

DEVELOPMENTAL STAGES OF A CYCLOPOID COPEPOD *CYCLOPINA LONGIFERA* (SEWELL) REARED IN THE LABORATORY

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ABSTRACT

There are six naupliar stages in the life history of *Cyclopina longifera* (Sewell). Nauplii of this species resemble in all the essential features as the shape of the body, 3-segmented antennule and biramous antennae with those of other Cyclopoid copepods. However, the endopod of the mandibles is a 2-lobed structure and the labrum is quite large. The presence of six naupliar stages in this species is an interesting feature as other members of the family Cyclopoidae have mostly five naupliar stages. The development of the copepodids is normal and gradual.

INTRODUCTION

*Cyclopina longifera* is a small cyclopoid copepod occurring in the Cochin Backwater throughout the year especially during post monsoon period (September to December). The developmental aspect of freshwater copepods has been dealt with by Walter (1922), Manfredi (1923), Candeias (1964) etc. Amongst the marine cyclopoid copepods, work has been done mainly with reference to the different species of genus *Oithona* by Murphy (1923), Gibbons and Ogilvie (1933), Rao (1958), Haq (1965) and Goswami (1974).

Little work has been done on the life history of brackish water cyclopoid copepods. The present paper deals with the complete life history of *C. longifera* carried out under laboratory conditions. Ovigerous females from the freshly collected zooplankton samples were kept singly in the finger-bowls containing filtered seawater. The developmental stages

were fed on a culture of *Dunaliella primolecta*\*. The culture was maintained using "Erd schreiber" culture solution containing sodium nitrate, sodium hypophosphate in soil extract. Drawings were made by a camera lucida. Total lengths were measured from the anterior margin of the body to the posterior region excluding appendages and the caudal setae.

DEVELOPMENTAL STAGES

Six naupliar and five copepodid stages precede the adult stage. The development is completed from egg to maturity within 7-8 days at room temperature of 25°C to 28°C and salinity 10‰ to 16‰. The instars are separated by a single moult.

*Naupliar stages*

The nauplii are transparent and dorso-ventrally compressed. After the nauplii are released, the empty egg-sacs

\* Kindly supplied by Miss Veronica Alvarez, Taraporevale Aquarium, Bombay.

are shed, retaining the same shape as when carried by the ovigerous female.

*Stage I (Fig. 1)*

Length = 0.086 mm. The body is egg-shaped and dorso-ventrally compressed. The antennule is 3-segmented, the first two segments with one seta each and the terminal segment with 3 setae. The antennae are biramous structures. The exopodite is 4-segmented, whereas endopodite is unsegmented and notched. There are two setae at the terminal end of the endopodite. The exopodite of the mandible is also 4-segmented. Terminal segment is with a pair of setae and other three segments bear one seta each. The endopodite is 2-lobed structure, the

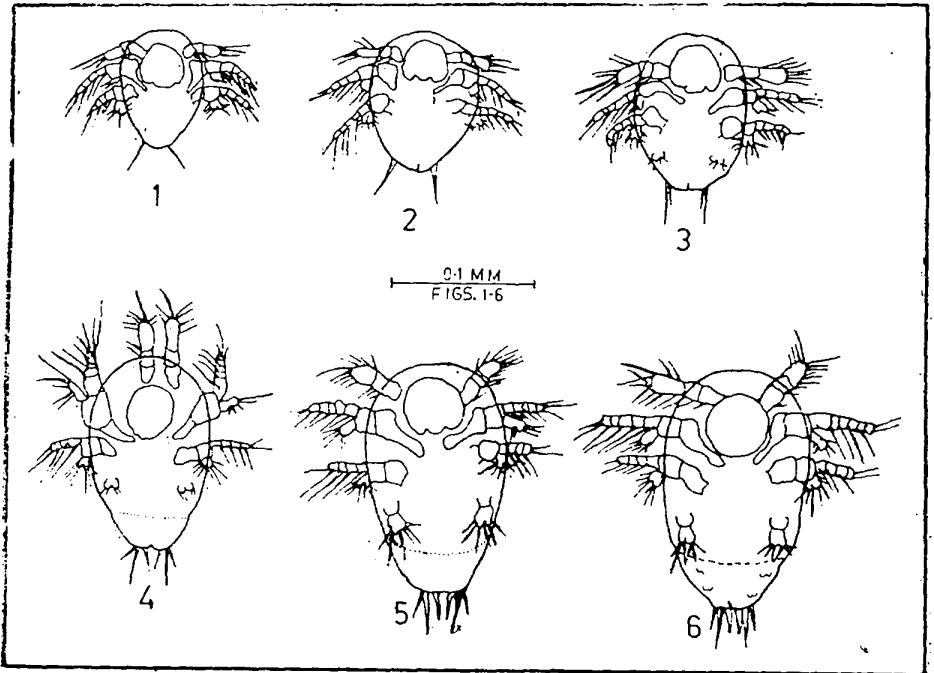
outer lobe with 3 setae and inner with 4 setae. The structure of the mandible remains almost the same in all the naupliar stages. It moults into the next stage after about 24 hours.

The caudal armature consists of a pair of setae at the posterior surface.

*Stage II (Fig. 2)*

Length = 0.097 mm. The labrum is large and tri-lobed. The terminal segment of antennule is with 5 setae. The antennae and the mandibles are as in the previous stage. The duration of this stage is 12 to 15 hours.

The caudal armature consists of two



*Figs. 1 to 6. Naupliar stages first to sixth.*

*Developmental stages of Cyclopina longifera*

strong setae with faint bifurcation at the posterior surface of the body.

*Stage III (Fig. 3)*

Length = 0.107 mm. Body is oval-shaped, the terminal segment of antennule with an additional pair of setae. The antennae are as in the previous stage and rudiments of maxillule are visible. It lasts for the same period as nauplius II.

The posterior surface of the body shows two setae on each side of the cleavage.

*Stage IV (Fig. 4)*

Length = 0.129 mm. The body is oval shaped and differentiated into anterior and posterior regions. The exopodite of the antenna is 5-segmented. There is a pair of setae at the notched surface of the endopodite. The antennule and the maxillule, as in the previous stage. The duration of this stage is 10-12 hours.

The caudal armature consists of 3 setae on either side of the cleavage.

*Stage V (Fig. 5)*

Length = 0.150 mm. Differentiation of

the body is more pronounced. The anterior portion is rounded, whereas the posterior portion is tapering. The terminal segment of exopodite of antennule is with 9 setae. The exopodite of antenna is 5-segmented. Maxillulae appear to be divided into two parts. The caudal armature is as in the previous stage. It lasts for 8-10 hours.

*Stage VI (Fig. 6)*

Length = 0.172 mm. The terminal segment of the antennule with 10 setae. The antennae and mandibles as in the previous stage. The two portions of the maxillule bear 3 setae each. Rudiments of first and second swimming legs are present. It moults into copepodid stage I after 10-12 hours.

The caudal armature consists of 3 setae on each side of the cleavage at the posterior surface of the body.

The distinctive characters of the nauplii and duration of each has been given in Table I.

Table I. Distinctive characters of nauplii of *C. longifera* (Sewell) and duration of each.

Naupliar Stage	Average length in mm	Approximate duration in hours	Distinctive characters
I	0.086	24	Body egg-shaped, distal segment of antennule with 3 setae, 2 delicate setae at the posterior surface of the body.
II	0.097	12-15	Distal segment of the antennule with 5 setae, slight indentation at the posterior surface with a seta on each side.
III	0.107	12-15	Body oval-shaped, distal segment of the antennule with 7 setae. Two setae on each side of the cleavage at the posterior surface.
IV	0.129	10-12	Body differentiated into anterior and posterior regions. Distal segment of the antennule with 7 setae. Three setae on each side of the cleavage. Rudiments of maxillule present.
V	0.150	8-10	Differentiation of body more pronounced. Distal segment of antennule with 9 setae, maxillule divided into 2 portions.
VI	0.172	10-12	Distal segment of antennule with 10 setae. Two portions of maxillule with 3 setae each. Rudiments of first and second swimming legs are present.

*Copepodid stages*

There are six stages, the last of which moults into an adult. The body shape, mouthparts and appendages assume the general pattern of the adult except for size and addition of few segments and setae. The segmentation of prosome and urosome as well as the development of swimming legs are their distinctive features.

*Stage I (Fig. 7)*

Length = 0.236 mm. Body consists of 5 segments, 3 prosomal and 2 urosomal. The furcal ramus is short and stumpy with a spine and 3 caudal setae. The antennule is 4-segmented with the terminal segment having 4 setae. The endopodite of the antenna is 2-segmented, the distal segment with 4 setae and a bristle. Maxillule and maxilliped are both 3-segmented.

Two pairs of swimming legs are present, attached to the posterior margins of first two segments of the prosome. The third paired leg is developing. The rami of first and second legs are 2-jointed and of the third leg 1-jointed. The distal joint of exopod of first leg (Fig. 8) has 3 spines and 4 setae. The endopod has 3 spines and 3 setae. In the second leg (Fig. 9) exopod has an additional seta, the endopod is similar in structure to the endopod of the first leg. The exopod of the third leg (Fig. 10) has a small notch, indicating its division into 2-jointed structure in the next stage. The endopod has 2 spines and 4 setae.

*Stage II (Fig. 11)*

Length = 0.280 mm. Body consists of 6 segments, 4 prosomal and 2 urosomal. The terminal segment of antennule

has 2 more setae. Antenna and other mouthparts are as in the previous stage.

There are three pairs of swimming legs. The rami of three paired legs are 2-jointed and of the fourth developing leg is 1-jointed. The distal joint of exopod of the first leg (Fig. 12) has 3 spines and 5 setae, and the endopod with 2 spines and 5 setae. In the second leg (Fig. 13) the endopod has 3 spines and 4 setae and exopod 4 spines and 5 setae. The distal joint of exopod of the third leg (Fig. 14) is similar to that of the second leg, however, the endopod has 2 spines and 5 setae. The endopod of the 4th leg has 2 spines and 3 delicate setae (Fig. 15).

*Stage III (Fig. 15)*

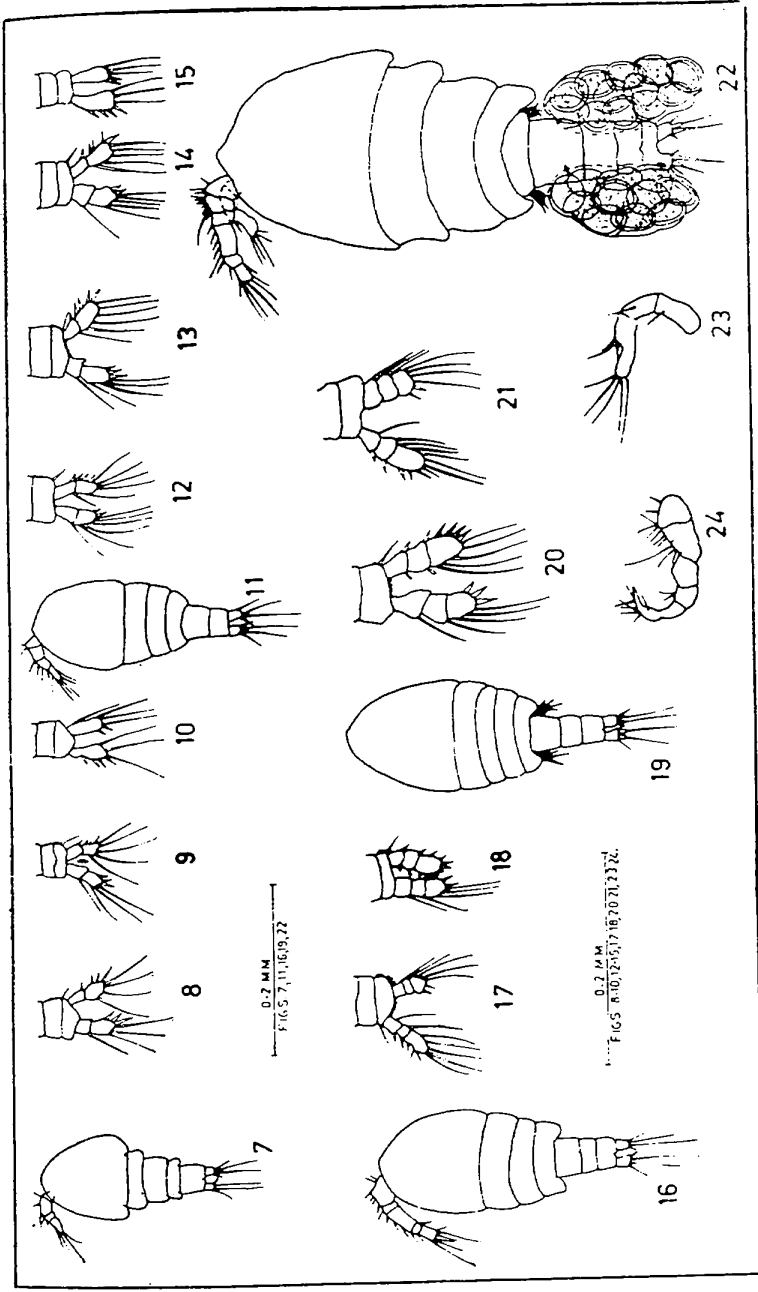
Length = 0.322 mm. Body with 7 segments, 4 prosomal and 3 urosomal. Antennule is 5-segmented. Antennae and other mouthparts as in the previous stage.

Four paired legs are present. The rami of first three pairs of legs are 3-jointed and of the fourth leg 2-jointed. The distal joint of the exopod of first leg (Fig. 17) is similar to the exopod of first leg of the previous stage, however, the endopod has 1 seta less. The distal joint of exopod of second and third legs (Fig. 18) is similar to the distal joint of the second leg of Copepodid II.

*Stage IV (Fig. 19)*

Length = 0.408 mm. There are 5 prosomal and 3 urosomal segments. Antennule, antennae and mouthparts are as in the previous stage.

There are four pairs of 3-jointed legs. The first leg is similar to the first leg of the previous stage, except that the exopod has an additional spine and in the distal



Figs 7 to 24. Copepodid stages

Fig. 7 Copepodid I, Figs. 8 to 10 First to third legs of copepodid I, Fig. 11 Copepodid II, Figs. 12 to 15 First to fourth legs of copepodid II, Fig. 16 Copepodid III, Figs. 17 & 18 First and second legs of copepodid III Fig. 19 Copepodid IV, Figs. 20 & 21 Second and fourth legs of copepodid IV, Fig. 22 The adult female Fig. 23 The antenna of adult female, Fig. 24 The antennule of adult male.

joint of the endopod; the seta has been replaced by a spine (Fig. 20). The second and third leg (Fig. 21) are similar to the first leg except that the middle joint of the endopod of these legs bears 2 setae. The distal joint of exopod of fourth leg has 3 spines and 4 setae.

*Stage V*

Length = 0.494 mm. There are 9 body segments, 5 prosomal and 4 urosomal. The antennule is 6-segmented. Antennae and mouthparts as in adult.

Four pairs of legs are present. Fifth leg is rudimentary. The first leg is similar to the first leg of the previous stage except that endopod has 2 spines and 3 setae. In the second and third legs the endopod has 3 spines. The fourth leg is similar to the corresponding leg of the previous stage except that the middle segment bears two setae.

The distinctive characters of the copepodid stages and duration of each have been shown in Table II.

*The adults*

Sexes can be differentiated on the

basis of size, segmentation of the body and geniculation of the antennule. The females are larger in size than the males (Lengths: ♀ = 0.602 mm and ♂ = 0.580 mm). Additional urosomal segment is present in the latter. The antennule is geniculated in males and serves as a grasping organ during mating.

*The female (Fig. 22)*

Body consists of five prosomal and four urosomal segments. Flap-like lateral projection is present on the first urosomal segment. The egg-sacs are small containing 12-15 brownish eggs. The fifth paired leg is rudimentary.

The antennule is 6-segmented. The antennae are 3-segmented, the distal segment is notched bearing setae (Fig. 23). The maxillule and maxilliped are as in copepodid I except for their size and number of bristles and setae.

Five paired legs are present. The first four pairs of legs are similar to the four paired legs of the previous stage except for the size and the development of the spines and setae. The fifth pair is rudimentary as in other cyclopoid copepods

*Table II.* Distinctive characters of the copepodid stages of *C. longifera* (Sewell) and duration of each.

Copepodid stages	Average length in mm	Approximate duration in hours	Number of prosomal segments	Number of urosomal segments	Number of antennule segments	Number of paired swimming legs
I	0.236	24-30	3	2	4	2
II	0.280	24	4	2	4	3
III	0.322	12-15	4	3	5	4
IV	0.408	12-18	5	3	5	4
V	0.494	18-24	5	4	6	4
VI (Adults)	0.602 (♀)	--	5	4	6	5
	0.580 (♂)	--	5	5	6	6

## Developmental stages of *Cyclopina longifera*

### The males

Body consists of ten segments with equal number of prosomal and urosomal segments. The antennule is geniculated (Fig. 24). They moult about 24 hours earlier than the females. Vestige of 6th paired leg is present.

### General observations and discussion

*Cyclopina longifera* was first recorded by Sewell (1924) from Chilka Lake. It occurs in Cochin Backwater throughout the year with the highest breeding intensity during postmonsoon. As both these environments are subjected to wide fluctuations in salinity, experiments were performed in the laboratory with different dilutions of seawater. It was observed that the adult specimens could tolerate directly seawater (32.5‰). The survival rate was quite high (65%) in the salinity up to 10‰. At salinity of 5‰ it was found to be 38‰. The salinity of 2‰ or below was lethal, however, if the adults are gradually acclimatised, they thrive well in the fresh water, but no nauplii survive. No naupliar development was observed in freshwater, since even the fertilized eggs did not hatch. The optimum salinity for this species was found to be between 15‰ to 20‰.

Experiments were also performed using

temperature as a variable factor. The survival rate of adults after 24 hours of observations indicated that upto 38°C there was 100 % survival and at 40°C only 60%. Temperature of 42°C and above was lethal.

There are six naupliar stages in the lifehistory of *C. longifera*. Manfredi (1923), Candeias (1964), Auvary and Dussart (1967) working on cyclopoid copepods found only five naupliar stages, whereas El-Maghraby (1965), Elgmork and Langeland (1970) and Goswami (1972) have reported six naupliar stages.

The development of this species resembles in all the essential features with those of other cyclopoid copepods. The interesting features being the 2-lobed endopod and large labrum in nauplii. The presence of six naupliar stages in the lifehistory of *C. longifera* establishes a closer affinity to the family Oithonidae, the marine groups of cyclopoid copepods.

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### REFERENCES

- AUVARY, C. and B. DUSSART, 1967. Role de quelques facteurs du milieu sur le development post-embryonnaire des cyclopoïdes (Crustacés copepodes). *Bulletin Zoological Society, France*, 92: 11-22.
- CANDEIAS, A., 1964. Contribution to the knowledge of the development of *Halicyclops neglectus*. Kiefer. *Revista de biologia, Lisboa*, 4 (1-2): 171-188.
- ELGMORK, K. and A. J. LANGELAND, 1970. The number of naupliar stages in Cyclopoida (copepoda). *Crustaceana*, 18: 277-282.

- EL-MAGHRABY, A. M., 1965. The seasonal variations in the length of some marine planktonic copepods from the Eastern Mediterranean at Alexandria. *Crustaceana*, **8**: 37-47.
- GIBBONS, S. G. and H. S. OGILVIE, 1933. The development stages of *Oithona helgolandica* and *Oithona spinostris*, with a note on the occurrence of body spines in cyclopoid nauplii. *Journal of the Marine Biological Association of U. K.*, **18**: 529-550.
- GOSWAMI, S. C., 1972. Lifehistory of *Cyclops buxtoni* Gurney (copepoda). *Indian Journal of Marine Sciences*. **1**: 128-132.
- \_\_\_\_\_ 1971. Metamorphosis of two species of genus *Oithona*. Baird (Copepoda). *Indian Journal of Marine Sciences*, **4**: 60-67.
- HAQ, S. M., 1965. The larval development of *Oithonina nana*. *Journal Zoological, London*, **146**: 555-566.
- MANFREDI, P., 1923. Etude sur le developement larvaire de quelques especes du genera *Cyclops*. *Annales de biologie Lacustre, Bruxelles*, **12**: 272-303.
- MURPHY, H., 1923. The life cycle of *Oithona nana* reared experimentally. *University of California Publication in Zoology*, **22**: 449-454.
- RAO, V. R., 1958 The development of a cyclopoid copepod. *Oithona rigida* (Giesbrecht). *Andhra University, Memoir*, **2** (62): 128-131.
- SBWELL, R. B. S., 1924. Fauna of the Chilka lake. Crustacea. copepoda. *Memoir Indian Museum*, **5**: 771-851.
- WALTER, E., 1922. Ueber die Lebensdauer der freilebenden süsswasser - Cyclopoiden und andere Fragen ihrer Biologie. *Zoologischer Jahresbericht Systematica*, **44**: 375-420.