

**A NEW SPECIES OF SHRIMP, *ACETES COCHINENSIS* (CRUSTACEA:
DECAPODA, SERGESTIDAE) FROM SOUTHWEST COAST OF INDIA
WITH AN ACCOUNT OF ITS LARVAL DEVELOPMENT**

By P. VEDAVYASA RAO

Central Marine Fisheries Research Institute

DURING the course of examination of tow-net collections made at Cochin, a number of specimens belonging to the genus *Acetes* H. Milne-Edwards were collected and a closer study of their taxonomic features revealed that they do not agree with those of any of the species described so far (Kemp, 1917 ; Hansen, 1919 ; Burkenroad, 1934 ; Colefax, 1940 ; Nataraj, 1947 and Pathansali, 1966). Hence they are dealt with here as new to science.

SERGESTIDAE DANA

SERGESTINAE BATE

Acetes H. Milne-Edwards

Acetes cochinensis sp. nov.

Material :

Several specimens ranging in total length from 10.5 to 20.0 mm., obtained from inshore sea and estuarine backwaters of Cochin, southwest coast of India, 3.5-11 metres.

Holotype : ♀ 18.350 mm., carapace 4.100 mm.; locality—inshore sea of Cochin (24-5-1966).

Allotype : ♂ 13.300 mm., carapace 2.875 mm.; locality—inshore sea of Cochin (24-5-1966).

Type specimens (Holotype, female, CMFRI No. 107 and Allotype, male, CMFRI No. 108) are deposited in the reference collection of Central Marine Fisheries Research Institute, Mandapam Camp.

Description :

Body whitish. In male, eye stalks long and about 1/5 carapace length, the proximal portion narrow and the distal almost as broad as the oval cornea. In female, the eye stalk slightly longer, being about 1/3 carapace length.

Carapace : Medially glabrous and laterally pitted ; supraorbital and hepatic spines well developed. Rostrum small, projecting just beyond the anterior margin of the carapace and terminating in a sharp triangular spine ; ventral margin straight and at an angle of about 60° to the body ; dorsal margin slightly concave ; 2 sharp denticles of which the anterior is smaller, present proximally.

Antennule : Peduncle 3-segmented, the basal segment hollowed out to fit the contour of eye stalk, carries a prominent statocyst situated near the outer margin. Just above the statocyst region, the outer margin deeply indented and bears externally a large triangular tooth; the upper and inner borders of the segment carry long setae. In female (Fig. 1, B), basal segment is about 4 times as long as broad and 1.3 times the length of 2nd and 3rd segments together; the 2nd segment smallest and about $2\frac{1}{2}$ times as long as broad; the 3rd segment slender and 5.5 times as long as broad. Of the two flagella, upper very long, the proximal portion of which is thick and formed by 12-14 short segments beset with a number of aesthetes; the lower slightly longer than the third segment of the peduncle and consists of 9-10 segments.

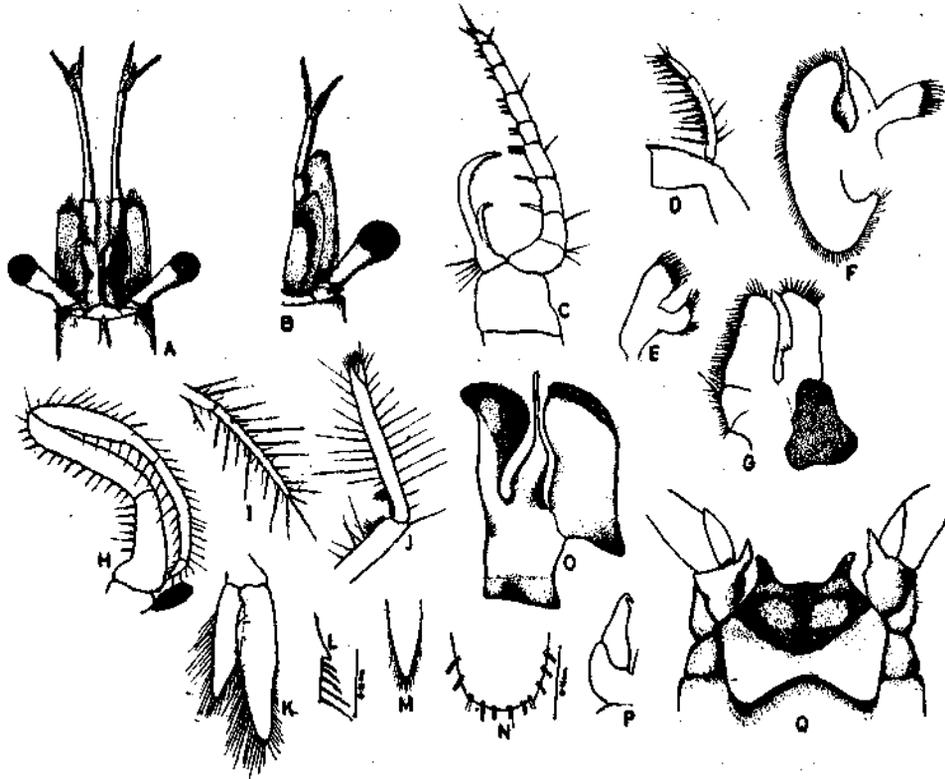


FIG. 1. *Acetes cochinensis* sp. nov.

In male (Fig. 1, A) the first two segments similar to those of female; the 3rd segment very much longer and about 15-17 times as long as broad; the lower antennular flagellum (Fig. 1, C) 11-segmented with the first two joints longer than the others. From the distolateral region of the 2nd segment a pair of clasp spines arise, one of which very much longer than the other reaching as far as a group of three stout spines on the 6th segment; upper flagellum similar to that of female.

Antenna : Antennal scale is about 2.5 times as long as the peduncle; the outer margin smooth and terminates in a small spine; inner margin beset with long setae;

antennal flagellum very long and with a flexion. The segments of the flagellum proximal to the area of flexion have short stiff hairs and the point of flexion is formed by 5-6 segments which are without hair, but the segments distal to that have a pair of long setae which are arched over to form a wide tube-like structure.

Mandible (Fig. 1, D) : Palp 3-jointed, the proximal segment very small, 2nd segment very much longer and beset with hairs especially on the inner side ; the incisor region consists of a sharp tooth and the wider molar region has a serrated edge.

First maxilla (Fig. 1, E) : Bilobed and with strong spine-like bristles at the tip of the lobes.

Second maxilla (Fig. 1, F) : Protopodite undivided and setose at the inner edge ; endopodite small, undivided and tip carries a conspicuous seta ; exopodite of typical form.

First maxilliped (Fig. 1, G) : Very much flattened ; peduncle small, 2-jointed ; endopod unsegmented and inner edge beset with bristles ; exopod also without segments, carrying bristles at the tip, and has a blunt projection with a few small setae on its inner margin ; epipod present.

Second maxilliped (Fig. 1, H) : Protopod with an epipodite ; exopod absent ; endopod 5-segmented, the last two segments being slender and the distal three curved inwards.

Third maxilliped : Very long and slender, 7-segmented, reaches a little beyond the antennal scale ; the whole appendage carries long and stiff bristles ; terminal segment not divided (Fig. 1, I).

First pereopod : Relatively short, chelate and a clasping organ formed by stout bristles at the articulation of carpus and propodus present (Fig. 1, J). A group of smaller bristles in the propodus are placed on a concave surface and these are preceded by longer bristles.

Second pereopod : Much longer and extends as far as the distal end of eye stalk.

Third pereopod : Longest, extending as far as the distal end of the antennal scale ; basis only $\frac{1}{2}$ the length of ischium which is the longest segment.

In the female, 4th and 5th legs are wanting, but the male retains the vestiges of these legs.

Abdomen : Of typical *Acetes* form. The last segment is more than twice its greatest width and ends in a small median dorsal spine. No tooth on the first sternum between the pleopods.

Pleopods : First pair uniramous and the others biramous decreasing in length posteriorly. In the male the first and the second pleopods are modified.

Uropod (Fig. 1, K & L) : The proximal outer margin of the exopodite smooth and terminates in a small tooth, the margin posterior to which being ciliated ; the non-ciliated portion is slightly longer in the proportion 9 : 10.

Telson (Fig. 1, M & N): As long as the 4th abdominal segment; the tip rounded and fringed with setae. The posterolateral corners provided with a minute blunt tooth.

Petasma (Fig. 1, O): In male the first pleopod bears the petasma. It is formed by pars externa and pars media, pars astrigens completely wanting; pars externa quite wide and about 3 times as long as broad, inner margin concave and carrying a number of small tubercles at the tip. Pars media is also broad, basal margin concave and the outer corner slightly produced; processus ventralis originates at the middle of this lobe and has the proximal part thick, while the distal straight and needle-like. The capitulum is thicker and carries numerous hooks on the outer part.

The endopod of the second pleopod has flat lamella at its base and the tip of this carries 2 small curved teeth (Fig. 1, P).

Female genital area (Fig. 1, Q): The third thoracic sternite project backwards as a broad plate, posteriorly overlying the 4th somite. The plate is slightly concave in the middle line and provided with a crescent-shaped groove transversely; the free posterior margin is conspicuously concave. When the genital plate is dissected out carefully with the third leg, it is seen that immediately inner to the coxal expansion, a pair of processes one on each side run anterior and downwards, bordered by coxal projections and 2nd sternal plate.

Affinities: The present species exhibits close affinities with *A. japonicus* Kishinouye. The important differences noticed from this species are given in Table I.

TABLE I
Showing the differences between *A. japonicus* and *A. cochinesis*

Characters	<i>A. japonicus</i>	<i>A. cochinesis</i>
Antennule	3rd segment 10 times as long as broad; the segment opposite to the tip of larger clasping spine of the outer antennular flagellum of male bears a small blunt process at proximal end and two short spinules distally.	3rd segment 15-17 times as long as broad; the segment opposite to the tip of larger clasping spine of the outer antennular flagellum of male bears 3 pointed spines.
Third maxilliped	Terminal segment divided into 3 sub-segments.	Terminal segment undivided.
Third thoracic sternite of female	No processes at the anterior of the sternal plate.	Anteriorly produced into a pair of processes which run anterolaterally and downwards.
Petasma	The distal portion of pars externa without tubercles; processus ventralis reaches the end of the lobe or terminates abruptly with a blunt apex.	The distal portion of pars externa with tubercles; processus ventralis reaches the tip or goes beyond the end of the lobe.
Uropod	No tooth between the ciliated and non-ciliated portion of the exopod.	A distinct tooth present between the ciliated and non-ciliated portion of the exopod.

Although the female genital area and the petasma of the present species are very much similar to that of *A. japonicus* the differences shown in Table I are quite distinctive. In the presence of a spine between the ciliated and glabrous portion of the exopod of uropod *A. cochinchensis* is nearer to *A. indicus* group, but differs considerably from this group of species in its characteristic genital area and the petasma.

DEVELOPMENT

Larval development of *Acetes* was described by Brooks (1883), Soejima (1926) and Menon (1933). But there is no complete account of the development of any *Acetes* from egg to postlarvae. Soejima (*op. cit.*) described the naupliar and protozoal stages of *A. japonicus*, while Menon (*op. cit.*) gave a good account of the development of *A. erythraeus* Nobili from protozoa to postlarval stages.

Materials for the present study were obtained from plankton collections made during the months, April-June, 1966 and 1967. Plankton tows were generally carried out with a half meter organdy net during the early hours of morning at sub-surface waters. For developmental studies live plankton were brought to the laboratory and the eggs carefully picked out by a pipette. These eggs were kept in small glass vessels containing filtered sea water collected from the same locality where plankton collections were made. The water in the container was changed twice in a day in order to minimise ciliate infection. Temperature of the water during the rearing experiments varied from 26.8° to 29.8°C. It was possible to rear the eggs up to protozoa I stage and subsequently, live protozoae collected from the plankton were reared up to mysis stage. The rest of the stages were collected from the plankton during the period.

Larvae were fed with the culture of *Chlamydomonas* sp. during rearing experiments.

LIST OF ABBREVIATIONS

A1	Antennule
A2	Antenna
Ab	Abdomen
Md	Mandible
Mx1	First maxilla
Mx2	Second maxilla
Mxp1	First maxilliped
Mxp2	Second maxilliped
Mxp3	Third maxilliped

Eggs: Fertilised eggs in advanced state of development were collected during April-May. These are spherical and have large perivitelline spaces. They measured from 0.475 to 0.500 mm. in diameter. The embryonic mass which is enclosed by a thin membrane measured 0.175 to 0.200 mm.

The earliest stage (Fig. 2, A) obtained seems to be a blastula immediately after completion of segmentation. In the next stage (Fig. 2, B) the rudiments of the first three naupliar appendages can be clearly made out. Fig. 2, C shows the distinct outline of the developing nauplius with further enlarged appendages.

Hatching was observed in the laboratory. Before nauplius comes out, it moves its appendages briskly at short intervals and finally emerges out breaking

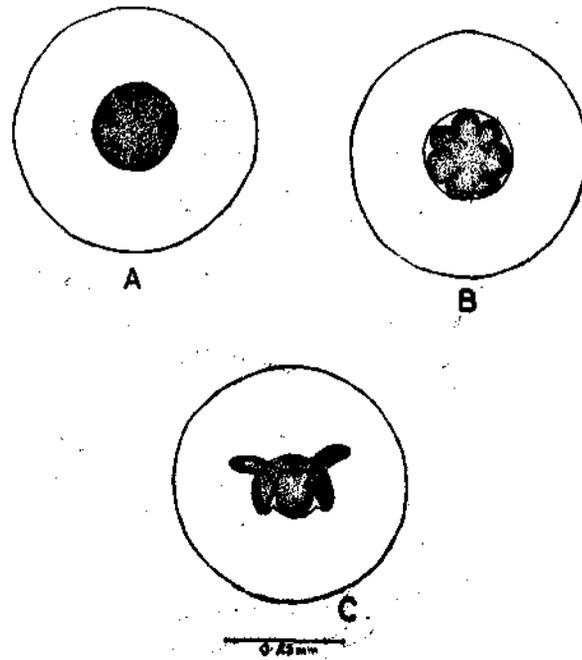


FIG. 2. Eggs of *Acetes cochinensis*

the egg membrane by its furcal spines. Hatching took place at all times in the day and the process requires about 2 to 3 minutes.

NAUPLIUS I

(Fig. 3, A)

The newly hatched larva is slightly brownish and opaque. The body is oval-shaped. The median or the naupliar eye is present near the anterior end of the body. Posteriorly it carries a pair of furcal spines. At the base of the antennule, antenna and the posterior end near the origin of furcal spines there are reddish pigments.

Length 0.20 to 0.22 mm.; greatest width 0.126 to 0.128 mm.

A1	Uniramous, unjointed; 3 unequal terminal setae, 1 small lateral seta.
A2	Biramous, unjointed; endopod with 2 terminal setae; exopod longer and with 2 terminal, 3 lateral setae.
Md	Biramous; endopod with 2 terminal and 1 subterminal setae; exopod with 3 terminal setae.

The larva swims briskly for a short period beating its appendages, then slowly sinks dorsal side down in a perpendicular position with its appendages extending upwards.

NAUPLIUS II

(Fig. 3, B)

18 hours after hatching the larva moults to the second stage. Body is slightly elongated and posteriorly bilobed showing the development of the telson. The

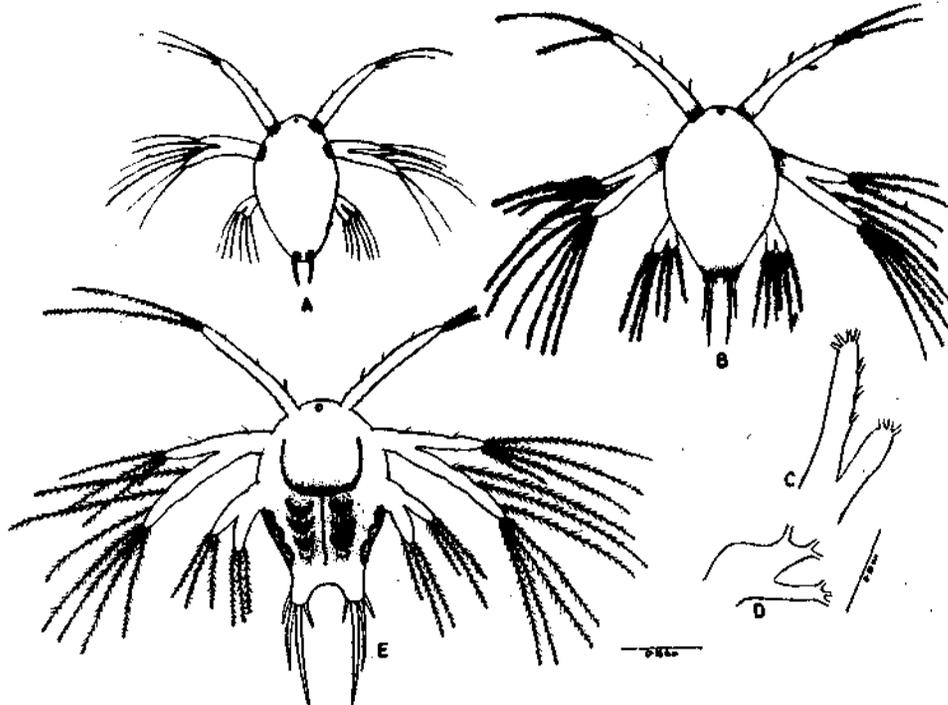


FIG. 3. Nauplii of *Acetes cochinensis*

colour and the pigmentation of the larva are same as in the previous stage. Median eye persists. On the ventral side, rudiments of maxillae can be made out.

Length 0.27 to 0.29 mm.; greatest width 0.16 to 0.18 mm.

A1	Uniramous, unjointed; 3 terminal plumose setae of unequal length, 3 inner and 1 outer shorter lateral setae.
A2	Biramous, unjointed; setae plumose; endopod (Fig. 3, C) with 3 terminal, exopod with 4 terminal and 3 lateral setae.
Md	Biramous; both exo and endopod with 3 plumose setae (Fig. 3, D).
Caudal furca	Developing, each lobe with 4 setae.

NAUPLIUS III

(Fig. 3, E)

30 hours after hatching or 12 hours after the second moult, the larva moults into this stage. The larva increases in size and the body becomes translucent. Bases of antennule, antenna and caudal lobes appear reddish. The telson is bilobed and the appendages show sign of segmentation. On the ventral side rudimentary maxillae and maxillipeds appear.

Length 0.29 to 0.32 mm.; greatest width 0.18 to 0.20 mm.

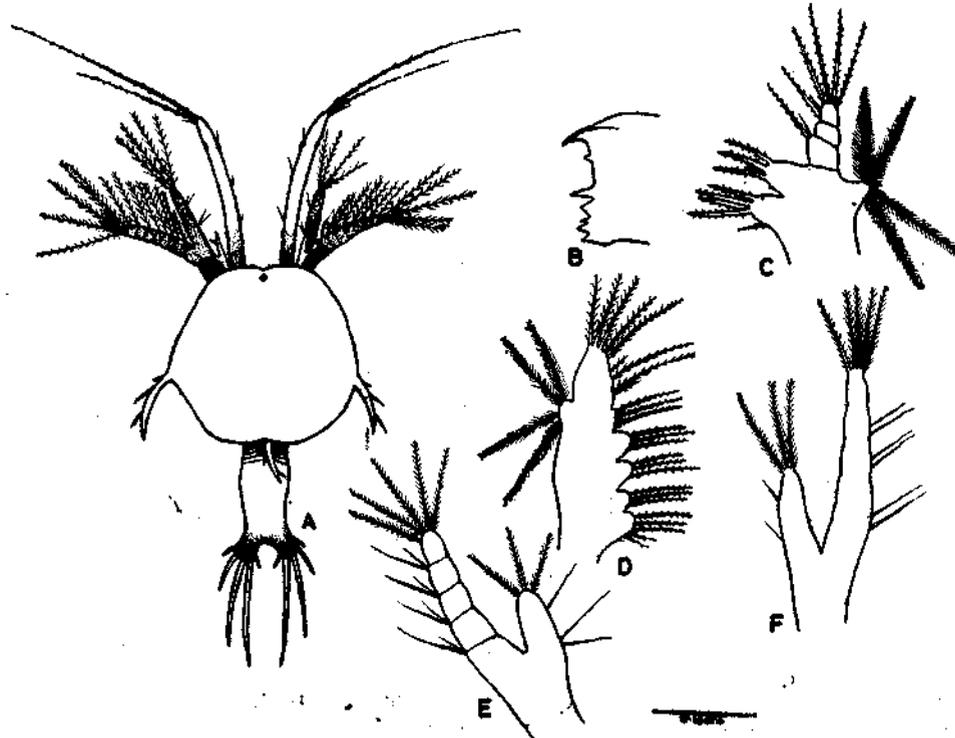
A1	Uniramous ; basal portion 5-segmented ; 3 terminal setae of unequal length, outer lateral seta disappears.
A2	Biramous ; 2 faintly jointed protopod and endopod ; exopod 4-5-segmented ; setation remains unchanged.
Md	Unchanged
Mx1, Mx2, Mxp1, Mxp2	Biramous ; rudimentary buds.
Caudal furca	2 lobes, each lobe with 4 setae.

PROTOZOEAE I

(Fig. 4)

The transformation from the last nauplius to the first protozoa takes place about 42 hours after hatching. Striking changes in the shape and appearance of the larva take place during this moult. The anterior part of the body develops a carapace. A pair of swellings representing the stalked eyes and visible only on the ventral side develop on either side of the persisting median eye. The posterior part is greatly extended forming the abdomen and the telson is well developed.

The larva appears as a whitish dot in the plankton. But the lobes of the telson, the median dorsal portion of the exposed thorax, the antenna and the proximal portion of the antennule are light red. It swims actively bending its abdomen against the anterior portion of the rest of the body.

FIG. 4. Protozoa I of *Acetes cochinensis*

Length 0.56 to 0.58 mm.

Carapace	Broader than long; with paired anterior, lateral spines and a single median posterior spine; anterior spines bifurcated, each branch as well as the lateral and posterior median spines with short lateral processes (Fig. 4, A).
Thorax	Short and segmented.
Ab	Short and unsegmented
Telson	Bilobed, each lobe with 5 spines (Fig. 4, A).
Eyes	Median eye present; a pair of compound eyes developed underneath the carapace.
A1	7-segmented, proximal 5 segments short, 6th twice the length of the former, 7th indistinct and with 3 terminal setae of unequal length, 3 shorter lateral setae present.
A2	2-jointed protopod and endopod; latter with apical setae; exopod 9-jointed, 1 lateral seta each on joint 2-8 and 5 terminal apical setae on joint 9.

Labrum	Globular with a long anterior spine.
Md	7 teeth ; incisor tooth large and with a conspicuous basal ridge, 3rd tooth from the ventral margin long, slender and pointed ; molar region with 4 subequal teeth (Fig. 4, B).
Mx1	Protopod with 2 lobes, the proximal and the distal provided with 5 and 4 short setae respectively ; endopod 3-jointed, 2 inner setae on first 2 joints, 4 terminal setae on 3rd joint ; exopod small, knob-like and with 4 plumose setae (Fig. 4, C).
Mx2	Protopod with 4 lobes, the proximal one carries 5-6 setae, each of the other lobes with 3 setae ; endopod 4-jointed, 3 setae on 1st joint, 2 setae on the next 2 joints, 5 terminal setae on joint 4 ; exopod small and with 4 plumose setae (Fig. 4, D).
Mxp1	Endopod 4-jointed ; the first 3 segments carry 2 setae each and the 4th with 5 plumose setae ; exopod unjointed and with 3 terminal and 3 lateral setae (Fig. 4, E).
Mxp2	Endopod indistinctly 4-jointed ; the first 3 segments with 2 setae each and the 4th with 5 terminal setae ; exopod $\frac{1}{2}$ as long as endopod and with 3 terminal and 2 lateral setae (Fig. 4, F).
Mxp3	Rudimentary and bud-like with 2 short terminal setae.

PROTOZOEAE II

(Fig. 5)

The characteristic features of this stage are the development of a prominent rostrum at the anterior end of the carapace and the segmentation of the abdomen.

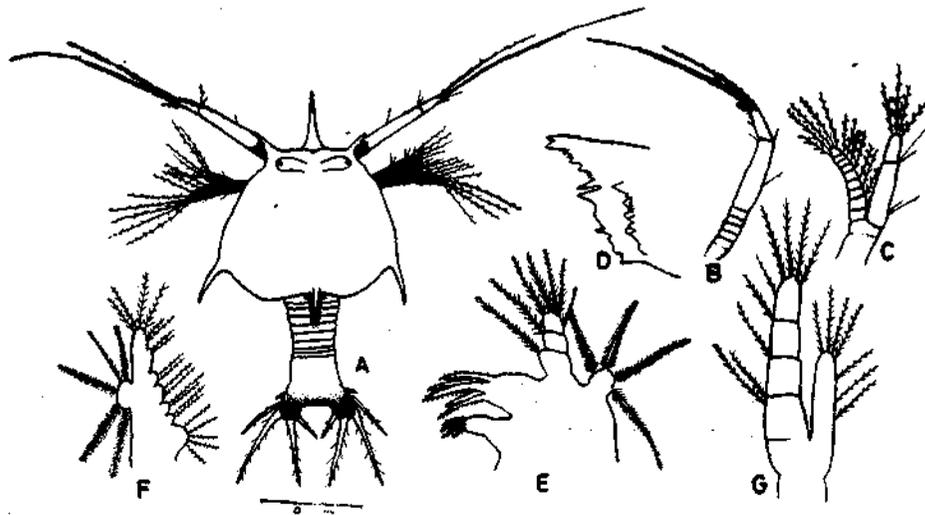


FIG. 5. Protozoa II of *Acetes cochinensis*

The colouration of the larva remains unchanged with reddish pigments at the bases of the antennule, whole of antenna, the median exposed part of thorax and the telson lobes. Out of the 5 spines in each telson lobes, the inner and outermost spines are short, but in some specimens the outermost spine is longer and equal to the next spine.

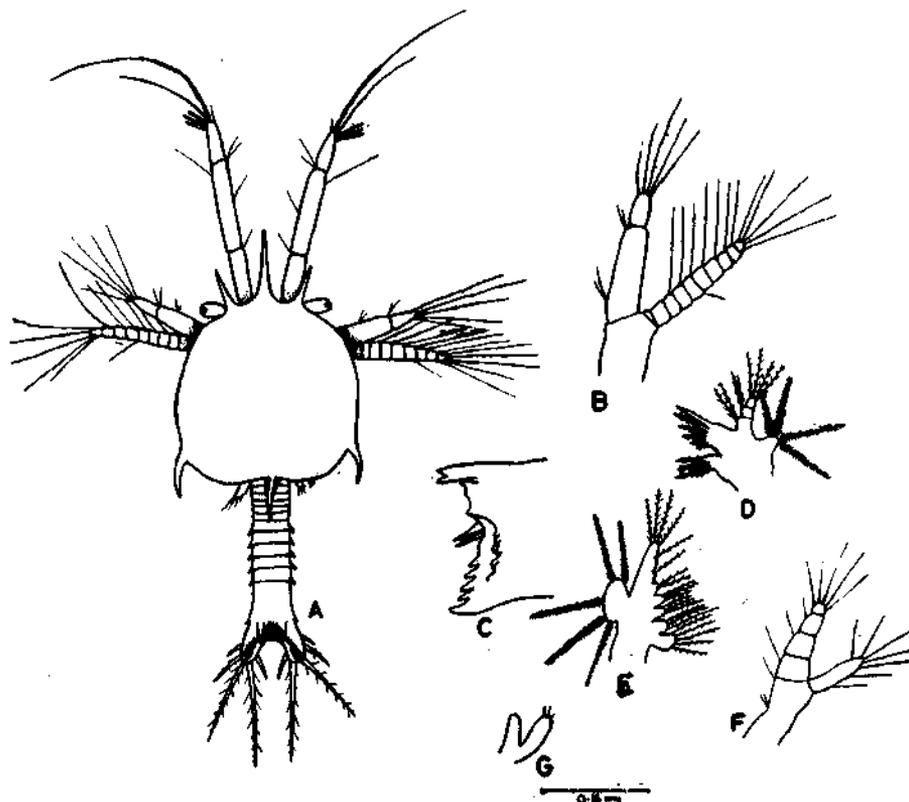
Length 0.96 to 0.97 mm.

Carapace	Rostrum well developed ; anterior, lateral and posterior spines without lateral processes (Fig. 5, A).
Thorax	Short and segmented.
Ab	6 segments.
Telson	Lobes well developed, each lobe with 5 spines (Fig. 5, A).
Eyes	Median eye persists ; compound eyes not free of carapace and with a stout stalk.
A1	7-segmented, and additional small seta at outer subterminal margin develops (Fig. 5, B).
A2	As in protozoa I (Fig. 5, C).
Labrum	No change.
Md	With 12-14 teeth and a few tubercles on the inner side close to the base of the teeth (Fig. 5, D).
Mx1	As in protozoa I (Fig. 5, E).
Mx2, Mxp1	Exopod with an additional seta (Fig. 5, F & G).
Mxp2, Mxp3	No change.

PROTOZOEAE III

(Fig. 6)

The important changes in this stage are the development of uropod and the lateral spines in the abdominal segments. The reddish pigments of the telson lobes are reduced to narrow streaks, the pigments of the antennule and antenna are reduced very much and confined to the proximal region only.

FIG. 6. Protozoa III of *Acetes cochinensis*

Length 1.75 to 1.80 mm

Carapace	Rostrum, anterior, lateral and posterior spines present, anterior spine has lost its branching.
Thorax	Segmented with rudimentary appendages.
Ab	6-segmented with a pair of short posterolateral spines.
Telson	No change.
Eyes	Median eye persists ; compound eye free of carapace on small stalk.
A1	3-segmented, the proximal joint formed by the fusion of basal 5 segments ; the distal segment with 3 aesthetes and 3 terminal setae.
A2	Protopod 2-jointed ; exopod 9-10 jointed, 1 inner lateral seta on joint 2 to 8-9, 1 outer lateral seta on joint 5 (Fig. 6, B).

Labrum	The anterior spine considerably reduced.
Md	2 pointed teeth of incisor region develop serrations on dorsal side (Fig. 6, C).
Mx1	No change (Fig. 6, D).
Mx2	Exopodite slightly enlarged with 5 plumose setae (Fig. 6, E).
Mxp1	Exopodite a little more than $\frac{1}{2}$ as long as endopodite and with 4 terminal and 3 lateral setae (Fig. 6, F.)
Mxp2	Only minor change in rotation of exopod.
Mxp3	Biramous, exo and endopod unsegmented, former with 3 setae (Fig. 6, G).
Pereopods	1-3 biramous and small ; 4th rudimentary.
Uropod	Biramous and small.

Mysis

(Fig. 7)

The transformation of the protozocea III into mysis brings profound changes. The larva now attains more or less shrimp-like form. The paired anterior and lateral spines as well as the posterior spine disappear from the carapace. The abdomen becomes slender and the anterior 3 segments develop pleopods. Uropods are conspicuously developed and setose. The lobes of the telson of the previous stage are approximated and narrow with a deep median indentation. Each lobe carries a pair of spines, the inner of which is larger. In some specimens, an additional pair at the posterolateral border is also observed.

Length 1.95 to 2.00 mm

Carapace	Covering thorax dorsally and laterally ; restrum small with a minute dorsal spine ; supracrbital and pterygostomial spine present.
Ab	Segments 1-5 of almost equal length and with short lateral spines ; 6th elongated with posterior median dorsal spine.
Telson	Median notch deep ; 2 spines to each lobe (Fig. 7, J), varying.
Eyes	Median eye disappears ; stalked eyes well developed.
A1	3-segmented, 1st joint much elongated with 4 setae along the inner border ; 3rd joint with 2 unsegmented flagella, the inner of which is with 3 aesthetes (Fig. 7, B).

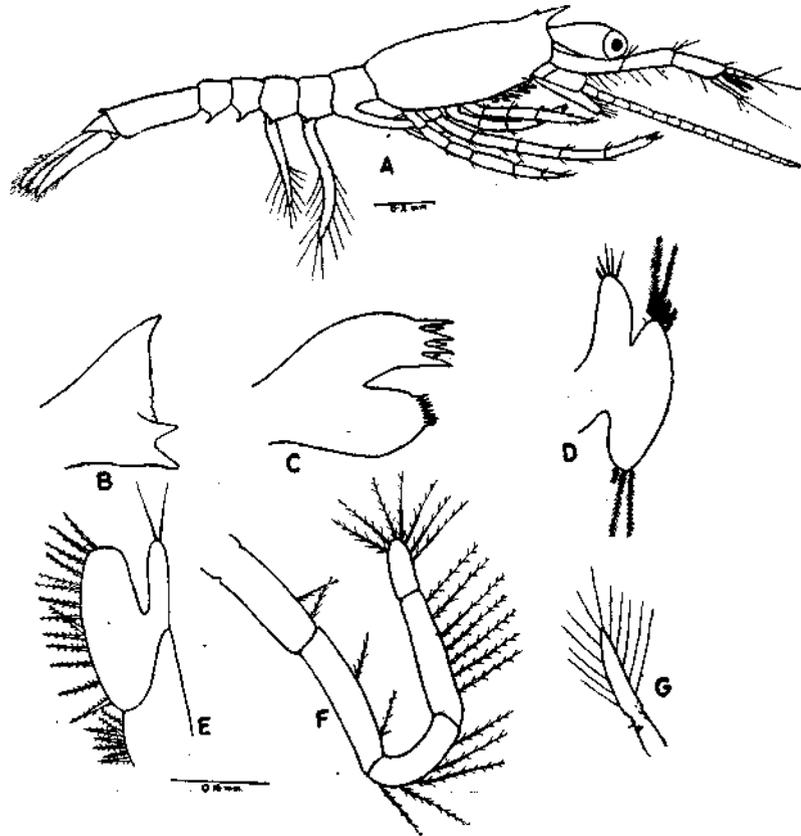
FIG. 7. Mysis of *Acetes cochinensis*

A2	Protopod 2-jointed; flagellum long, slender and 7-jointed, the distal joint with 2 setae; exopod (developing antennal scale) flattened, narrow and with 5-6 setae (Fig. 7, C).
Labrum	Anterior spine absent.
Md	With 7-8 teeth, no palp (Fig. 7, D).
Mx1	2 endites developed, the proximal with 5-6 short setae, the distal with 6 longer spines; exo and endopod lost (Fig. 7, E).
Mx2	1 lobe without seta; exopod enlarged and with 5 setae (Fig. 7, F).

Mxp1	Protopod large; exo and endopod unsegmented and devoid of hairs, former $\frac{1}{2}$ as wide as the latter (Fig. 7, G).
Mxp2	Protopod 2-jointed; endopod 5-jointed; exopodite $\frac{1}{2}$ the length of endopodite and with 4 terminal plumose setae (Fig. 7, H).
Mxp3	No change.
Pereopods	4 pereopods, 1-3 biramous with 5-jointed endopodite, the terminal joint being indistinct chelae; exopodite unsegmented and with 4 plumose setae; 4th uniramous with 4 terminal setae (Fig. 7, I).
Pleopod	On first 3 abdominal segments and uniramous.
Uropod	Exopod with a small sharp spine on the outer margin at $\frac{1}{3}$ length from the tip; 4-5 setae on outer margin; endopod with 18-19 setae (Fig. 7, J).

POSTLARVA I

(Fig. 8)

FIG. 8. Postlarva I of *Acetes cochinensis*

This stage was collected from the plankton when mysis stage occurred in large numbers. The larva now develops setae on the pleopods and the exopods of the legs are reduced considerably.

Length 2.125 to 2.5 mm

Carapace	Rostrum small, triangular with a dorsal tooth; supraorbital and pterygostomial spine present.
Ab	6-segmented; 1-5 with lateral spines, 6 with posterior median dorsal spine.
Telson	With 2 pairs of spines.
Eyes	Same as in mysis.
A1	Peduncle 3-jointed; proximal segment develops a basal swelling (developing statocyst). Inner flagellum unjointed with 4 apical setae; outer 2-segmented, the proximal joint with 3 aesthetes and the distal tipped with 3 setae.
A2	Flagellum long with 18-20 segments; scale narrow with 3 setae at tip and 3 on the inner border.
Labrum	more flattened.
Md	Incisor region with 1 prominent and molar region with 2-3 smaller teeth (Fig. 8, B).
Mx1	No change (Fig. 8, C).
Mx2	Endite with 5 setae; exopod ear-shaped with 5 setae at the outer and 3 setae on the posterior margin (Fig. 8, D).
Mxp1	Protopod 2-jointed; endopod small, unjointed with 2 setae (Fig. 8, E).
Mxp2	Endopod 5-jointed, the last 3 segments curve inwards; exopod vestigial (Fig. 8, F).
Mxp3	Endopod 7-jointed with setae along its border; exopod small and unarmed.
Pereopods	3 chelate legs; 4th disappears.
Pleopods	On 1-3 abdominal segments, uniramous with unjointed protopod and exopod, the latter bordered with long plumose setae (Fig. 8, G).
Uropod	More setae developed.

POSTLARVA II

(Fig. 9)

The larva increases in size and is characterised by the development of a small hepatic spine in the carapace. Rudimentary and non-functional pleopods develop on the 4th and 5th abdominal segments.

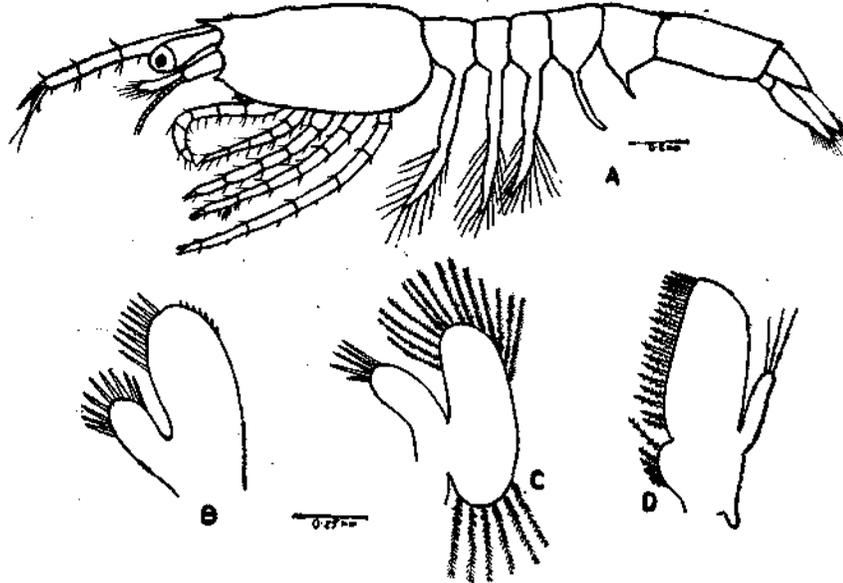


FIG. 9. Postlarva II of *Acetes cochinensis*

Length 2.85 to 3.00 mm

Carapace	Rostrum with a small dorsal tooth and 2-3 small hairs behind the tooth; supraorbital and pterygostomial spine unchanged; a small hepatic spine developed.
Ab	Unchanged.
Telson	Median indentation more shallow and broader, the inner pair of spines considerably reduced.
A1	In the proximal segment a small spine developed on the outer lateral margin above the statocyst swelling; outer flagellum 8-9 jointed.
A2	Flagellum with more than 20 segments; scale with 12 plumose setae and a well developed anterolateral spine.
Md	No change.

Mx1	Both the endites carry stout setae and in addition the distal endite with 6-7 small teeth on the distolateral border (Fig.9, B).
Mx2	Scale enlarged with 20 setae (Fig. 9, C).
Mxp1, Mxp2	Nearly unchanged.
Mxp3	Without exopod.
Pereopods	increase in length.
Pleopods	5-pairs, uniramous, 1-3 well developed with exopod carrying setae; 4-5 rudimentary.
Uropod	No change.

Postlarva III

(Fig. 10)

Length 3.25 to 3.35 mm

Carapace	Nearly unchanged except the pterygostomial spine disappears and the anterolateral angle blunt.
Ab	Unchanged.
Telson	Increases in size with 1 pair of posterior spines separated by a shallow median depression (Fig. 10, E).
A1	Spine on the outer lateral angle of the statocyst swelling enlarged; external flagellum 10-11 segmented with 4 aesthetes at the thickened basal portion.
A2	Scale with 15 plumose setae.
Mx1	No change.
Mx2	Endite with 8-9 setae, a small palp developed; scale with plumose setae all along the border except the middle portion (Fig. 10, C).
Mxp1, Mxp2, Mxp3 and Pereopods	Nearly unchanged.
Pleopods	5 pairs; 1 uniramous with 12 setae; 2-3 develop small endopod, exopod with 12-14 setae; 4th with a bud-like endopod and exopod with 12 setae. 5th uniramous and devoid of hairs.
Uropod	No change except an increase in the number of setae on exo and endopod (Fig. 10, E).

POSTLARVA IV

Length 4.075 mm

The larva at this stage attains most of the adult characters. The lateral spines of the abdominal segments reduced; antennules and antenna attain most of the

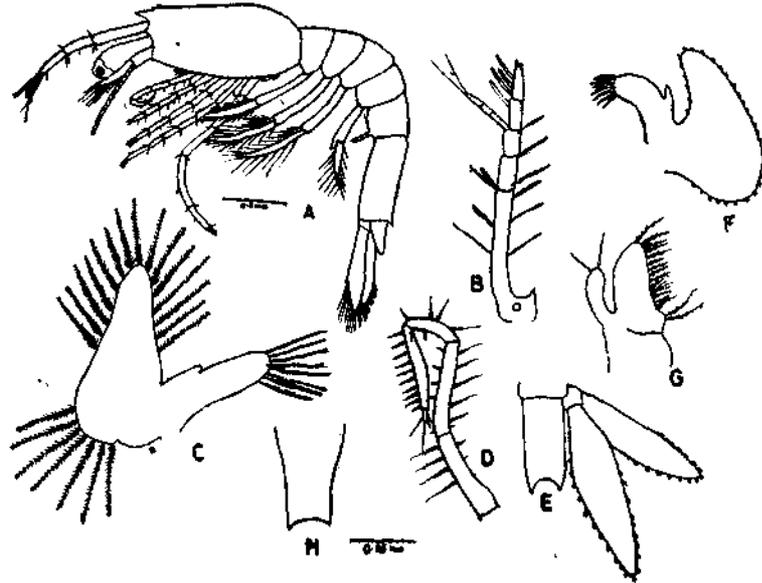


FIG. 10. Postlarva III of *Acetes cochinensis*

adult characters. The scaphognathite develops setae all along its borders (Fig. 10, F). All pleopods are well developed, the first pair uniramous and the last pair with a small endopod which is unarmed. Telson and uropod are same as in the previous stage.

POSTLARVA V

Length 4.22 mm

The important differences noticed from the previous stage are the increase in the number of aesthetes in the antennular flagellum; the antennal scale provided with 24-26 setae; well developed palp in the second maxilla; all pleopods except the first with well developed endopods and nature of telson. The telson increases in size and the lateral spines are reduced (Fig. 10, H). The gap between the spines widens, gradually the tip becoming rounded to attain the adult characters.

REMARKS

In *Acetes*, the eggs are pelagic and are similar to penaeid eggs in having a large perivitelline space. Although these eggs are larger when compared to penaeid eggs (Menon, 1951 & Subrahmanyam, 1965), the proportion of the embryonic mass to the diameter of the egg is smaller.

In general, the development of *A. cochinensis* follows the same pattern as that of *A. japonicus* (Soejima, *op. cit.*) and *A. erythraeus* (Menon, *op. cit.*). A comparison of the corresponding stages of the three species is given in Table II.

TABLE II

Stage	<i>A. japonicus</i>	<i>A. erythraeus</i>	<i>A. cochinensis</i>
Nauplius I	Size : 0.11 mm	..	Size : 0.20-0.22 mm
Nauplius II	Size: 0.17 mm ; antennule faintly segmented with 3 terminal setae ; exopod of the antenna jointed ; endopod unsegmented ; 2 furcal spines.	..	Size: 0.27-0.29 mm ; antennule unsegmented with 3 terminal setae ; exo and endopod of antenna unsegmented ; 4 furcal spines.
Nauplius III	Size: 0.25 mm ; antennule 7-segmented ; exopod of antenna segmented ; endopod unsegmented.	..	Size: 0.29-0.30 mm ; antennule 6-segmented ; exo and endopods faintly segmented.
Protozoa I	Size: 0.30 mm ; antennule 7-jointed, tip carrying 3 setae ; exo and endopod segmented, each with 3 terminal setae ; telson with 6 pairs of spines.	Size: 0.58-0.59 mm ; antennule 7-jointed, tip carrying 4 setae ; exo and endopod of antenna segmented, each with 5 terminal setae ; telson with 6 pairs of spines.	Size: 0.56-0.58 mm ; antennule 7-jointed, tip carrying 3 setae, exo and endopod of antenna segmented, the former with 5 and the latter with 4 terminal setae ; telson with 5 pairs of spines.
Protozoa II	Size: 0.52 mm ; antennule with 3 terminal setae ; telson with 6 pairs of spines.	Size : 0.92 mm ; antennule with 4 terminal setae ; telson with 6 pairs of spines.	Size: 0.96-0.97 mm ; antennule with 3 terminal setae ; telson with 5 pairs of spines.
Protozoa III	Size: 0.90 mm ; telson with 6 pairs of spines.	Size: 1.8 mm ; telson with 6 pairs of spines.	Size: 1.75-1.80 mm ; telson with 5 pairs of spines.
Mysis		Size: 2.3 mm ; antennal flagellum 11-12-segmented ; mandible devoid of teeth ; abdomen with median dorsal spine on 4th to 6th segment ; telson with 6 spines.	Size: 1.95-2.00 mm ; antennal flagellum 7-segmented ; mandible with 7-8 teeth ; median dorsal spine on 6th abdominal segment ; telson with 4 spines.
Postlarva I		Outer antennular flagellum with 2 aesthetes ; antennal flagellum with many segments, scale with 8-10 setae ; mandible with 2 sharp teeth and 3 tubercles.	Size: 2.125-2.5 mm ; outer antennular flagellum with 3 aesthetes ; antennal flagellum 18-20 segmented, scale with 6 setae ; mandible with a large tooth and 2-3 smaller teeth.

Stage	<i>A. japonicus</i>	<i>A. erythraeus</i>	<i>A. cochinesis</i>
Postlarva II		Size: 3.0 mm; carapace without hepatic spine; basal statocyst swelling in the antennule carries 2 plumose setae; external flagellum 12-jointed; antennal scale with 13 setae.	Size: 2.85-3.00 mm; carapace with hepatic spine, no setae above the statocyst swelling, but a small tooth developing; external flagellum 8-9-jointed; antennal scale with 12 setae.
Postlarva III		Size: 3.5 mm; outer antennular flagellum 16-17 jointed and with 5 aesthetes; antennal scale with 15-17 setae; telson with 4 spines.	Size: 3.25-3.35 mm; outer antennular flagellum 15-16-jointed and with 4 aesthetes antennal scale with 15 setae; telson with 2 spines.
Postlarva IV		Size: 4.00 mm; outer antennular flagellum with 6 aesthetes; antennal scale with 21 setae; telson elongated.	Size: 4.075 mm; outer antennular flagellum with 5 aesthetes; antennal scale with 20 setae; telson with 2 small spines.

In the number of naupliar stages *A. cochinesis* is similar to *A. japonicus*, there being 3 stages. But the nauplii of the former can easily be distinguished by their larger sizes. In the second naupliar stage there are only two furcal spines in *A. japonicus*, whereas four furcal spines can be distinguished in the present form.

Both *A. erythraeus* and the present species metamorphose through three protozoal stages. But Soejima (*op. cit.*) described only two stages in *A. japonicus*. However, his figure of zoea (fig. VI) resembles closely the third protozoa of *A. erythraeus* and *A. cochinesis* particularly in the characters like the presence of the anterior, lateral, and posterior processes of carapace and the absence of pleopods in any of the abdominal segments. The general characters of the protozoal stages viz., the absence of rostrum and stalked eyes, presence of anterior, lateral and posterior processes of the carapace, seven-segmented antennule, segmented endo and exopodites of antenna, nature of first and second maxillae, segmentation of thorax and unsegmented abdomen on the first stage; development of rostrum, stalked eyes and the nature of carapace spines, antennule, antenna and maxillae in the second stage and the presence of rudimentary thoracic limbs, paired lateral spines in the abdominal segments and the development of uropod in the third stage are identical in all the species. But in features such as telsonic armature and setation of different appendages show considerable differences (ref. Table II).

There are four mastigopus stages in *A. erythraeus*. In the present form five stages are distinguished. The general organisation is similar in both the forms, but the present one differs from *A. erythraeus* in possessing a small hepatic spine in the second postlarval stage. In the third stage, the telson bears only a single pair of spines which in fifth stage attain the adult form.

In most of the decapoda, the pleopods appear simultaneously and becomes functional in the postlarval phase. But in *Acetes*, *Gennadas* and allied genera (Gur-

ney, 1942) they appear in succession, first as nonsetose rudiments, later developing as setose appendages. The sequence of the appearance of pleopod in *A. cochinensis* is as follows and comparable with that of *A. erythraeus*.

Stage	Non-setose	setose
Mysis	3	0
Postlarva I	0	3
Postlarva II	2	3
Postlarva III	1	4
Postlarva IV	0	5

As already mentioned above, it has not been possible to rear the eggs to postlarval stages. But a rough estimation of the duration of larval life can be made by following the occurrence of larval stages in the plankton analysed during the period. The following table gives the occurrence of larval forms raised by rearing and in the plankton collected during May-June, 1966.

TABLE III

Date	Stage	Obtained from
11-5-66	Eggs and nauplius I	Rearing and plankton
12-5-66	Nauplius II & III and Protozoa I	Rearing
13-5-66	Protozoa I & II	Rearing and plankton
27-5-66	Protozoa III, mysis and postlarva I	Plankton
10-6-66	Postlarva III & IV	Plankton
15-6-66	Postlarva IV	Plankton
28-6-66	Postlarva V and juveniles (5.5 to 6.375 mm)	Plankton

From the above table it can be reasonably deduced that the larval life may extend to about six weeks to reach the juvenile stage.

ACKNOWLEDGEMENTS

The author is greatly indebted to Dr. S. Jones, Director, Central Marine Fisheries Research Institute, for his guidance and to Shri K. H. Mohamed and Shri M. J. George for their encouragement and critically reading of the manuscript. Thanks are also due to Dr. K. Alagarwami for his help in procuring some of the literature. The author is grateful to the Department of Atomic Energy, Bombay, for providing a fellowship during the tenure of which the work was partially carried out.

REFERENCES

- BROOKS, W. K. 1882. *Lucifer*, a study in morphology. *Phil. Trans. Roy. Soc., London*, clxxiii : 57-137.
- BURKENROAD, M. D. 1934. The Penaedae of Louisiana, with a discussion of their world relationships. *Bull. Amer. Mus. Nat. Hist.*, lxxviii : 126-32.
- COLEFAX, A. N. 1940. An Australian species of *Acetes* (Crustacea Macrura, Sergestidae), with remarks on the distribution and literature of the genus. *Rec. Australian Mus.*, 20 : 341-353.
- GURNEY, R. 1942. Larvae of decapod crustacea. *The Ray Society, London*, 306 pp.
- HANSEN, H. J. 1919. The Sergestidae of the Siboga Expedition. *Siboga Exped.*, 38 : 31-48.
- KEMP, S. 1917. Notes on Crustacea Decapoda in the Indian Museum. The genus *Acetes*. *Rec. Indian Mus.*, 13 : 43-58.
- MENON, M. K. 1933. The life histories of Decapod Crustacea from Madras. *Bull. Madras Govt. Mus. N.H. Section*, III (3) : 1-45.
- . 1951. The life history and bionomics of an Indian penaeid prawn *Metapenaeus dobsoni*, Miners. *Proc. Indo-Pacif. Fish. Coun.*, 3 : 14.
- NATARAJ, S. 1947. On some species of *Acetes* (Crustacea, Sergestidae) from Travancore. *Rec. Indian Mus.*, 45 (2 & 3) : 139-148.
- PATHANSALI, D. 1966. *Acetes* (Sergestidae) from Malay Peninsula. *Bull. Nat. Mus. Singapore*, 33 (8) : 59-63.
- SOEJIMA, I. 1926. On the metamorphosis of *Acetes japonicus* Kishinouye. *Suisan Gakkwai-Ho.*, 4 (3) : 153-163.
- SUBRAHMANYAM, C. B. 1965. On the unusual occurrence of penaeid eggs in the inshore waters of Madras. *J. Mar. biol. Ass. India*, 7 (1) : 83-88.