with 2, 3 and 4 setae distally; endopod with 2 terminal and
1 basal setae (on slightly expanded part); scaphognathite with 5 marginal setae.

**First maxilliped (Fig. 57, h):** Endopod small, unsegmented with 3 terminal and a basal setae; exopod well developed with 4 terminal setae. Basis short with 4 spine-like setae.

**Second maxilliped (Fig. 57, i):** Endopod not clearly segmented bearing 1 basal and 4 subapical setae, tip produced into sharp point minutely serrated as in *A. inopinatus*. Exopod with 4 + 2 setae; basis with 3.

**Third maxilliped (Fig. 57, j):** Endopod showing traces of segmentation distally and ending in an acutely pointed process with 2 setae distally; exopod with 4 + 2 setae.

**Pereiopod buds (Fig. 57, t):** First pair biramous bud, fifth a long uniramous one, no other pereiopods present.

**Telson (Fig. 57, s):** Triangular with a shallow posterior median notch; process formula 7 + 7, posterior margin minutely spinulose as shown in figure.

**Chromatophores:**

Larva is almost yellowish red with following chromatophores (of which red branched chromatophores are more prominent than the golden yellow which is of diffused type): Antennular peduncle with a distal red; eye with a
FIGURE 58. Alpheus edwardsi (Audouin) - Second Zoa.

a - entire larva, c - antennule, d - antenna, e - mandible,
f - first maxilla, g - second maxilla, h - first maxilliped,
i - second maxilliped, j - third maxilliped, k - first pereiopod,
o - fifth pereiopod, s - telson.
distal and a posterior prominent red along the inner margin with golden yellow behind the cornea and in the proximal portion of the ocular peduncle; carapace with 3 red around gastric region on a larger golden yellow patch and with 3 larger red around cardiac region on a yellow patch (of these posteriormost is horizontally placed), a golden patch medio-dorsally in between these gastric and cardiac chromatophores. Abdomen - first segment with a single medio-dorsal but small red, second with a pair of red (small), third segment with a single medio-dorsal much prominent red. Telson at its base with a rather horizontally placed quite prominent red on a golden yellow patch.

**Second Zoa**

(Fig. 58)

Total length - 2.3 mm; carapace length - 0.5 mm.

A short, rather blunt rostrum present; eyes stalked, slightly narrower anteriorly; carapace with a distinct mid-dorsal hump; abdomen smooth, still 5-segmented.

**Antennule** (Fig. 58, c) : Peduncle 2-segmented but segmentation not complete as yet; first segment with 2 and second with a single small, setae distally; inner ramus still not separated clearly and with a long seta; outer bearing 2 aesthetascs and a seta.
FIGURE 59. Alpheus edwardsi (Audouin) - Third Zoa.

a - entire larva, c - antennule, d - antenna, e - mandible,
f - first maxilla, g - second maxilla, h - first maxilliped,
i - second maxilliped, j - third maxilliped, k - first pereiopod,
o - fifth pereiopod, s - telson and uropod.
Antenna (Fig. 58, d): Not much changed over previous stage.

Mandible (Fig. 58, e): Both processes now clearly marked out; incisor with one big and 2 shorter teeth while molar armed with 4 teeth.

First and second maxilla (Figs. 58, f & g): Coxal endite of first maxilla now with 4 setae except for which no other change.

Maxillipeds (Figs. 58, h - j): Enopod of third maxilliped now produced into a characteristic long spine, rest as in previous stage.

Pereiopod buds (Fig. 58, t): Buds of previous stage (first and fifth) now more elongated.

Telson (Fig. 58, s): Process formula 8 + 8, small median pair being added on, spinules on posterior margin continued as in previous stage.

Third Zoea
(Fig. 59)

Total length - 2.3 mm; carapace length - 0.6 mm.

Rostrum now well developed; carapace smooth except for hump; abdomen 6-segmented; uropods present.
Antennule (Fig. 59, c): Third segment of peduncle not yet clearly separated; both first and second segments with a long seta each on inner side besides 2 small outer in former, and 6 setae arranged as in figure in latter; inner ramus not clearly segmented and with a long plumose seta; outer ramus with 3 unequal aesthetascs and a plumose seta.

Antenna (Fig. 59, d): Endopod with its long seta lost; scale with 11 inner marginal and only a single outer setae.

Mandible (Fig. 59, e): Teeth now more distinct and sharp.

First and second maxilla (Figs. 59, f & g): Coxal endite setae increased to 5 in number in first maxilla; no other change.

Maxillipeds (Figs. 59, h - j): Endopod of second and third maxillipeds showing indistinct segmentation; long produced tip of third now reduced.

Pereiopods (Figs. 59, t): First pair (Fig. 59, t) with functional exopod bearing $4 + 2$ setae and a rudimentary bud-like endopod; fifth 5-segmented with usual spiniform process; remaining pairs indistinct.

Telson and Uropods (Fig. 59, s): Telson roughly quadrangular, process formula $7 + 7$.

Uropods biramous, exopod well developed with 6 setae and endopod bud-like without any setae.
Remarks:

Early larval stages of this species have been described by Gurney in 1927 and 1938, but as *A. audouini* Courtière - in the former work, he describes three larval stages collected from plankton of the Suez Canal while in latter the laboratory hatched second stage only from the Red Sea material. As such, comparison of the present material is made with Gurney's (1938) laboratory obtained second stage only as under:

The larvae of present material and those of Gurney (1938) are almost similar except for differences in size (2.3 mm in present material while 2.75 mm in Gurney's) and setation of antennule and maxillipeds endopods.
10. ALPHEUS INOPINATUS HOLTHUIS & GOTTLIEB
FIGURE 60. Alpheus inopinatus Holthuis & Gottlieb - First Zoa.

a - entire larva, c - antennula, d - antenna, e - maxillarp.
f - first maxilla, g - second maxilla, h - first maxilliped,
i - second maxilliped, j - third maxilliped, k - first cerai pod,
q - fifth pereiopod, s - telson.
10. *Alpheus inopinatus* Holthuis & Gottlieb

**First Zoea**

(Fig. 60)

Total length - 2.1 mm; carapace length - 0.5 mm.

Body slender; carapace without a distinct, visible rostrum; eyes sessile; abdomen 5-segmented, smooth.

**Antennule** (Fig. 60, c): Uniramous and unsegmented; inner ramus represented by a long plumose seta with basal part enlarged into knob-like structure; outer ramus bearing 1 broad and 3 slender aesthetascs and a plumose seta.

**Antenna** (Fig. 60, d): Endopod small, less than half length of scale and ending in a spine-like tooth and a seta; scale broad, 2-segmented and with 10 plumose setae along inner margin + 2 setae on outer. Peduncle with a strong ventral spine.

**Mandible** (Fig. 60, e): Poorly developed, without any distinct teeth and incisor and molar processes not clearly differentiated.

**First maxilla** (Fig. 60, f): Coxal and basal endites each with 2 spine-like setae and 2 large, non-serrated teeth respectively; endopod ending in a tooth-like process.
Second maxilla (Fig. 60, g): The 3 endites with 1, 3 and 3 setae distally; endopod with 2 setae terminally; scaphognathite with 5 marginal setae.

First maxilliped (Fig. 60, h): Endopod poorly developed, small, unsegmented and with 3 terminal setae. Exopod well developed with 4 long terminal natatory and 1 short subterminal setae. Basis with 4 spine-like short setae.

Second maxilliped (Fig. 60, i): Endopod without clear segmentation and terminating sharply into a broad, seta-like point minutely serrated as in figure; a similar and a simple seta subterminally. Exopod with 4 long terminal and 1 long and 1 short subterminal setae. Basis with 3 small spine-like setae.

Third maxilliped (Fig. 60, j): Endopod unsegmented but long and reaching beyond exopod and terminating into acute tip bearing a subterminal pair of setae. Exopod with 4 terminal and 2 + 1 subterminal setae.

Pereiopod buds (Fig. 60, t): First a biramous and fifth an elongated uniramous buds but second to fourth not yet developed.

Abdomen (Fig. 60, a): 5-segmented, smooth; no pleopod buds.

Telson (Fig. 60, s): Triangular, with a shallow median notch on posterior margin; process formula 7 + 7. Basal
FIGURE 61. Alpheus inopiaatus Holthuis & Gottlieb - Second stage

a - entire larva, c - antennule, d - antenna, e - maxilla,
f - first maxilla, g - second maxilla, h - first maxilliped,
i - second maxilliped, j - third maxilliped, k - first pereiopod,
l - second pereiopod, o - fifth pereiopod, s - telson.
portion of telson narrow and long, not yet separated from sixth abdominal segment.

**Chromatophores:**

Except for red branched and a few golden yellow chromatophores distributed as follows, larva is almost transparent: Antennular peduncle with a tiny distal reddish brown; a prominent antero-distally on the inner angle of eye and similar but a tiny one posteriorly on eye; on either side of cardiac region, a red branched and posterior to it a deep red somewhat semicircular, (not branched) thin band (seen more prominently in ventral view). Abdomen - second segment with a medio-dorsal pair of golden yellow but less branched chromatophore; third segment with three pairs of medio-dorsal rather small chromatophores of which anterior 2 pairs are red branched whereas posterior one golden yellow, fourth and fifth segments without any chromatophores. Telson at its base with a comparatively much larger, red branched (ventrally much prominent) chromatophores.

**Second Zoea**

(Fig. 61)

Total length - 2.3 mm; carapace length - 0.6 mm.

Rostrum well developed, smooth and pointed; dorsal hump on carapace distinct; eyes stalked; sixth abdominal segments still fused to telson.
Antennule (Fig. 61, c): Peduncle 2-segmented, first segment long and second small with 2 and 1 setae respectively on their dorsal margins. Inner ramus small, still fused to peduncle, bearing a plumose seta; outer ramus as in previous stage.

Antenna (Fig. 61, d): No change except for segmentation of scale being absent.

Mandible (Fig. 61, e): With molar and incisor parts well marked; former with 4 and latter with 2 teeth.

First maxilla (Fig. 61, f): Coxal endite now with 4 setae, but for which no change.

Second maxilla (Fig. 61, g): Setation on endites increased to 2, 4 and 4 from proximal to distal; scaphognathite still with 5 setae.

Maxillipeds (Figs. 61, h - j): Endopod of second maxillipeds now with 1 basal and 2 more subterminal setae and showing 3 distinct + 1 indistinct segments; third maxilliped with endopod characteristically produced into long tapering point with 3 + 2 setae at its base. No other change.

Pereiopod buds (Fig. 61, t): Those of previous stage more elongated, second pair developed as biramous bud.
FIGURE 62. *Alpheus inopinatus* Holthuis & Gottlieb - Third instar

- **a** - entire larva
- **c** - antennule
- **d** - antenna
- **a** - mandible
- **f** - first maxilla
- **g** - second maxilla
- **h** - first maxilliped
- **i** - second maxilliped
- **j** - third maxilliped
- **k** - first peraeopod
- **l** - second peraeopod
- **o** - fifth peraeopod
- **s** - telson and uropod.
Telson (Fig. 61, s): Process formula 8+8, eighth pair small and median.

Third Zoea  
(Fig. 62)

Total length - 2.5 mm; carapace length - 0.7 mm.

Rostrum now more pronounced; pterygostomial margin produced into a spine; abdomen 6-segmented and uropods present.

Antennule (Fig. 62, c): Peduncle 3-segmented, second and third segments equal in length and first longer than both; first segment with 2 setae on inner side distally, second with one inner and one outer setae and third with 5 unequal setae on distal margin. Inner ramus as in previous stages but seta reduced; outer ramus with 2 broad aesthetascs and a seta.

Antenna (Fig. 62, d): Endopod seta much reduced in size; scale with 12 inner marginal setae and a single seta on outer margin.

Mandible (Fig. 62, e): Molar part now with 5 and incisor with 4 teeth.

First maxilla (Fig. 62, f): Coxal endite setae increased to 5, no other change.
Second maxilla (Fig. 62, g): appendage with 2 terminal teeth and one basal on enlarged part, rest as in previous stage.

Maxillipeds (Figs. 62, h - j): While first and second maxillipeds not much changed, third now with 4-segmented endopod with its tip normally produced but not much elongated.

Pereopods (Fig. 67, t): First and fifth functional, former with a small bud-like endopod and functional exopod with 4 terminal + 2 subterminal plumose setae, latter uniramous, 4-segmented, tip produced into typical elongated drawn-out spine; second and third pairs as small, biringulous buds.

Abdomen (Fig. 62, a): Now 6-segmented; a long, narrow, sixth segment separated clearly from telson.

Telson and Uropods (Fig. 62, s): Telson rather rectangular with process formula 7 + 7.

Uropods with well-developed exopod bearing 5 plumose setae; endopod small, bud-like and without any setae; protopod not yet differentiated.
11. **ALPHEUS MACRODACTYLOUS** ORTMANN
FIGURE 63. Alpheus macrodactylus Ortmann – First Zoea.

11. *Alphea* macrodactylus Ortmann

First Zoea

(Fig. 63)

Total length - 2.1 mm; carapace length - 0.5 mm.

Rostrum indistinct, a small dorsal hump on carapace present; eyes sessile; abdomen 5-segmented.

Antennule (Fig. 63, c) : Peduncle unsegmented; inner ramus represented by a long plumose seta; outer ramus with 1 broad + 3 slender aesthetascs and a seta.

Antenna (Fig. 63, d) : Endopod with a long seta and a terminal tooth; scale 5-segmented with 10 setae on inner margin and 2 setae on outer. Peduncle with a sharp spine ventrally at base of endopod.

Mandible (Fig. 63, e) : Poorly developed with no teeth.

First maxilla (Fig. 63, f) : Coxal endite with 2 setae and basal with 2 large smooth teeth; endopod with a large apical seta-like process.

Second maxilla (Fig. 63, g) : The 3 endites with 2, 3 and 4 setae respectively, scaphognathite with 5 setae uniformly distributed along its margin.

First maxilliped (Fig. 63, h) : Endopod small, unsegmented
bearing 3 setae terminally; exopod long, unsegmented with 4 long terminal natatory setae. Basis short with 4 small setae.

**Second maxilliped** (Fig. 63, i): Endopod well developed with 4 indistinct segments, first with a single seta on inner margin, second with a distal inner seta, last segment ending in an acutely pointed seta-like tip; exopod with 4 terminal + 2 subterminal setae. Basis unarmed.

**Third maxilliped** (Fig. 63, j): Endopod not clearly segmented, longer than exopod, ending in a sharp point; exopod with 4 terminal + 2 subterminal setae. Basis unarmed.

**Pereiopod buds** (Fig. 63, k - o): First pair biramous and fifth uniramous buds, second to fourth yet to develop.

**Telson** (Fig. 63, s): Triangular, with a shallow posterior median notch. Process formula 7 + 7, second to fourth processes on lobe; posterior margin armed with fine spinules as in figure (seen only under high magnification).

**Chromatophores:**

The larva is almost colourless except for the following chromatophores: One tiny blue spot distally on antennule, one large branched red distally on the inner angle of eye, one rather horizontal, much branched red chromatophores
FIGURE 64. *Alpheus macrodactylus* Ortmann - Second Zoea.

a - entire larva, b - front enlarged, (dorsal view), c - antennule, 
d - antenna, e - mandible, f - first maxilla, g - second maxilla, 
h - first maxilliped, i - second maxilliped, j - third maxilliped, 
k - first pereiopod, o - fifth pereiopod, s - telson.
situated posteriorly on carapace, one relatively smaller transverse bright red mid-dorsally on third abdominal segment and one large transverse much branched red on telson.

Second Zoea
(Fig. 64)

Total length - 2.2 mm; carapace length - 0.6 mm.

Rostrum and dorsal carapace hump distinct; pterygostomial margin with a sharp spine; abdomen still 5-segmented.

Antennule (Fig. 64, c): Peduncle 2-segmented, first segment long with 2 distal setae on outer side, second with a distal seta at base of outer ramus; inner ramus not yet clearly marked; outer ramus with 1 broad and 4 slender aesthetasc.

Antenna (Fig. 64, d): Not much changed except for absence of segmentation on scale.

Mandible (Fig. 64, e): Still with teeth poorly developed, only 2 on incisor part and 3 - 4 small blunt projections on molar part.

First and second maxilla (Figs. 64, f - g): Not much changed over previous stage.

- **a** - entire larva, **b** - front enlarged, (dorsal view), **c** - antenna, **d** - mandible, **f** - first maxilla, **g** - second maxilla.
- **h** - first maxilliped, **i** - second maxilliped, **j** - third maxilliped, **k** - first pereiopod, **o** - fifth pereiopod, **s** - telson and uropod.
Maxillipeds (Figs. 64, h - j): Except for tip of endopod of third maxilliped becoming greatly elongated spine-like process, no other change. Segmentation of endopod in all maxillipeds rather indistinct.

Pereiopod buds (Figs. 64, k-o): Both first and fifth now more elongated, rest yet to develop.

Telson (Fig. 64, s): Process formula 8 + 8, eighth pair median and small.

### Third Zoea
(Fig. 65)

Total length - 2.3 mm; carapace length - 0.6 mm.

Rostrum more produced. Abdomen now 6-segmented and uropods present.

**Antennule** (Fig. 65, c): Peduncle now 3-segmented, basal segmentation not so clear, first segment with a single inner seta, second with 3 short outer and a long inner setae distally, third with 6 setae of which 5 at base of outer ramus and 1 at base of inner. Outer ramus with 2 aesthetascs and 2 hair-like non-plumose setae while inner ramus now separated from peduncle, bearing a long plumose seta terminally.

**Antenna** (Fig. 65, d): Endopod small ending in a tooth but
long plumose setae lost in this stage; scale with 11 setae on inner and 1 small seta on outer margin.

Mandible (Fig. 65, e): Incisor part with 3 long, spine-like teeth and molar with 4 short teeth.

First and second maxilla (Figs. 65, f & g): Not much changed.

Maxillipeds (Figs. 65, h - j): Endopod segmentation of second and third maxillipeds now clear; long produced tip of endopod of third now reduced.

Pereiopods (Figs. 65, k - o): First pair with functional exopod bearing 4 terminal + 2 subterminal plumose setae and a small endopod bud; fifth uniramous but 4-segmented, tip produced into long elongated spine. No other pairs present.

Telson and Uropods (Fig. 65, s): Telson roughly quadrangular with a median notch posteriorly. Process formula 7 + 7, first process of previous stage being absent.

Uropods shorter than telson; exopod well developed bearing 6 plumose setae; endopod shorter than exopod and without any setae; protopod not yet separated.
12. *ALPHEUS BANNERTI* N. 3P.
FIGURE 66. Alpheus banneri n.sp. - First Zoea.

a - entire larva, c - antennule, d - antenna, e - mandible
f - first maxilla, g - second maxilla, h - first maxilliped,
i - second maxilliped, j - third maxilliped, k - first pereiopod,
o - fifth pereiopod, s - telson.
12. *Alpheus banneri* n. sp.

First Zoea  
(Fig. 66)

Total length - 2.3 mm; carapace length - 0.5 mm.

Body smooth; carapace without distinct rostrum; eyes sessile; abdomen 5-segmented.

Antenna (Fig. 66, c): Peduncle unsegmented; inner ramus represented by a long plumose seta; outer ramus with 3 unequal aesthetascs and a plumose seta.

Antenna (Fig. 66, d): Endopod small, less than 1/2 scale with a plumose seta and a tooth apically; scale with 10 inner marginal and 2 outer marginal setae. Peduncle with a spine medio-ventrally.

Mandible (Fig. 66, e): Future incisor part with 2 tooth-like projections.

First maxilla (Fig. 66, f): Endopod with a large seta; basal endite with 2 spine-like teeth and coxal with a spine-like tooth and 3 setae.

Second maxilla (Fig. 66, g): 3 lobes of endites bearing 2, 3 and 3 setae respectively; endopod with 2 terminal setae; scaphognathite with 5 marginal setae.

First maxilliped (Fig. 66, h): Endopod poorly developed,
unsegmented and with 3 terminal setae; exopod well developed with 4 terminal setae; basis with 4 short setae.

Second maxilliped (Fig. 66, i): Endopod 2-segmented, first longer with 2 setae, one basal and other distal, second segment ending acutely (tip minutely serrated) bearing 4 setae; exopod well developed with $4 + 1 + 1$ setae. Basis with 3 setae.

Third maxilliped (Fig. 66, j): Endopod with 2 segments, first longer with a seta near its apex, second ending acutely in a fairly long point and with 2 setae; exopod with $4 + 2 + 1$ setae.

Pereiopod buds (Fig. 66, t): First pair biramous and fifth pair uniramous buds.

Telson (Fig. 66, s): Triangular, posterior margin with a shallow median notch; process formula $7 + 7$.

Chromatophores:

The larva appears orange red in general colouration. The red chromatophores are much branched, large and are mainly distributed on diffused yellow background as follows: One dorsally on antennule; one distally on inner margin of eye; 3 large on carapace (of which one is distal, second at middle and the last posterior); each abdominal segment with one large chromatophore, but the one on the fifth segment is much larger than others, with
FIGURE 67. Alpheus banneri n.sp. - Second larva.

a - entire larva, c - antennule, d - antenna, e - mandible
f - first maxilla, g - second maxilla, h - first maxillipod
i - second maxillipod, j - third maxillipod, k - first pereiopod
l - fifth pereiopod, s - telson
its branches so profusely spread longitudinally as to
give an appearance of two chromatophores rather than one;
telosn with one distal and one posterior chromatophore,
as shown in figure.

Second Zoea
(Fig. 67)

Total length - 2.3 mm; carapace length - 0.5 mm.

Rostrum distinct but short; carapace hump present;
pterygostomial angle rounded; eyes stalked; abdomen still
5-segmented.

Antennule (Fig. 67, c): Peduncle 2-segmented, each
segment with 2 small setae as in figure; inner ramus
represented by a seta with a basal knob; outer ramus with
3 aesthetascs and a seta.

Antenna (Fig. 67, d): Not much changed over previous
stage.

Mandible (Fig. 67, e): Incisor part with 3 and molar
with 5 spine-like sharp teeth.

First and second maxilla (Figs. 67, f & g): Almost as in
earlier stage but endopod of latter with a basal seta.

Maxillipeds (Figs. 67, h – j): Only remarkable change is
FIGURE 68. Alpheus banneri n.sp. - Third Zoa.

a - entire larva, c - antennule, d - antenna, e - mandible
f - first maxilla, g - second maxilla, h - first maxilliped
i - second maxilliped, j - third maxilliped, k - first pereiopod
o - fifth pereiopod, s - telson and uropod.
characteristic prolongation of tip of endopod in third maxilliped.

**Pereiopod buds** (Fig. 67, t): Except for increase in size, no other change.

**Telson** (Fig. 67, s): Process formula $3 + 3$, eighth pair being median and small.

**Third Zoea**

(Fig. 68)

Total length - 2.5 mm; carapace length - 0.6 mm.

Rostrum short and hump on carapace more pronounced; pterygostomial angle rounded; sixth abdominal segment now separated from telson; uropods present.

**Antennule** (Fig. 68, c): Peduncle 2-segmented, first with a long and 2 smaller setae at apex, second with a long seta at base of inner ramus and 4 smaller setae of which 2 on distal and 2 on outer margins; inner ramus with a long terminal and 2 small subterminal setae; outer ramus with aesthetascs and a seta.

**Antenna** (Fig. 68, d): Endopod with its long seta lost and scale with 12 inner marginal and only one outer marginal setae; peduncle with a lateral spine on inner margin.
Mandible (Fig. 68, e): Incisor process with 3 long, sharp teeth and a blunt short tooth; molar with 5 sharp teeth.

First and second maxilla (Figs. 68, f & g): Distalmost lobe of endites of latter now armed with 5-6 setae.

Maxillipeds (Figs. 68, h - j): Endopod of second 3-segmented and that of third 4-segmented with its tip not so much produced as in previous stage. No other change.

Pereiopods (Fig. 68, t): First pair now with a functional exopod bearing 4 + 2 setae and a small endopod bud; fifth uniramous, 4-segmented with the characteristic spiniform process; second developed as a small bud.

Abdomen (Fig. 68, a): Now 6-segmented, sixth segment being free from telson. No pleopod buds.

Telson and Uropods (Fig. 68, s): Telson roughly quadrangular with a posterior notch in the middle. Process formula 8 + 8.

Both endopod and exopod of uropods developed; exopod with 6 setae and endopod bud-like, without any setae.