

# LARVAL STAGES OF LABORATORY REARED HARPACTICOID COPEPOD *EUTERPINA ACUTIFRONS* (DANA)

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## ABSTRACT

Laboratory reared larvae of *Euterpina acutifrons* (Dana) from an estuary have been described. The complete development took 16 to 18 days at room temperature (25° to 27°C) and at salinity ranging from 32‰ to 35‰. Six naupliar and five copepodid stages precede the adult. The nauplii in shape resemble those of the other free living harpacticoid copepods except for the presence of a characteristic blunt process at the posterior end of the body. The prehensile endopodite of the antenna is poorly developed and the exopodite of the mandible is long, 3-segmented with plumose setae. The development of the copepodids is gradual with minor changes in the size of the body segments and in the number of spines and setae on the paired legs.

## INTRODUCTION

*Euterpina acutifrons* (Dana) is a small (0.710 - 0.731 mm) harpacticoid copepod with a world-wide distribution in estuarine, inshore and oceanic waters. This species constitutes a major food item of sardines. Despite its common occurrence and possible utilization as a food in aquaculture of fishes, no attempt has been made in India to rear the species in the laboratory. Krishnaswami (1950a) gave an account of only the sixth naupliar stage and first copepodid stage of *E. acutifrons* from the Madras inshore plankton. Rao (1958) described the developmental stages of this species from plankton collections off Waltair. Both the authors described the stages from fixed

zooplankton material. Moreover, the morphological description of the larvae and their appendages given by Rao (1958) are incomplete. The present paper gives a complete account of the larval stages reared in the laboratory.

## MATERIAL AND METHODS

Larvae hatched in the laboratory were fed on freshly collected detritus from the Cochin backwaters and on culture of *Dunaliella primolecta*. The method of collection of detritus was as described by Qasim and Sankaranarayanan (1972). Preserved specimens (15-20) of each stage were measured and their average length was determined.

RESULTS

Hatching took place 20-24 hours after the release of ovigerous females in finger-bowls containing 150 ml of filtered sea-water of 32‰ to 35‰ salinity and at room temperature of 25°C to 27°C. Six naupliar and six copepodid stages identified in the life-cycle of *E. acutifrons* are as follows:-

Naupliar stages Figs. 1-15): The nauplii are transparent and dorsoventrally compressed. They are separated from each other by a single moult, the last naupliar stage gets metamorphosed into the first copepodid stage. The duration of the naupliar stages lasts for about 10 days.

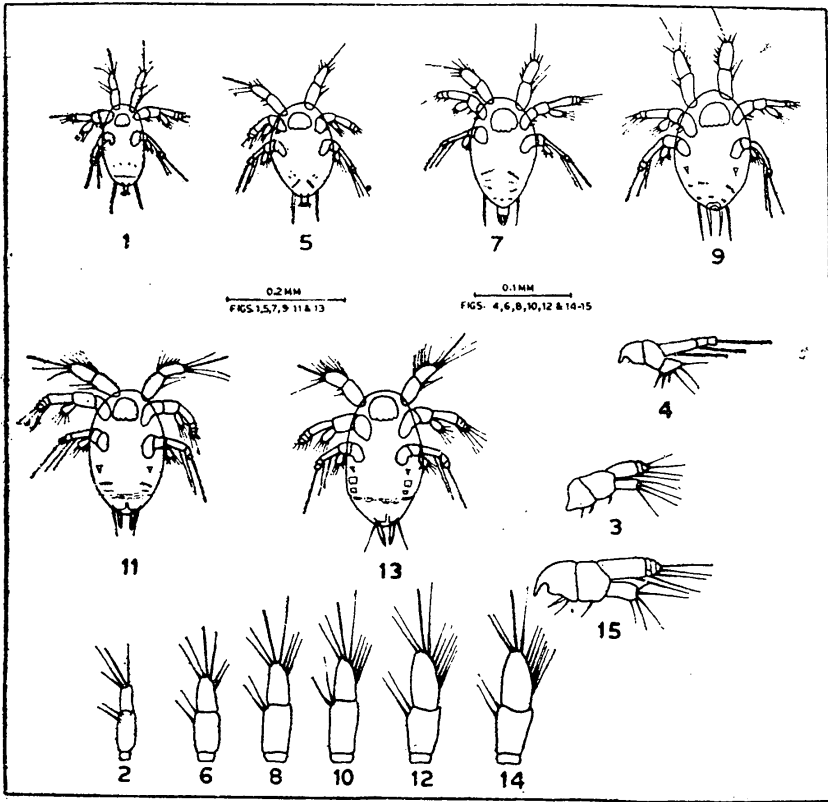


Fig. 1 — Naupliar stages of *Enterpina acutifrons* (Dana)

- |                          |                          |                         |
|--------------------------|--------------------------|-------------------------|
| 1) Stage I               | 2) Stage I - antennule   | 3) Stage I - antenna    |
| 4) Stage I - mandible    | 5) Stage II              | 6) Stage II - antennule |
| 7) Stage III             | 8) Stage III - antennule | 9) Stage IV             |
| 10) Stage IV - antennule | 11) Stage V              | 12) Stage V - antennule |
| 13) Stage VI             | 14) Stage VI - antennule | 15) Stage VI - antenna  |

*Stage I* :— Length = 0.107 mm. The body is oval and completely covered by the dorsal cephalic shield (Fig. 1.1). The labrum is large and lobed posteriorly. The antennule is 3-segmented, the first segment is very small and indistinct. The second segment is the largest with two lateral setae. The third segment bears four setae (Fig. 1.2). The number of the antennular segments remains unchanged in all the naupliar stages but with every moult, there is an addition of setae on the terminal segment. Again up to the fourth naupliar stage, the second antennular segment is the largest but in the fifth and sixth stages the terminal segment is the largest. The antenna is biramous, exopodite is 3-segmented (Fig. 1.3). The basal segment of the exopodite is the largest and clearly divided, the remaining two with indistinct demarcations, each segment has plumose setae on the posterolateral surface. The endopodite is 1-segmented with four terminal setae. The antenna remains unchanged up to the fifth naupliar stage. The mandible is biramous (Fig. 1.4). The exopodite is indistinctly 3-segmented with a seta in each segment. The endopodite is 1-segmented with three thick spines and three setae. The mandible remains unchanged in all the naupliar stages. There is a row of small spinules along the posterior surface of the body. The caudal armature has two bristles with a few spinules on the blunt process in between the bristles.

*Stage II* :— Length = 0.133 mm (Fig. 1.5). The terminal segment of the antennule has two more lateral setae (Fig. 1.6). The row of spinules along the posterior surface of the body is more distinct. The

caudal armature is similar to the previous stage except that the bristles are slightly thicker.

*Stage III* :— Length = 0.156 mm (Fig. 1.7). The body is more elongate than broad (5.2 : 2.9). The terminal segment of the antennule has an additional seta (Fig. 1.8). Numerous rows of small spinules are present along the posterior surface of the body and the caudal armature possess spines in between the bristles.

*Stage IV* :— Length = 0.198 mm. The body gets elongated further and projects beyond the dorsal cephalic shield (Fig. 1.9). The terminal segment of the antennule has one more seta (Fig. 1.10). The rudiments of maxillules become visible. The posterior borders of the body is bifurcated and remains so in the subsequent stages. The row of spinules on the body and the caudal armature are as in the previous stage.

*Stage V* :— Length = 0.225 mm. The body is oblong-shaped and divided into anterior and posterior regions (Fig. 1.11). The rows of spinules on the body and the maxillules are as in the previous stage but the spines of the caudal armature become comparatively thicker and the terminal segment of the antennule has two more setae (Fig. 1.12).

*Stage VI* :— Length = 0.248 mm. (Fig. 1.13). The terminal segment of the antennule is with a total number of 11 setae including an aesthete (Fig. 1.14). The exopodite of the antenna is 4-segmented and the endopodite has one more seta than what was recorded in the first naupliar stage (Fig. 1.15). The rows of spinules on the body are reduced. The maxillules become developed and spine-shaped.

The rudiments of the first and second swimming legs are discernible. The length measurements of laboratory reared nauplii and those collected from plankton from various regions were slightly different (Table I).

cephalothoracic (one cephalic and three thoracic) and one abdominal segments (Fig. 2.1). The percentage proportion between the cephalothoracic and abdominal regions is 84 : 16. The antennule is 4-segmented with

TABLE I — Showing the length measurements (in mm) of the naupliar stages of *E. acutifrons* (Dana) from different areas

		AREAS OF STUDY				
		TROPICAL			TEMPERATE	
Naupliar Stages	Cochin Backwater (Present study)	Madras (Krishnaswami 1950a)	Off Waltair Rao (1958)	Sao Vincento Brazil Fanta (1972)	Sao Sebasto (1972)	Anglessy England (Haq 1965)
First	0.107	—	0.108	0.097	0.097	0.100
Second	0.133	—	0.135	0.119	0.119	0.117
Third	0.156	—	0.157	0.142	0.140	0.134
Fourth	0.198	—	0.198	0.160	0.159	0.154
Fifth	0.223	—	0.225	0.175	0.179	0.176
Sixth	0.248	0.300	0.248	0.200	0.205	0.194

The sixth naupliar stage moults into first copepodid stage.

*Copepodid Stages* :- ( Fig. 2, 1-22).

The copepodid stages of *E. acutifrons* are active and feed voraciously on detritus. As in nauplii, each stage is separated by a single moult, the last stage being the adult. The segmentation of the body and the development of the swimming legs follow the general pattern of harpacticoid development.

*Stage I* :- Length = 0.394 mm. The body resembles that of the adult in general shape. It consists of four

2, 1, 1 and 4 setae respectively (Fig. 2.2). The antennule has 2-segmented endopodite and a much reduced exopodite. The mandible is with well developed mandibular teeth. The maxilla and the maxilliped are both 3-segmented (Figs. 2.3 and 2.4). The mouth parts remain unchanged up to fifth copepodid stage except the antennule which usually shows additional segment with every moult. Two pairs of 1-segmented legs are present (Figs. 2.5 & 2.6). The third leg is rudimentary. The numbers of setae and spines on the exopod and the endopod of the first and second swimming legs are given in Table II.

Goswami: Larval Stages of a Copepod

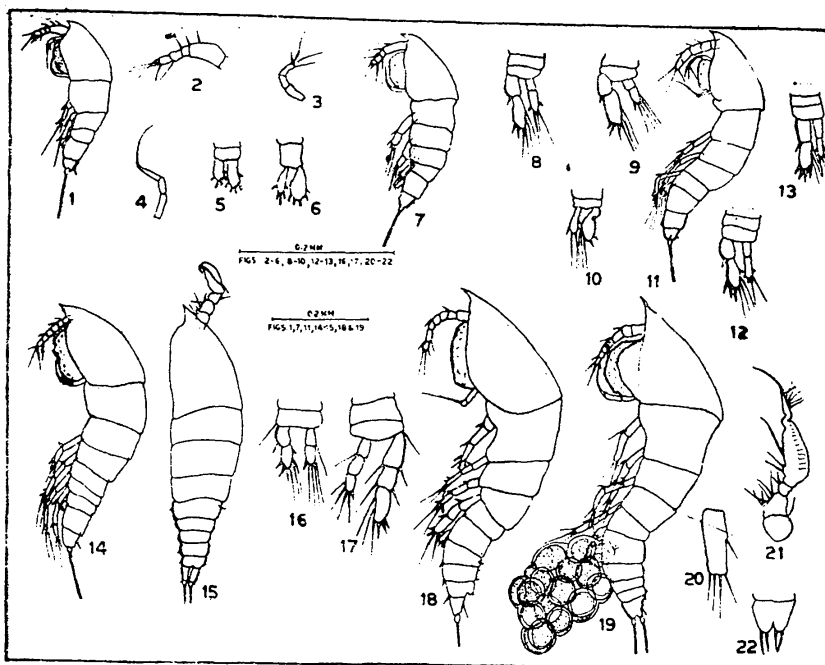


Fig. 2 — Copepodid Stage of *E. acutifrons* (Dana)

- |                               |                           |                           |
|-------------------------------|---------------------------|---------------------------|
| 1) Stage I                    | 2) Stage - antennule      | 3) Stage - maxilla        |
| 4) Stage I - maxilliped       | 5) Stage I - First leg    | 6) Stage I - Second leg   |
| 7) Stage II                   | 8) Stage II - First leg   | 9) Stage II - Second leg  |
| 10) Stage II - Thire leg      | 11) Stage III             | 12) Stage III - first leg |
| 13) Stage III - Second leg    | 14) Stage IV - female     | 15) Stage IV - male       |
| 16) Stage IV - first leg      | 17) Stage IV - second leg | 18) Stage V - female      |
| 19) Stage VI - adult female   |                           | 20) Stage VI - fifth leg  |
| 21) Stage VI - male antennule |                           | 22) Stage VI - fifth leg  |

TABLE II

Swimming legs	<i>Exopod</i>		<i>Endopod</i>	
	Seg. 1		Seg. 2	
	Setae	Spines	Setae	Spines
First	5	0	5	0
Second	4	1	5	0

*Stage II*:— Length = 0.430 mm (Fig. 2.7). The number of cephalothoracic segments is now five and the abdominal segment remains unchanged. The percentage proportion between these regions is 88 : 12. The antennule is as in the pre-

vious stage. Three pairs of legs are present. The first two legs are 2-segmented (Figs. 2.8 & 2.9) while the third leg is 1-segmented and forked (Fig. 2.10). The numbers of setae and spines on the paired legs are given in Table III.

TABLE III

Swimming legs	Exopod				Endopod			
	Seg. 1		Seg. 2		Seg. 1		Seg. 2	
	Setae	Spine	Setae	Spine	Setae	Spine	Setae	Spine
First	0	1	2	4	0	0	5	0
Second	0	1	3	3	0	0	4	1
Third	3	2	-	-	4	1	-	-

*Stage III* :— Length = 0.448 mm. The body comprises of five cephalothoracic and two abdominal segments (Fig. 2.11) with percentage proportion of 78:22. The antennule is 5-segmented. Four pairs of 2-segmented legs are present. The first

*Stage IV* :— Sexual dimorphism occurs in this stage (Figs. 2.14 & 2.15). The males are smaller than the females (male=0.508 mm, female = 0.528 mm). The antennules in the former are geniculated whereas in the latter they are straight and 6-segmented.

TABLE IV

Swimming legs	Exopod				Endopod			
	Seg. 1		Seg. 2		Seg. 1		Seg. 2	
	Setae	Spines	Setae	Spines	Setae	Spines	Setae	Spines
First	0	1	4	3	0	0	5	0
Second	0	1	3	4	0	0	5	0
Third	0	1	3	4	0	0	5	0
Fourth	0	1	3	4	0	0	5	0

and second legs (Figs. 2.12 & 2.13) show different number of setae and spines on the distal segment of the exopod. The remaining legs are similar to the second leg. The numbers of setae and spines on the paired legs are as in Table IV.

In addition to the four paired legs, a rudimentary fifth leg is present. The first leg (Fig. 2.16) is 2-segmented while the second to fourth are 3-segmented (Fig. 2.17). The numbers of setae and spines on the legs are given in Table V.

TABLE V

Swimming legs	Exopod						Endopod					
	Seg. 1		Seg. 2		Seg. 3		Seg. 1		Seg. 2		Seg. 3	
	Setae	Spine	Setae	Spine	Setae	Spine	Setae	Spine	Setae	Spine	Setae	Spine
First	1	0	4	3	-	-	1	0	4	1	-	-
Second	1	1	1	1	3	3	1	0	0	0	4	1
Third	1	1	1	1	3	3	1	0	1	0	4	1
Fourth	1	1	1	1	3	3	1	0	1	0	4	1
Fifth	-	-	-	-	-	-	2	0	-	-	-	-

Goswami: Larval Stages of a Copepod

*Stage V* :— Length = 0.634 mm (Fig. 2.18). The body consists of five cephalothoracic and four abdominal segments with proportion between the two regions being 83 : 17. The antennule is 7-segmented. This stage resembles the adult except for the length of the body and the development of the genital segment in the females. The paired legs are in the previous stage except that the exopod of each leg is slightly longer and the spines are stouter. The fifth leg is still rudimentary.

*Stage VI* :— (Adults) Sexual dimorphism is complete. The sexes can be separated on the basis of size (female = 0.731 mm, male = 0.629 mm). The number of segments in the female (Fig. 2.19) is the body same as in the previous stage but the genital segment is fully developed and swollen. Paired egg-sacs are present on the ventral surface of the body. The legs are as in the previous stage but the fifth leg is now better developed. The exopod is reduced and indistinct, the endopodite is 1-segmented with five setae (Fig. 2.20).

The antennules in the males are modified to form grasping organs. The antennular segments are reduced and 5-segmented. The fourth and fifth segments are fused and much thickened. The sixth and seventh segments are also fused to form the terminal section (Fig. 2.21). The legs are as in the females but their spines are stouter. The fifth leg (Fig. 2.22) bears exopod and endopod with two setae in each.

DISCUSSION

*E. acutifrons* is one of the few pelagic harpacticoid copepods, the majority of

them being benthic. This species occurs almost throughout the year in the Cochin backwaters and is one of the dominant copepod species from October to March. Seasonal occurrence of this species in the marine plankton samples from different regions has been recorded by Krishnaswamy (1950a), Rao (1958), Kartha (1959), EL-Maghraby (1965), Haq (1965), Ummerkutty (1967) and Fanta (1972).

During the present study, the larvae of *E. acutifrons* were reared on the culture of *Dunaliella primolecta* and on freshly collected detritus. Haq (1965) and Fanta (1972) both used culture of *Phaeodactylum tricorutum* during their rearing experiments. Tesch (1915) did not mention about the food given to the developmental stages of this species. Barton (1891) and Farenbach (1962) used red algae as food for the larvae of other harpacticoid copepods, *Harpacticus chelifer* and *Disthrodes cystoecus* respectively. Ummerkutty (1960) reared another harpacticoid copepod, *Tisbintra jonesi* on powdered *Gracillaria crassa*, ground-dried clam meat and a variety of freshly chopped seaweeds. Goswami (in press) reared the larvae of harpacticoid copepod, *Laophonte setosa* using only detritus as food.

There are six naupliar and six copepodid stages in the life-cycle of *E. acutifrons*. The same number of larval stages in this species has been recorded by Rao (1958), and Haq (1965). Tesch (1915) recorded only five naupliar and six copepodid stages. Six naupliar and six copepodid stages have also been reported in other free living harpacticoid copepods by earlier workers as in *Longipedia coronata*, *L. scotti* and *L. minor* (Nicholls, 1934), *Tisbe furcata*

(Johnson and Obson, 1948), *Macroestella gracilis* and *Leptostacus eryhalinus* (Krishnaswami 1950b, 1955), *Tisbintra jonesi* (Ummerkuty, 1960), *Diathrodes cystoecus* (Farenbech, 1962) and in *Laophonte setosa* (Goswami, in press).

In the first nauplius of *E. acutifrons* the antennule is 3-segmented. The number remains constant in all the naupliar stages but with every moult, there is increase in the number of setae on its terminal segment. The terminal segment of the antennule in the first naupliar stage has four setae but in the sixth stage, the total number of setae including an aesthete becomes eleven. The 3-segmented antennule in the naupliar stages of this species has also been observed by Tesch (1915) and Haq (1965). The former has not shown clearly the total number of setae on the terminal segment in the nauplii whereas, the latter has given the number as three and eleven in the first and sixth naupliar stages. Krishnaswamy (1950a) has also described and drawn the antennule as only 2-segmented in all the naupliar stages with two setae on the terminal segment.

The antenna is biramous, the exopodite is 3-segmented in the first naupliar stage and 4-segmented in the sixth. The endopodite is 1-segmented in all the nauplii. Krishnaswamy (1950a) and Haq (1965) described 4-segmented exopodite and 1-segmented endopodite in the sixth naupliar stage. Similar features were observed during the present study. Tesch (1915) has shown exopodite to be 5-segmented and endopodite as 2-segmented. Strangeiy enough, Rao (1958) has described both exopodite as and endopodite 1-segmented in all the naupliar stages.

The mandible is also biramous in *E. acutifrons*. The exopodite is 3-segmented and endopodite, 1-segmented in all the naupliar stages. This is in confirmation with the observation of Haq (1965). Tesch (1915) has not differentiated between exopodite and endopodite. Krishnaswamy (1950a) described exopodite as indistinctly 4-segmented and endopodite as 1-segmented in the sixth naupliar stage whereas Rao (1958) has stated endopodite as very small and indistinct and exopodite with 2 long and stout spines.

The maxillules appear as small curved spines in the fourth naupliar stage as observed by Haq (1965) but Tesch (1915) reported its presence even in the second naupliar stage. Krishnaswamy (1950a) described the rudimentary maxillules in the sixth naupliar stage. Rao (1958) has not mentioned about maxillules in the description of the naupliar stages. The first and second swimming legs are rudimentary structures in the sixth naupliar stages and confirm the observation of Krishnaswamy (1950a) and Haq (1965). Tesch (1915) reported the presence of first swimming leg as early as third naupliar stage and second in the fourth or fifth stage. Rao (1958) again gave no account of the swimming legs in the nauplii.

In the copepodid stages, the development of body segments and paired legs is on the same pattern as observed earlier by Tesch (1915), Lang (1948), El-Maghraby (1965) and Haq (1965), with minor changes in the size of the segments and number of setae on the paired legs.

It may be said in conclusion that the larval stages of *E. acutifrons* resemble



Goswami : Larval Stage of a Copepod

with other harpacticoid copepods but differ in the structure of endopodite of antenna, mandibles and by the presence of blunt process at the posterior extremity of the nauplii. These modifications may be for a better pelagic mode of life of this species.

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