

**STUDIES ON THE LARVAL STAGES OF EUPHAUSIACEA  
FROM THE INDIAN SEAS**

**2. DESCRIPTION OF POST-NAUPLIAR STAGES OF  
*STYLOCHEIRON CARINATUM* G. O. SARS**

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**ABSTRACT**

The complete post-naupliar developmental stages of *Stylocheiron carinatum* G. O. Sars identified from the zooplankton samples collected during cruises of R.V. *VARUNA* from the continental shelf waters of the south-west coast of India have been described. There are three calyptopis and six furcilia stages. The larvae at the stage of five terminal spines have been found to jump to a stage with one spine alone, thus skipping a stage with three terminal spines, which is a typical stage in the development of other euphausiids. A comparative study has been made with the larvae described by two other workers from the Pacific and the Atlantic oceans.

**INTRODUCTION**

*Stylocheiron carinatum* G. O. Sars is one of the most abundant euphausiids in the epipelagic zone of the tropical Indian Ocean. A detailed study of the developmental stages of this species has not been made so far, although brief descriptions for a few stages are given by Hansen (1912) (furcilia III and V); Lebour (1949) (egg and nauplius); Lewis (1955) (calyptopis I, II and III and furcilia I and II). Ponomareva (1969) has made some observations of living material on board R.V. *VITYAZ*. She has observed the hatching of the eggs and the development of nauplius through metanauplius and calyptopes. But detailed descriptions of the larval stages have not been given by her.

The present paper gives a detailed account of all the post-naupliar stages upto juveniles, embodying the salient characters of all the important metamorphosing organs in each stage. The paper also presents a comparative account of the larval stages of this species described by other authors from the Pacific and the Atlantic oceans. The source and the quantity of the material used for this study are given elsewhere (Mathew, 1971).

I am greatly indebted to Dr. E. G. Silas for guidance, helpful suggestions and critically going through the manuscript, and my sincere thanks are due to him.

**DESCRIPTION OF LARVAL STAGES**

***Stylocheiron carinatum* G. O. Sars (1883) (Figs. 1-3)**

***Calyptopis-I* (Fig. 1: a-f)**

**Material :** 3 larvae ; Total length (TL) : 1.73-1.74 mm ; Mean (M) : 1.74 mm.

Carapace smooth on its margins and covers cephalothorax and part of abdomen ; developing immobile, stalkless eyes seen beneath carapace as two pig-

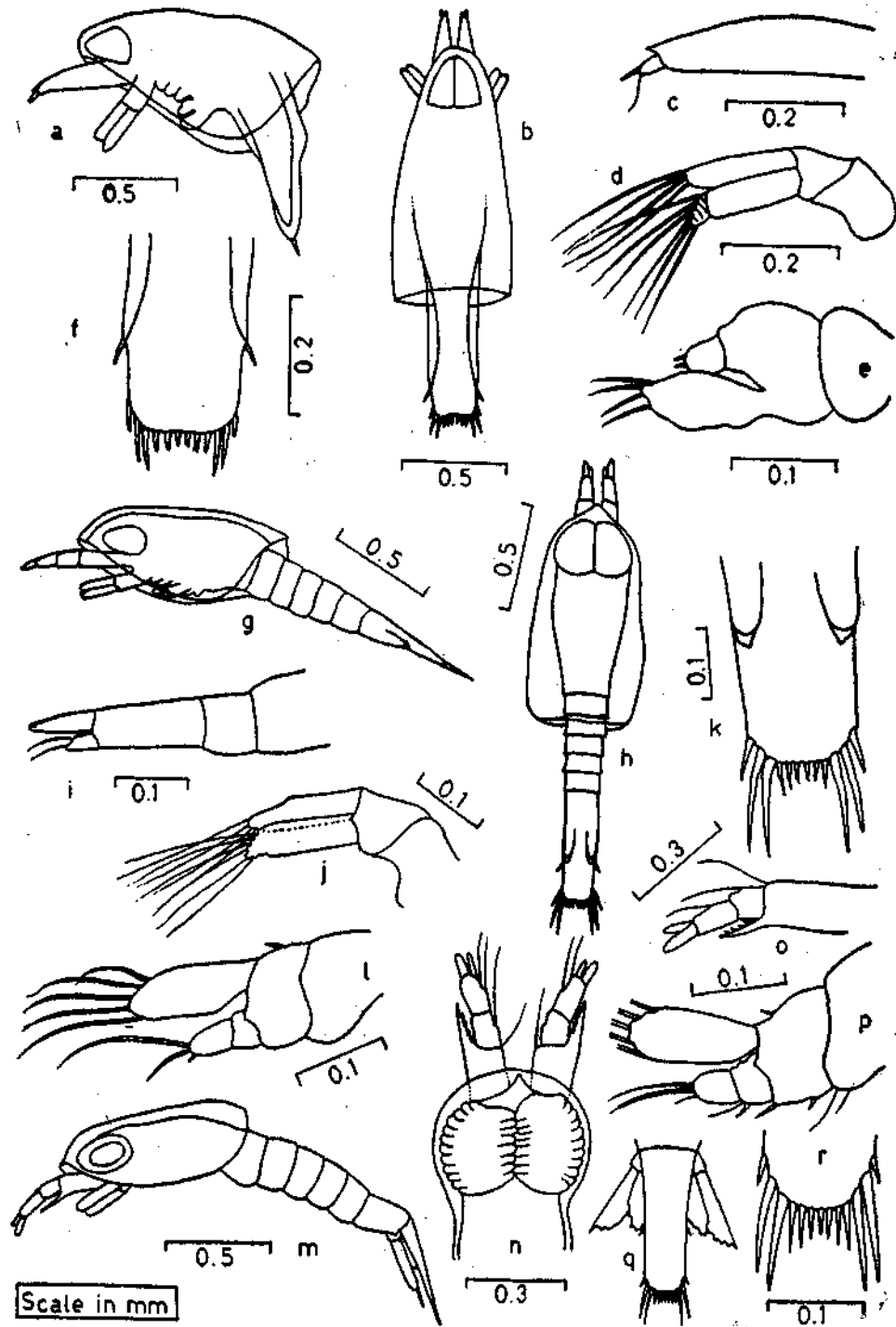


Fig. 1. a-f, cal. I. a: lateral view; b: dorsal view; c: antennule; d: antenna; e: Th-I; f: telson. g-l: cal. II. g: lateral view; h: dorsal view; i: antennule; j: antenna; k: telson; l: Th-I. m-r, cal. III. m: lateral view; n: dorsal view of cephalic region; o: antennule; p: Th-I; q: telson with uropods; r: terminal part of telson.

mented patches apposed together; antennule unsegmented; outer antennular flagellum developed as small bud with two terminal setae; inner flagellum represented as a small spine; antenna biramous, ramii being unmodified and serve as locomotor organs; abdomen not segmented; cephalothorax slightly longer than abdomen; telson part armed with a pair of lateral spines, 3 pairs of posterolateral spines of varying lengths and 6 terminal spines; uropods not developed; first pair of thoracic legs (Th-I) developed and differentiated into exopod and unsegmented endopod.

*Calyptopis-II* (Fig. 1 : g-l)

*Material* : 10 larvae; TL : 1.90-1.94 mm; M : 1.92 mm.

Carapace smooth on its margins and covers cephalothorax alone; no change to eyes except increase in size; antennule three-segmented, no spine or projections present on it; antennular flagella developed as buds, inner one being shorter than outer; no change to antenna; abdomen five-segmented; its length more than cephalothorax; uropods begin to develop and seen as two thickened patches posteriorly below cuticle; no change to armature of telson except for increase in length of spines; endopod of Th-I two-segmented.

*Calyptopis-III* (Fig. 1 : m-r)

*Material* : 23 larvae; TL : 2.08-2.15 mm; M : 2.12 mm.

Carapace still covers eyes completely; marked increase in pigmentation of eyes, ommatidia distinct; signs of development of rostral hood indicated below anterior portion of carapace; a long spine directed outwards developed at distal end of basal segment of antennule and it extends beyond middle of distal segment; antenna unchanged; abdomen six-segmented; outermost pair of posterolateral spines on telson shorter than in previous stage; an additional median spine developed on tip of telson, thus making a total of 7 terminal spines; uropods well distinguished; telson 3.30 times its width at point of insertion of lateral pair of spines; Th-I unaltered in shape and structure but with more setae on its inner margin.

*Furcilia-I* (Fig. 2 : a-f)

*Material* : 50 larvae; TL : 2.38-2.47 mm; M : 2.43 mm.

Eyes stalked, mobile and project out of carapace; anterior portion of carapace modified to form a narrow rostral hood and tip of rostral spine extends beyond margins of eyes; antennule more stout with flagella slightly lengthened; spine on distal end of basal segment of antennule reaches only half length of distal segment; antenna unchanged; pleopods not yet developed on first abdominal segment but a slight bulging seen in respective place; length of telson 4.15 times its width at point of insertion of lateral pair of spines; outermost pair of posterolateral spine on telson further reduced in length; terminal telson spines 7 in number; no change to Th-I except in development of more number of setae.

*Furcilia-II* (Fig. 2 : g-k)

*Material* : 72 larvae; TL : 2.54-2.69 mm; M : 2.63 mm.

Rostral hood elongate and narrow; indications of division of eye into an upper and a lower segment; a dorsal keel-like projection developed on median posterior

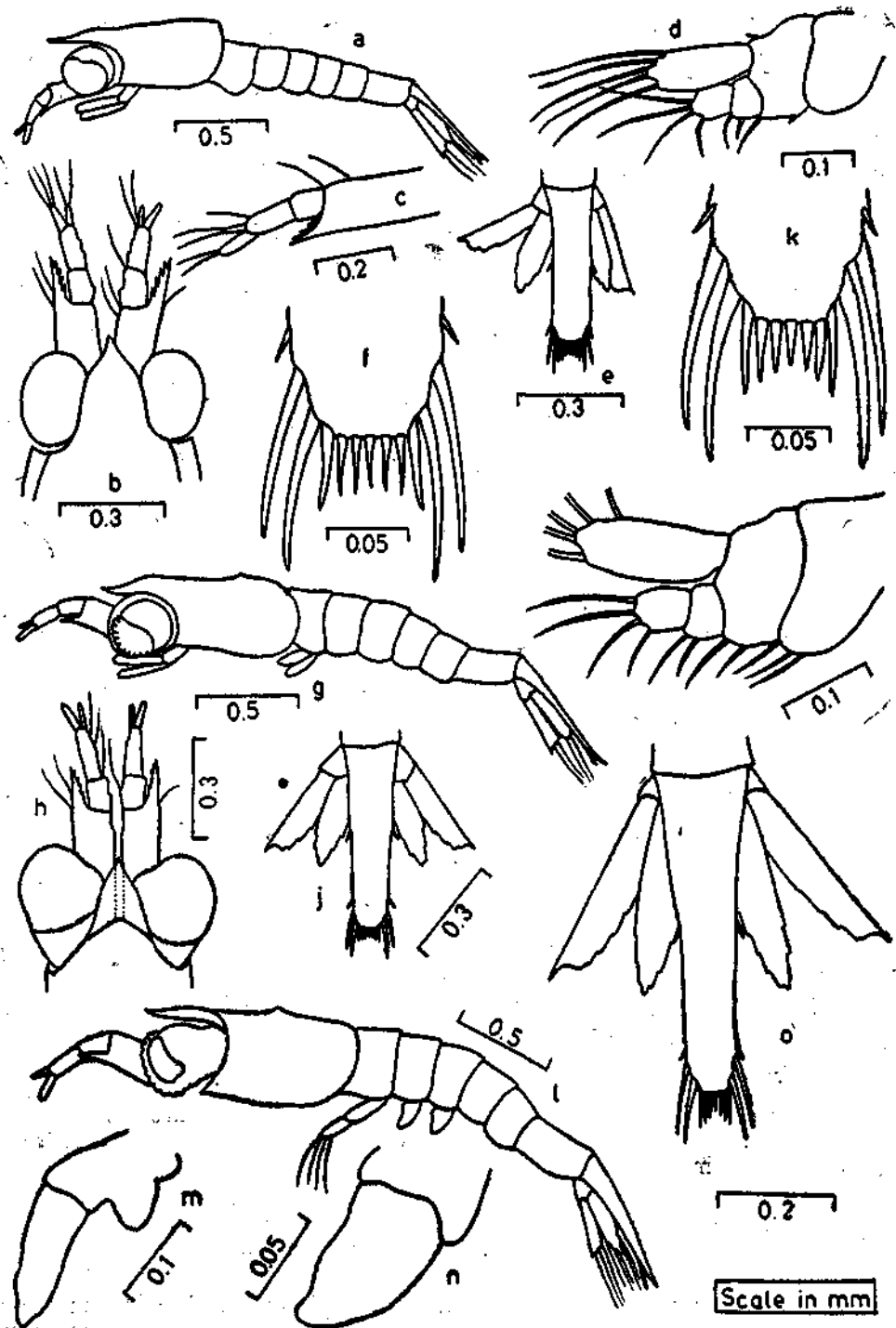


Fig. 2. a-f, fur. I. a: lateral view; b: dorsal view of cephalic region; c: antennule; d: Th-I; e: telson with uropods; f: terminal part of telson. g-k, fur. II. g: lateral view; h: dorsal view of cephalic region; i: Th-I; j: telson with uropods; k: terminal part of telson. l-o, fur. III. l: lateral view; m: Th-II; n: Th-III; o: telson with uropods.

half of carapace; antennule and antenna unchanged; spine on basal segment of antennule reach less than half length of its distal segment; a pair of simple non-setose pleopods developed on first abdominal segment; outermost pair of posterolateral spines further reduced in length; length of telson 4.50 times its width at point of insertion of lateral pair of spines; Th-I unchanged; Th-II developed as bud.

*Furcilla-III* (Fig. 2 : l-o)

*Material* : 77 larvae; TL : 2.82-3.07 mm; M : 2.92 mm.

Rostrum further narrowed and its tip ends in an acute point; dorsomedian keel on carapace more pronounced and moved further anteriorly; few crystal cones of eye aggregated at top to form upper portion; spine on basal segment of antennule extends slightly beyond distal margin of middle segment; no change to antenna; pleopods on first abdominal segment setose; simple non-setose pleopods developed on second and third abdominal segments; telson narrowed considerably, its length being 5.47 times its width at point of insertion of lateral pair of spines; terminal part of telson between inner posterolateral spines and terminal spines produced; no change to armature of telson; Th-I unchanged; endopod portion of Th-II lengthened but not segmented, exopod developed as bud; Th-III developed as bud.

*Furcilla-IV* (Fig. 3 : a-f)

*Material* : 86 larvae; TL : 3.0-3.24 mm; M : 3.15 mm.

Eye constricted into a small upper and a large lower portion; keel on dorsal side of carapace more pronounced and occupies an almost mid-position; basal spine on first antennular segment falls short of distal end of median segment; no change to antenna; first 3 pairs of abdominal pleopods setose; fourth and fifth pair of pleopods developed as buds; telson further narrowed and elongated, its length being 5.76 times its width at point of insertion of lateral pair of spines; terminal part of telson between inner posterolateral spines and terminal spines further produced; no change to armature of telson; outermost pair of posterolateral spines very feeble; Th-I unchanged; endopod of Th-II five-segmented; Th-III differentiated into exopod and unsegmented endopod; Th-IV developed as bud.

*Furcilla-V* (Fig. 3 : g-n)

*Material* : 33 larvae; TL : 3.28-3.41 mm; M : 3.36 mm.

Spine on basal segment of antennule extends slightly half of middle segment; all five pairs of pleopods setose; telson with 5 terminal spines only, its length being 6.53 times its width at point of insertion of lateral pair of spines, its terminal part between inner posterolateral spines and terminal spines considerably produced; inner posterolateral spines on telson altered in size and structure, being basally broad and tapering towards tips; Th-I unchanged; endopod of Th-III five-segmented and highly modified to form a false chelate leg in adult and it bears 4 long spines on ultimate and 2 long and one short spines on penultimate segments; endopod of Th-IV elongated and shows signs of segmentation; Th-V developed as bud.

*Furcilla-VI* (Fig. 3 : o-v)

*Material* : 78 larvae; TL : 3.50-3.71 mm; M : 3.63 mm.

Rostrum long and pointed as in adults; dorsal keel on carapace more distinct, and moved further forwards; endopod of antenna much lengthened and shows

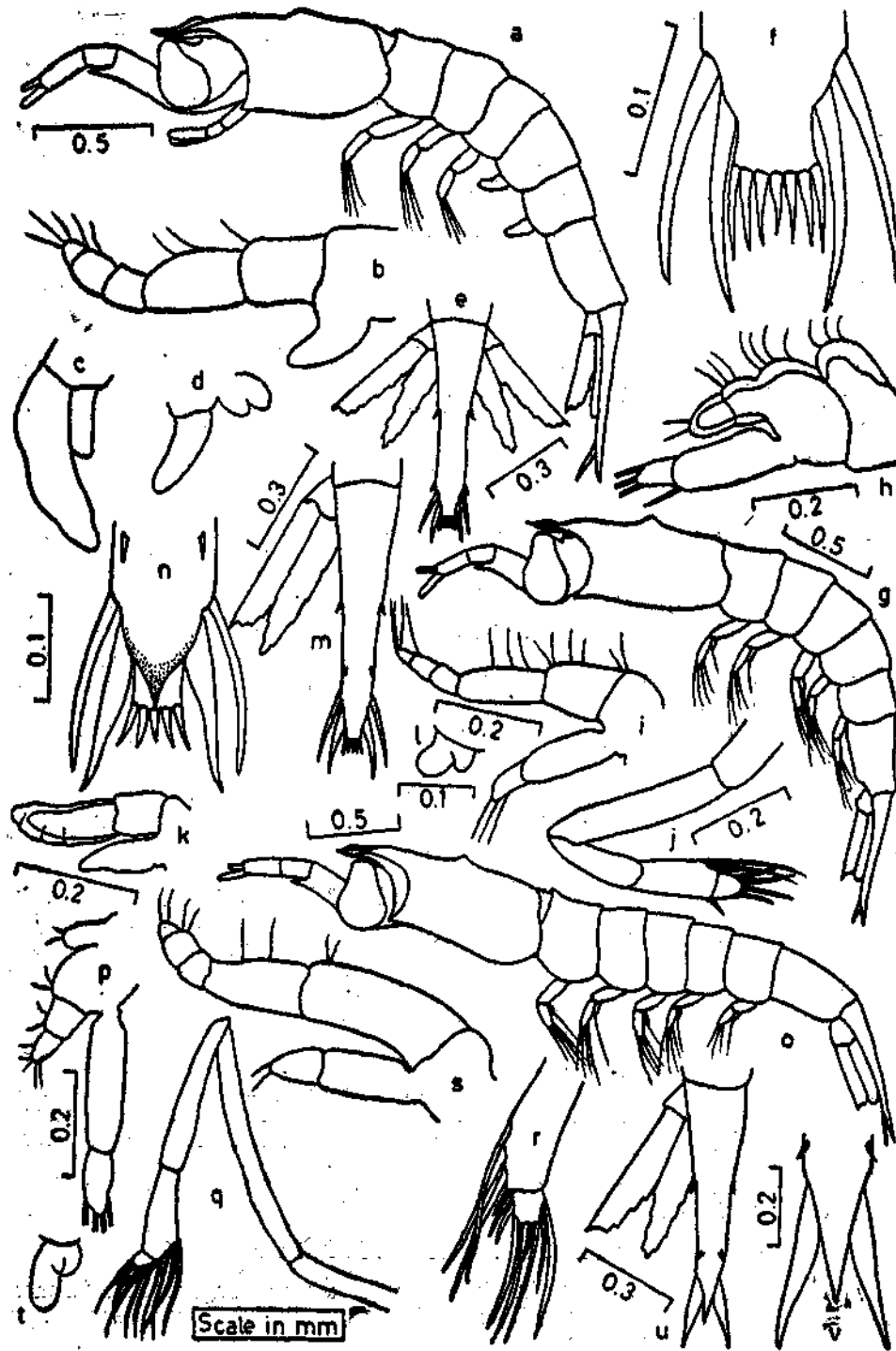


Fig. 3. a-f, fur. IV. a: lateral view; b: Th-II; c: Th-III; d: Th-IV; e: telson with uropods; f: terminal part of telson. g-n, fur. V. g: lateral view; h: Th-I; i: Th-II; j: Th-III; k: Th-IV; l: Th-V; m: telson with uropods; n: terminal part of telson. o-v, fur. VI. o: lateral view; p: Th-I; q: Th-III; r: terminal part of Th-III; s: Th-IV; t: Th-V; u: telson with uropod; v: terminal part of telson.

TABLE 1. *Sequence of development of pleopods and thoracic legs and reduction of terminal telson spines in furcilia larvae of S. carinatum G.O. Sars*

Characters	Fur-I	Fur-II	Fur-III	Fur-IV	Fur-V	Fur-VI
Pleopods	N=0 : S=0	N=1 : S=0	N=2 : S=1	N=2 : S=3	N=0 : S=5	N=0 : S=5
No. of terminal telson spines	7	7	7	7	5	1
Thoracic legs						
{ a:	—	2	3	4	5	—
{ b:	—	—	2	3	4	5
{ c:	1	1	1	1, 2	1, 2, 3	1, 2, 3, 4

N=non-setose and S = setose pleopods ; a, b, c : development of thoracic legs (a) as bud ; (b) differentiated into exopod and unsegmented endopod ; and (c) endopod segmented ; Fur-I to Fur-VI : furcilia stages I-VI.

TABLE 2. Comparative lengths (in mm) of post-naupliar larvae of *S. carinatum* G.O. Sars captured from three different geographical areas

Source of information	Region	Stages								
		Calyptopsis			Furcilia					
		I	II	III	I	II	III	IV	V	VI
Hansen (1912)*	Eastern tropical Pacific						2.80		3.00	
Lewis (1955)*	Northwestern temperate Atlantic	1.75	1.96	2.59	2.65	2.70				
Present investigations †	Western tropical Indian Ocean	1.74	1.92	2.12	2.43	2.63	2.92	3.15	3.36	3.63
		(1.73-1.74)	(1.90-1.94)	(2.08-2.15)	(2.38-2.47)	(2.54-2.69)	(2.82-3.07)	(3.00-3.24)	(3.28-3.41)	(3.50-3.71)

\* Total lengths of specimens measured are given.

† Mean of total lengths of specimens measured are given ; Length range given in paranthesis.



signs of segmentation; telson with one terminal spine; length of telson 7.25 times its width at point of insertion of lateral pair of spines; middle pair of posterolateral spines of telson lost; outermost pair of spines rudimentary, innermost pair as in previous stage; Th-I transformed into adult condition; Th-II as in furcilia V; Th-III further modified into a long prehensile organ, its terminal segment bearing 9 spines out of which 4 are extremely long; penultimate segment bears 4 spines on inner side, one being very short; endopod of Th-IV five-segmented; Th-V still as bud with exopod and endopod differentiated.

From this stage the larvae pass on to the juvenile stage (size range; 3.81-4.17 mm) where they grow more in size. The sexes are not distinguishable in the juvenile stage.

#### DISCUSSION

The developmental pathway of *S. carinatum* is rather rigid and hence the variant forms are almost absent. However, during the present investigations in a total of 419 furcilia larvae identified, one specimen with 3 non-setose pleopods, 13 specimens with 3 terminal spines on telson and 9 other specimens with 4 setose and one non-setose pleopods were present as variant forms.

One important feature found during the present studies is that the furcilia larvae skip one stage with 3 terminal telson spines and hence the sequence of reduction of terminal spines on telson is  $7 \rightarrow 5 \rightarrow 1$ . Similar abbreviation in the life history stages has been reported in other species of euphausiids also Lebour (1926) and Gurney (1947) in *Nematoscellus microps*; John (1936) in *Euphausia valleroni*; Boden (1955) in *Nematoscellus megalops*, and Baker (1959) in *Euphausia triacantha*.

Hansen (1912) described 2 furcilia stages of *S. carinatum* in the name of 'intermediate' furcilia and 'last' furcilia. Since he had only two stages, he could not probably determine to which particular stage his larvae belonged. The present study shows that the larvae described by Hansen are of the third and fifth furcilia stages respectively. Since Hansen has pointed out that he had examined only a poorly preserved specimen of his 'intermediate' furcilia, special attention was given to examine the larvae of the corresponding stage in the present collections. The only major discrepancy noted is with regard to the length-width proportion of the telson. In the present material the length of telson in this stage is found to be 5.47 times its width at the point of insertion of the lateral pair of spines. While Hansen found it to be only 4.5 times as long as wide, though the point at which the measurement of the width of telson was taken is not mentioned.

It would be of interest if a comparative study is made of the size of larvae taken from different geographical areas. The total length of the larvae described by Lewis (1955) from the Florida Current are more than that for the corresponding stages taken from the tropical waters of the northwestern Indian Ocean (Table 2). At the same time the two furcilia stages taken from the tropical Pacific Ocean and described by Hansen (1912) are found to be smaller than the corresponding stages in the present material. It is likely that the observed differences in the lengths are due to the differences in the ecological conditions of the respective areas. Adult specimens also show similar differences. *S. carinatum* recorded from the colder waters range between 10 and 12 mm while the adults taken from the equatorial region during the present investigations measure 6.75 to 9.00 mm. In spite of this, there is hardly any variation in the different characters at each stage.

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