J. NARA, 31 (1984) 81-96

Fecundity, Morphometry Post Embryonic Growth and Development of *Caridina simoni* Bouvier (Decapoda: Atyidae)

By

J. S. WEERAKKODY* and H. H. COSTA*

ABSTRACT

The fecundity, morphometry and the post embryonic development of *Caridina simoni* Bouvier which is the commonest atyid shrimp in Sri Lanka were studied. The fecundity values ranged from 12 - 55. There was a linear relationship between the logarithmic values of fecundity and body length and the same relationship was obtained for body length and weight. It was seen that the developmental period of this species was less than six days and during development it passed through six zoeal stages.

Introduction

Caridina, simoni Bouvier is a wide spread species in South Asia and is the commonest and the most abundant shrimp in Sri Lanka (Arudpragasam and Costa 1961; Costa 1973). It is distributed widely in Sri Lanka and has been collected from estuaries, rivers, streams and man made reservoirs.

Although many investigations have been carried out to culture species of prawns such as *Macrobrachium* rosenberji (Ling, 1962) and crabs such as *Scylla serrata* under laboratory conditions, only a few studies have been carried out to study the larvae of atyid shrimps. Edmondson as far back as 1935 noted a close similarity between the "first Zoea" of *C. barchydactyla brachydactyla, C. weberi, Atya serrata* and *A. bisulcata.*

According to the available literature, complete descriptions of larval development have been described for atyids by Yokoya (1931) Glaester (1976), Shokita (1976, 1978) and Hunte (1979) although brief descriptions of some larval stages of various atyids have been made earlier by Gauthier (1942) Shen (1939) and Edmondson (1935).

The present work was carried out with a view to culturing this shrimp. The possibility of producing zoeal stages for feeding *Macrobrachium* larvae was also investigated.

Materials and Methods

Specimens of *Caridina simoni* were collected from a fresh water stream at Kelaniya, by using fine mesh entomological net. From these samples ovigerous females were isolated and reared in flat glass troughs at room temperature in well aerated water containing detritus and plankton.

The batches of ovigerous specimens were under close observation until hatching. Just after hatching, the larvae were isolated six hourly and were preserved in 70% ethyl alcohol, Drawings and descriptions of the larvae were made from observations using projection, dessection.

* Department of Zoology, University of Kelaniya, Kelaniya.

and compound microscopes. The final details were obtained by combined observations of larvae isolated from each batch at similar intervals. Hatching of eggs was closely observed during day time as well as at night.

Various zoeal stages were classified according to the characteristics and shape of the uropods and the telson of larvae.

The following two measurments were used to characterize the growth of larvae.

(1) Carapace length; the length from the dorsal posterior extremity of the carpace to the dorsal anterior extremity (orbital region) of the carpace.

(2) Maximal carpace width.

Measurements were made for six days until the post-zoel stage was reached. The larvae were measured at 12 hour intervals and the mean value of the measurements was taken.

Results

Fecundity

From a sample of 26 female *Caridina simoni*, it was observed that the minimum number of eggs was 12 and maximum was 55. The 95% confidence intervals for mean fecundity was calculated statistically and was found to be 21.85 - 31.68. The mean dimesnsions of an egg about to hatch were 1.26 mm. and 0.77 mm. in length and breadth respectively. The fecundity of each individual was plotted against body length and a parabolic curve was obtained (fig. 1a). From these data (plotted in Fig. 1a), the relationship between the fecundity (F) and the body length (L) was found to be described by the equation:

$$F = 6.1301\ L^{2.2262}$$

indicating that the fecundity increases with increasing body length. This relationship can also be expressed logarithmically as:

$$\log F = 0.7875 + 2.2262 \log L$$

The coefficient of correlation calculated for the above data was relatively low ($r = 0.75$) indicating a non significant relationship between F and L.

Fig. 1b shows that there is a linear, relationship between the log a values of fecundity and body length.

Fig. 1a

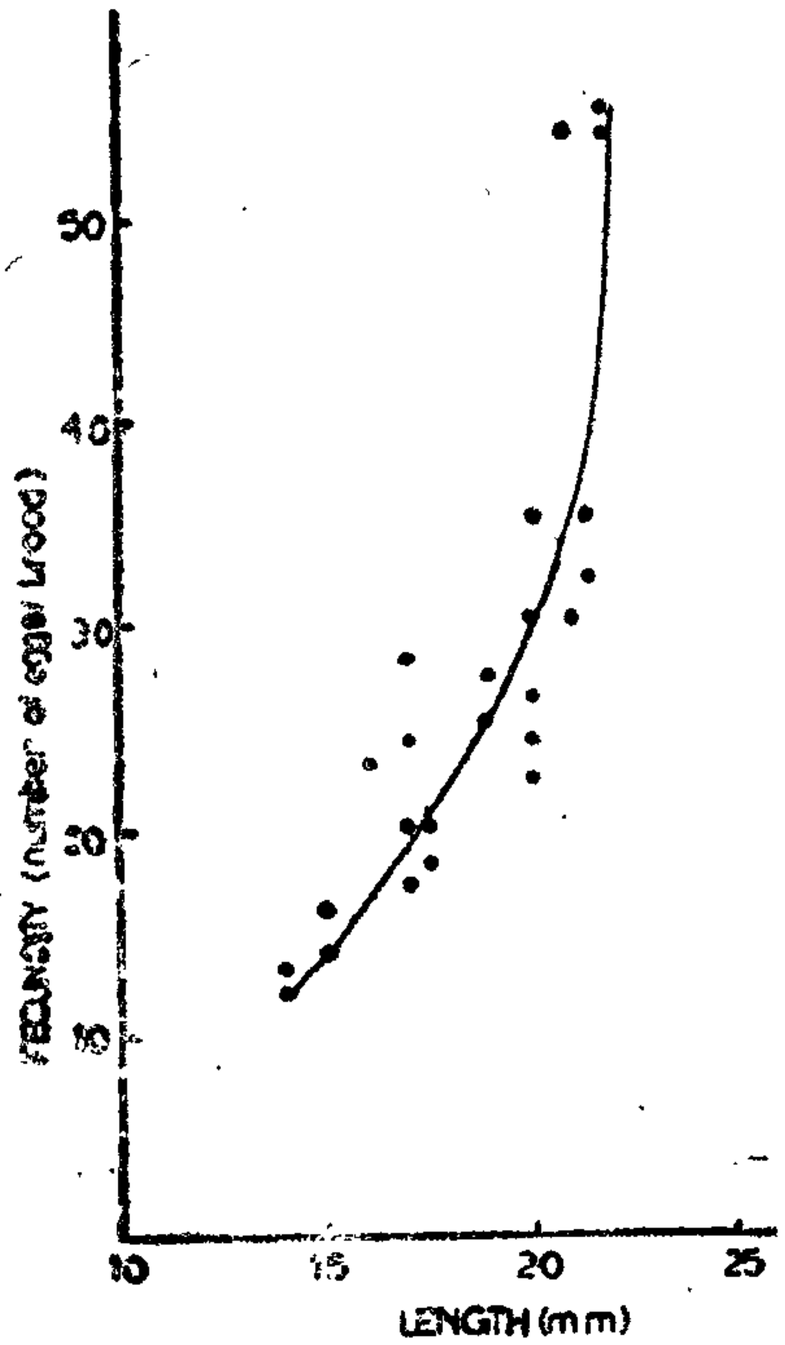

Fig. 1b

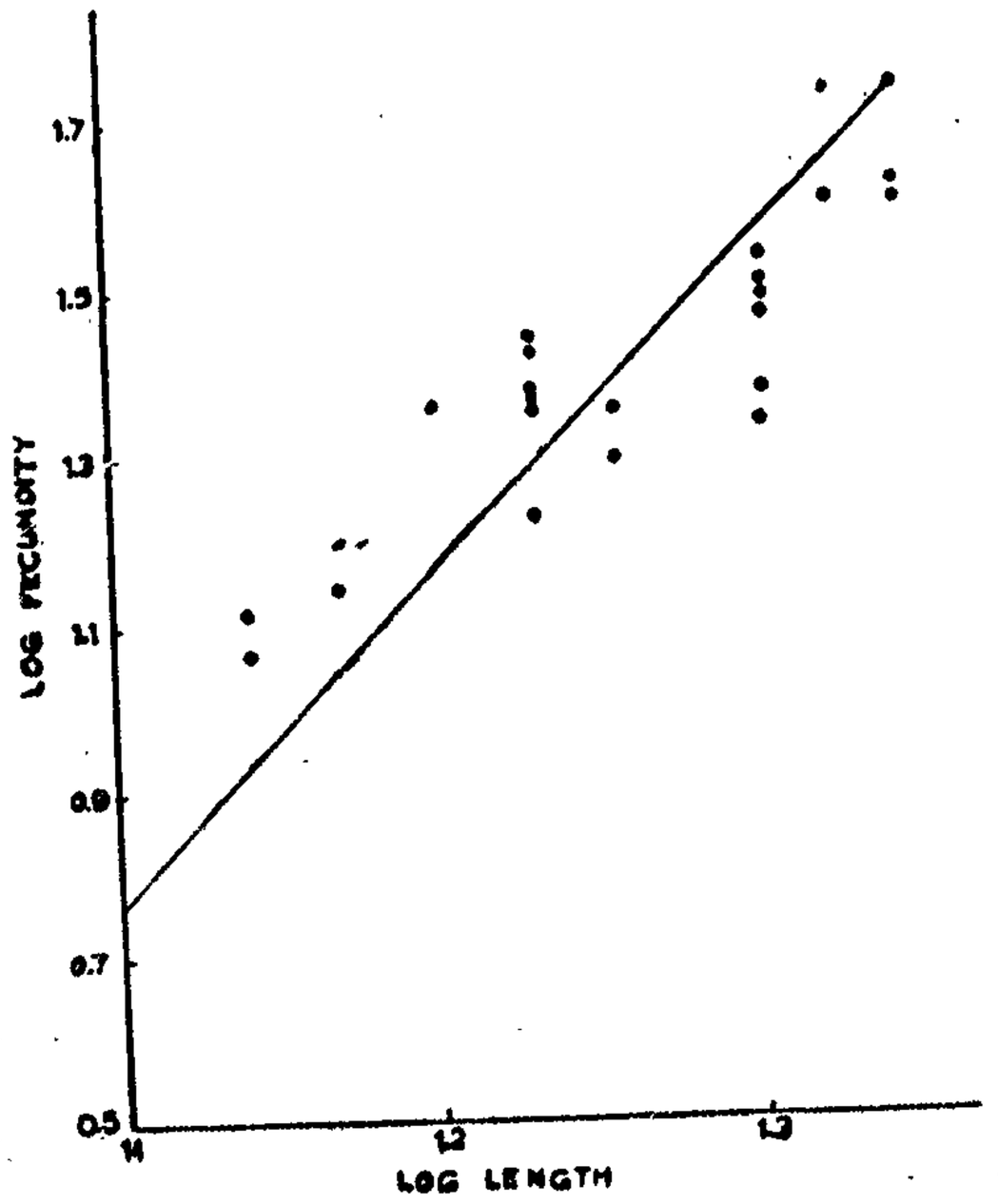

Fig. 2a

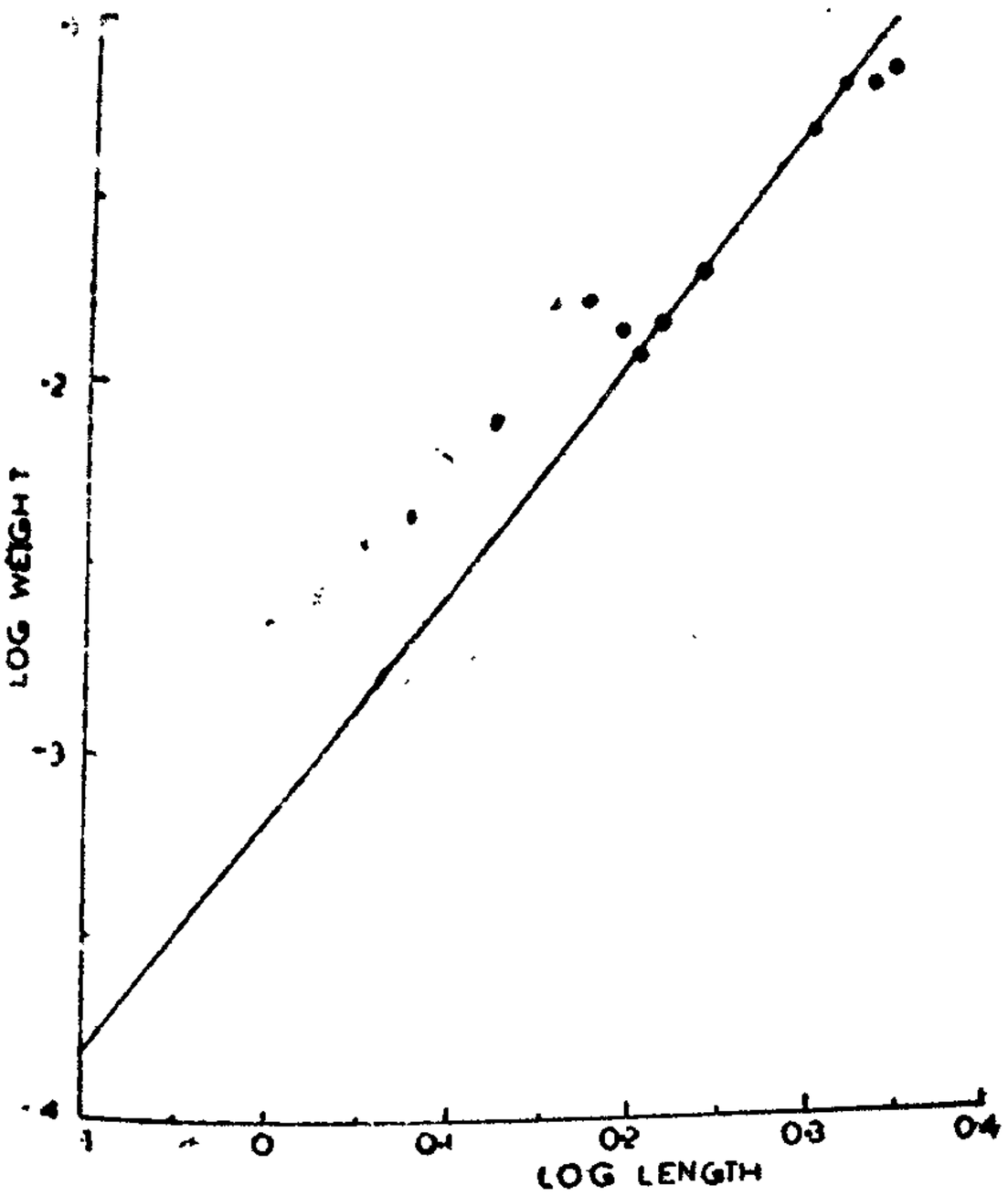

Fig. 2b

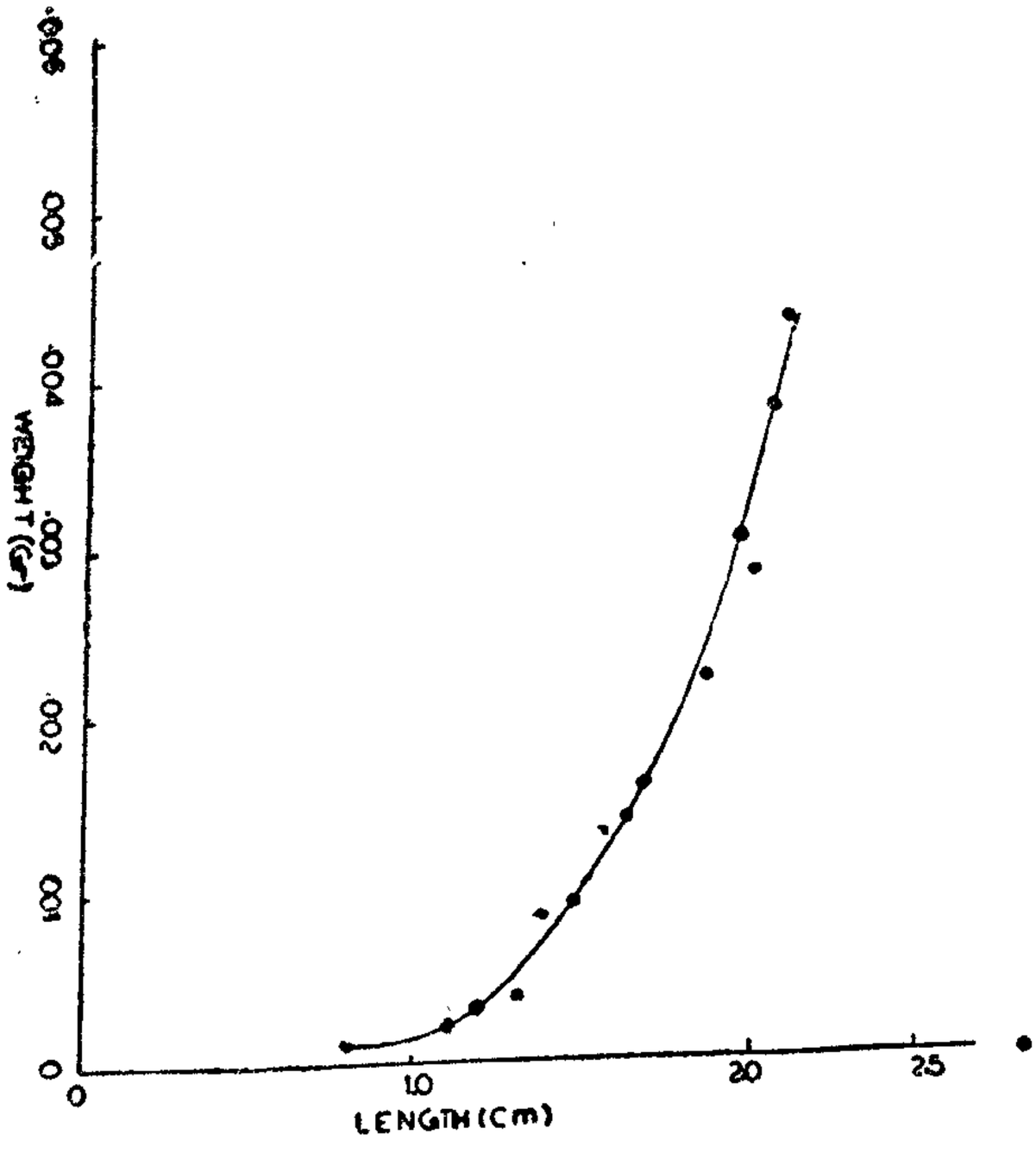

Fig. 1a.— Showing the relationship of Fecundity to lengnth in *C. Simoni*
Fig. 2*a*.— Relationship of weight to length in *C. Simoni*
Fig. 2b.— Relationship of log weight to log length in *C. Simoni*

Morphometry

A total of 118 specimens of *C. simoni* ranging in length from 0.4 cm. to 2.5 cm. was measured and weighed for studying the length-weight relationship of the species. When the length was plotted against (t value at 5% level for above data was 5.555) their weights, a parabola was obtained (Fig. 2a). This shows that the increase in weight of *C. simoni* is an exponential function of its length. The logarithmic length-weight graph shows a linear relationship. (Fig. 2b). The length weight relationships were calculated by using the formula $W = cL^n$, where the values of c and n were found to be 0.00015 and 4.3811 respectively. This can also be expressed logarithmically as :

$$\log W + 3.8239 = 4.3811 \log L$$

The coefficient of correlation calculated for the above data was very high ($r = 0.9051$), indicating the high significance of the relationship.

Larval Development

Meaurements for various zoea stages are given in Tables 1 & 2. The increase of carapace width and carapace length with time is given in Figures 3a and 3b.

C. simoni undergoes a short period of development of about six days, from the stage of hatching of eggs to the post-zoeal stage. During this period it passes through six stages including the post-zoeal stage before it reaches the juvenile stage.

Fig. 3a

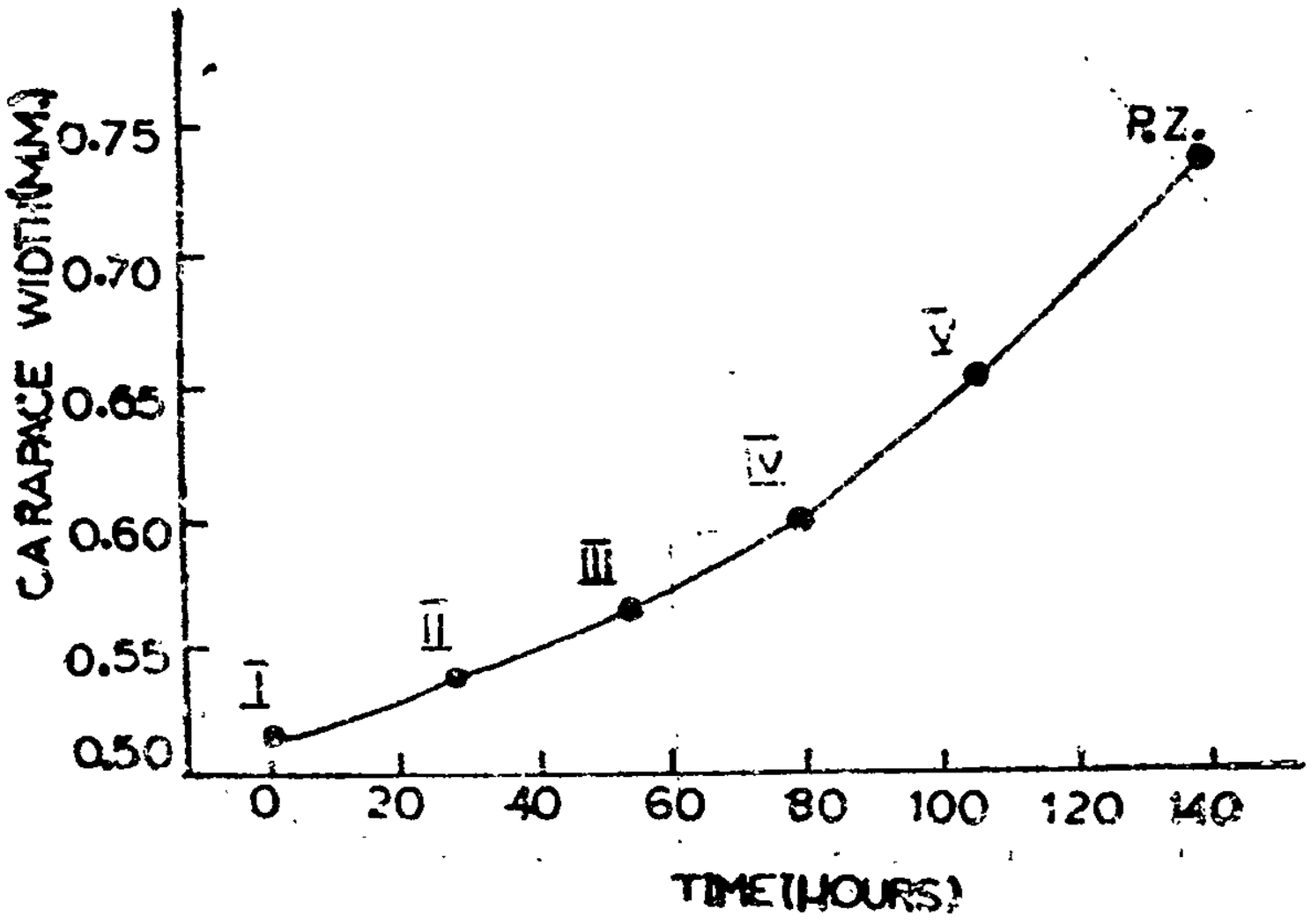

Fig. 3a.— Development of carapace width with time in *C. Simoni*

Fig. 3b.

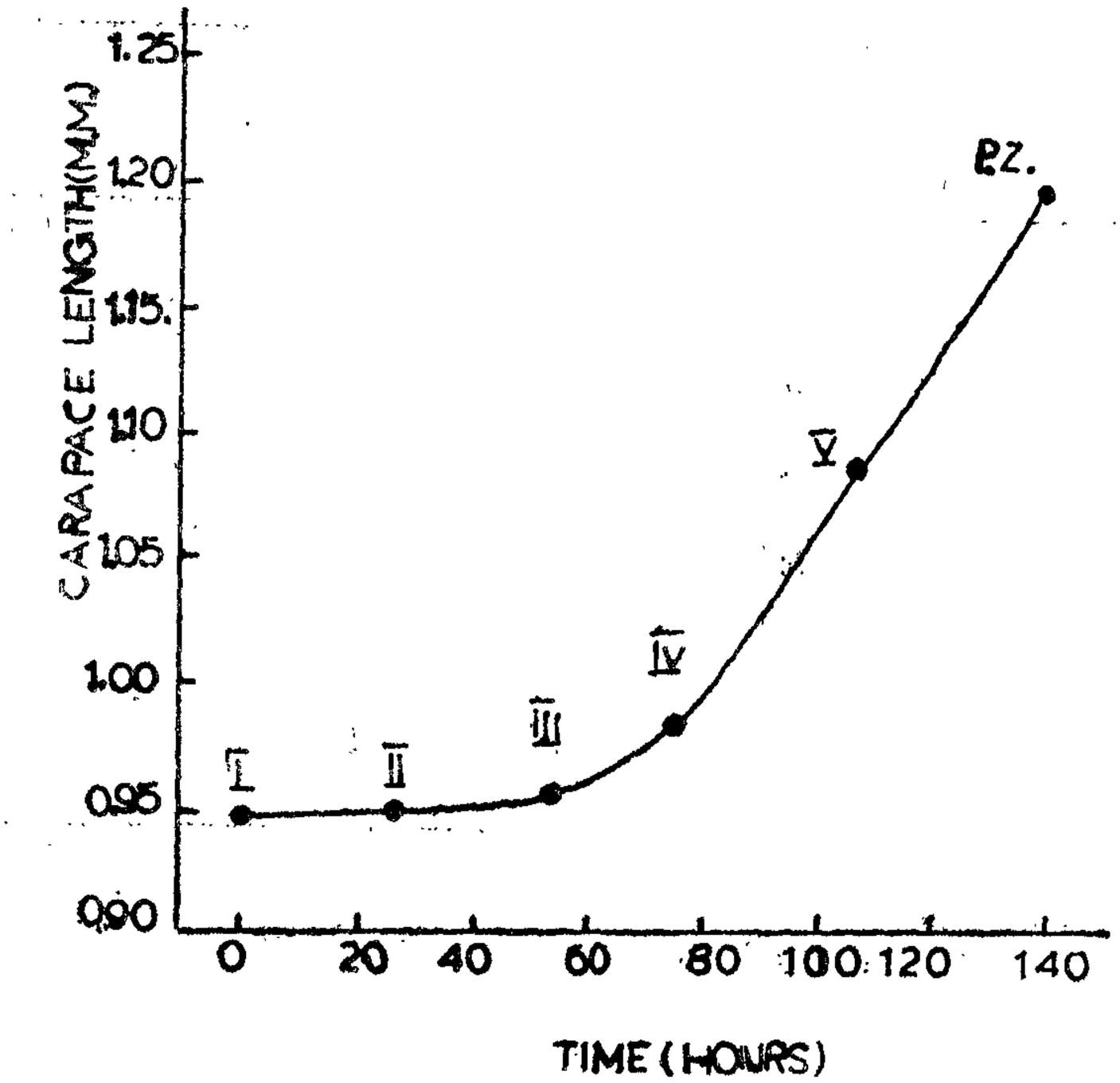

Fig. 3b.— Development of carapace length with time in *C. Simoni*

Fig. 4

Fig. 4.— *Caridina simoni* (Bouvier) eggs Mean length 1.26 mn. Mean width .77 mn.

TABLE 1

Stage	*Time hours*	*Mean Carapace length (mm)*	*Mean Carapace width (mm)*
Zoea I	0	0.945	0.51
Zoea II	27	0.947	0.535
Zoea III	54	0.951	0.556
Zoea IV	78	0.965	0.59
Zoea V	105	1.09	0.65
Post-Zoea	138	1.21	0.73

TABLE 2

SHOWING THE MEASUREMENTS FOR VARIOUS ZOEA STAGES

Stage	*hours*	*Mean time (hours)*	*Duration*	*Total length (mm)*	*Rostrum length (mm)*	*Telson length (mm)*	*Telson width (mm)*
Zoea I	0	0	24–30	2.465	0.105	0.315	0.462
Zoea II	24–30	27	18–36	3.570	0.210	0.357	0.504
Zoea III	48–60	54	12–36	3.780	0.273	0.420	0.567
Zoea IV	72–84	78	18–36	3.990	0.315	0.462	0.882
Zoea V	102–108	105	24–42	4.095	0.378	0.630	1.05
Post-Zoea	132–144	138	—	4.620	0.462	0.735	1.26

1st Stage - First Zoea (Figs. 5 and 11)

Duration : 24 - 30 hours. Mean total length: 2.46 mm.

The telson is triangualar in shape and is articulated with the 6th abdominal segment. The broad posterior end was bisegmented by means of a notch at the centre. The posterior end of telson contained 7 pairs of setae. The medial and the outer most pairs of setae were smaller in a size than the rest.

The rostrum was hardly visible. The compound eyes were sessile and were parallel to the upper surface of the carapace. First and Second antennae were prominent in front of the compound eyes. The first antenna had a segmented basal portion and it was biramous. The exopod was approximately of the same length as the endopod and had plumose setae. The second antennae to were biramous. The exoped was similar in length to the endopod and had plumose setae. The pleopods were observed as small buds.

Fig. 5

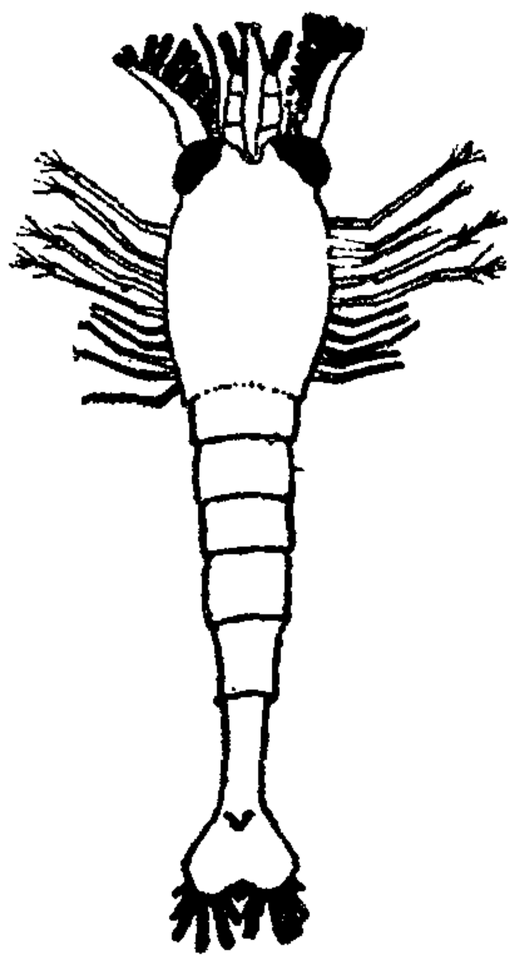

Fig. 11

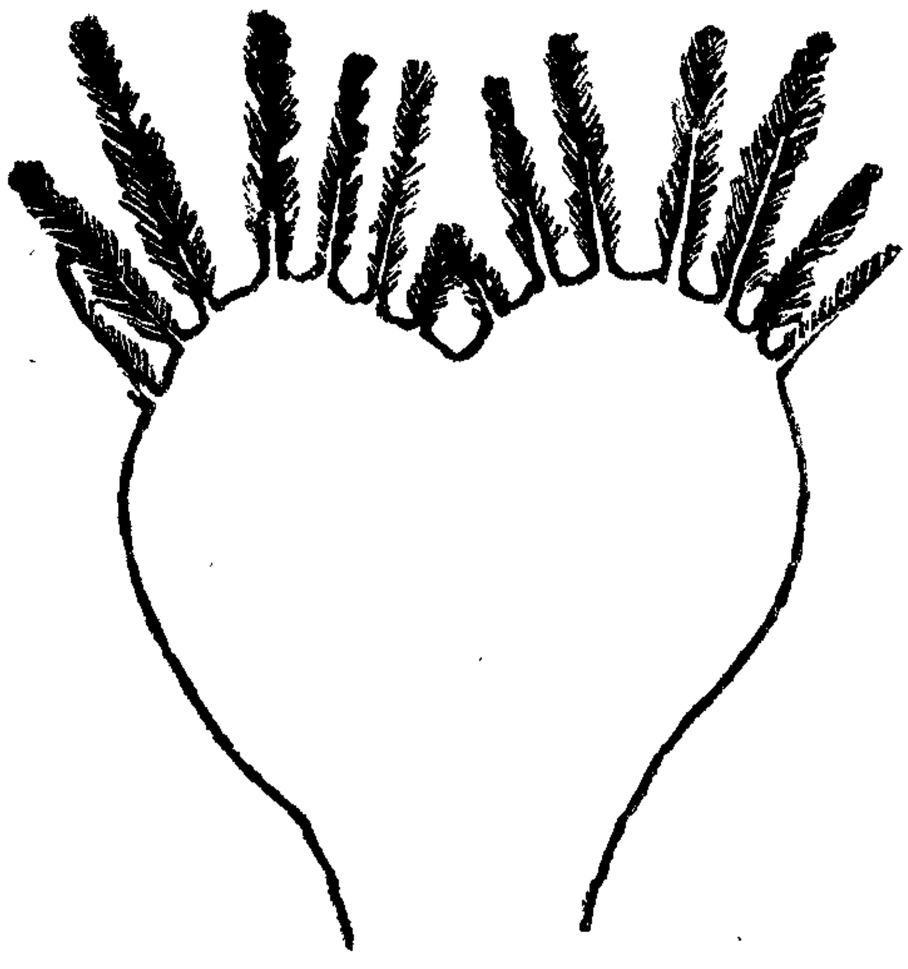

Fig. 5.— *Caridina simoni* (Bouvier) First zoea stage.

Fig. 11.— *Caridina simoni* (Bouvier) Telson: first zoea stage.

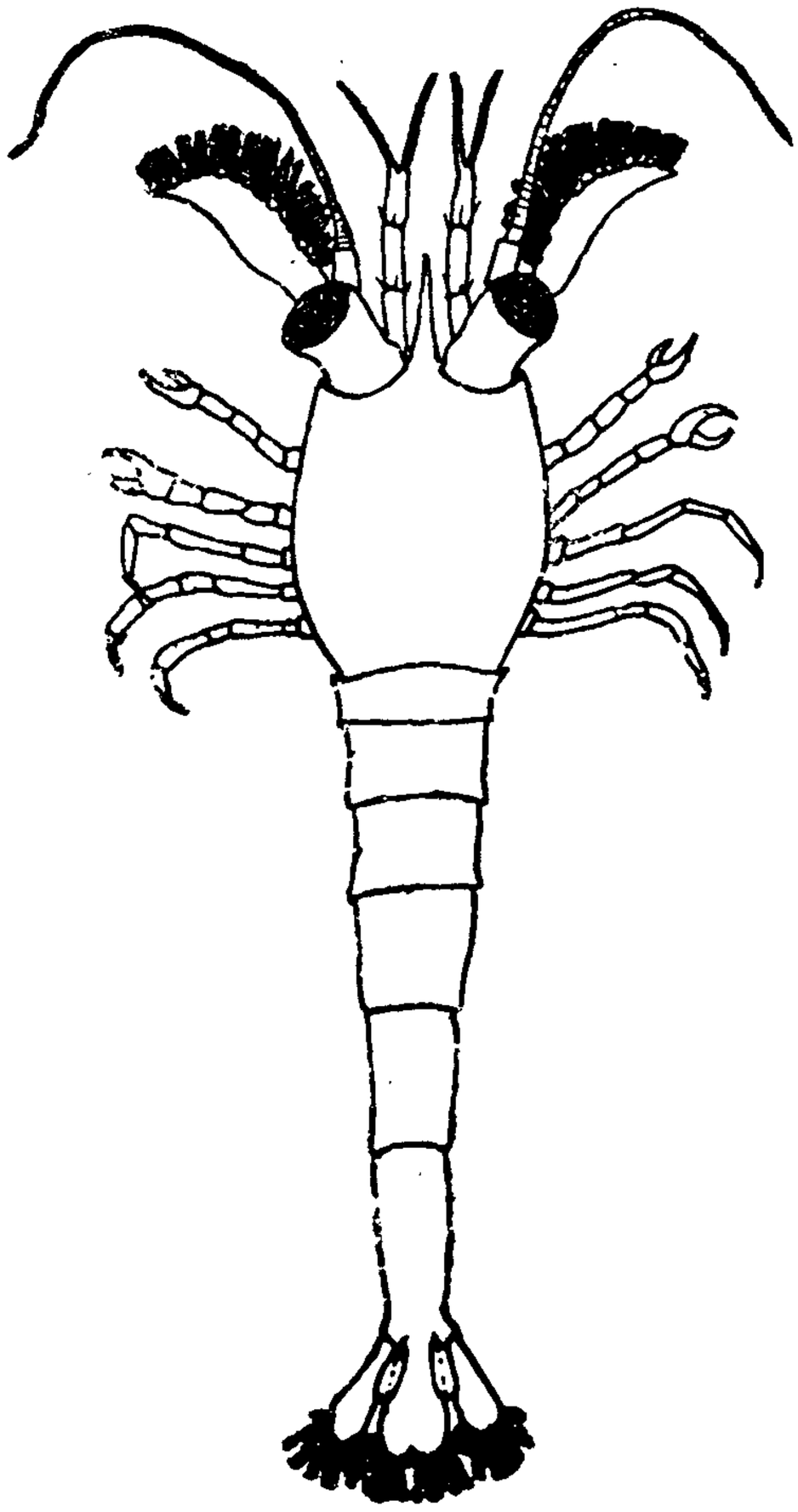

Fig. 8

4th Stage - Fourth Zoea (Figs. 8 and 14)

Duration : 18-36 hours. Mean total length: 3.99 mm.

The telson has 8 pairs of plumose setae at the posterior end and its breadth is now decreased. The upropod develops further and is articulated by means of a protopodite. The exopodite of the uropod has 8 pairs of plumose setae on each but the endopodites were not that developed and have no plumose setae.

Fig. 14

Fig. 8 :— *Caridina simoni* (Bouvier) Fourth Zoea stage.
Fig. 14.— *Caridina simoni* (Bouvier) Telson and uropods: fourth zoea stage.

5th Stage - Fifth Zoea (Figs. 9 and 15)

Duration : 24-42 hours. Mean total length: 4.09 mm.

The telson has further decreased in length and breadth relative to the 4th stage zoea larva and becomes narrower and trangular in shape. The exopodites as well as the endopodites of the uropods are equally developed. At this stage the telson is equal in length to the exopodites and endopodites of the uropods. Exopodites of the uropod bears 8 pairs of plumose setae.

Fig. 9

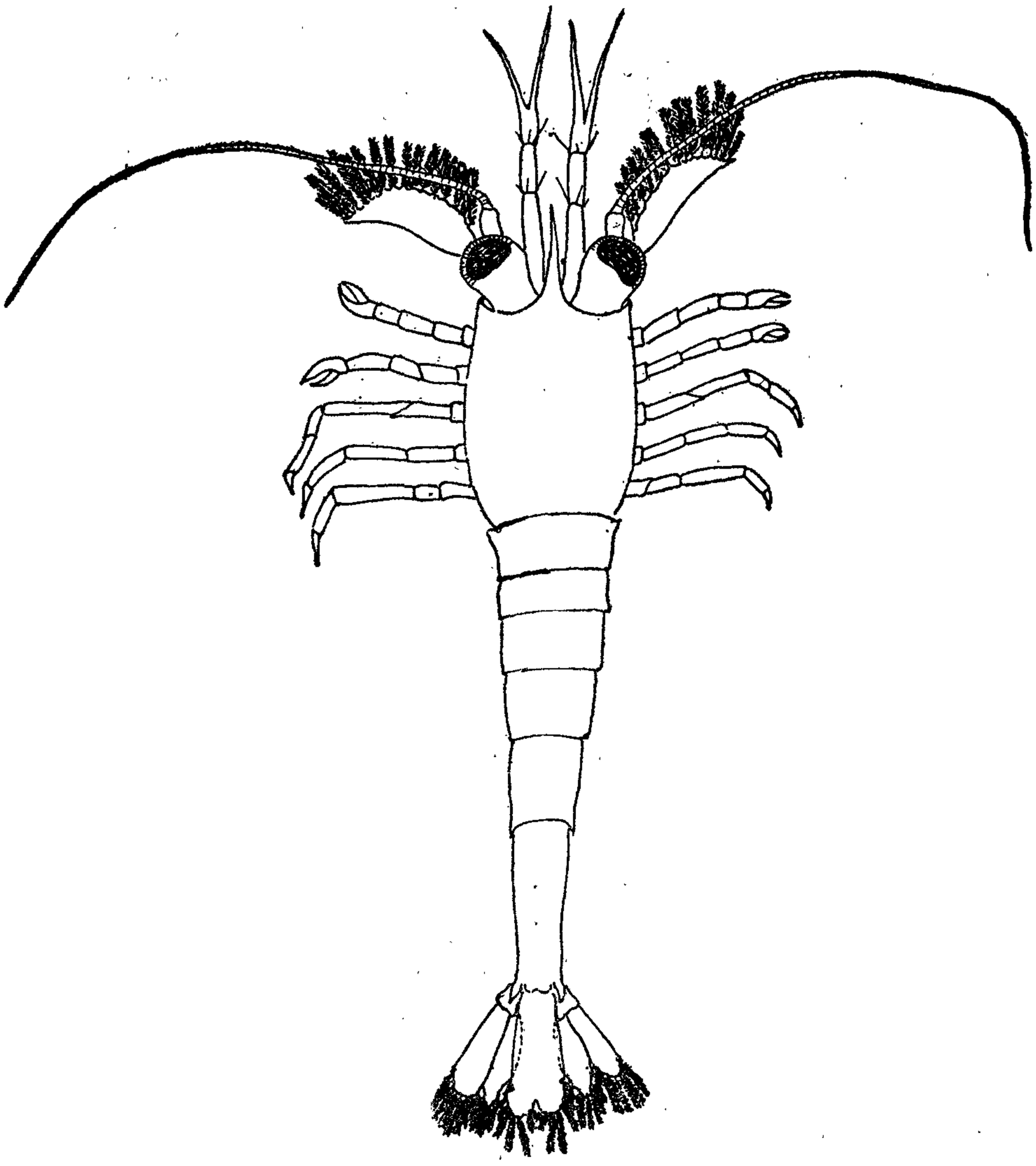

Fig. 9. — *Caridina simoni* (Bouvier) Fifth zoea stage

Fig. 15

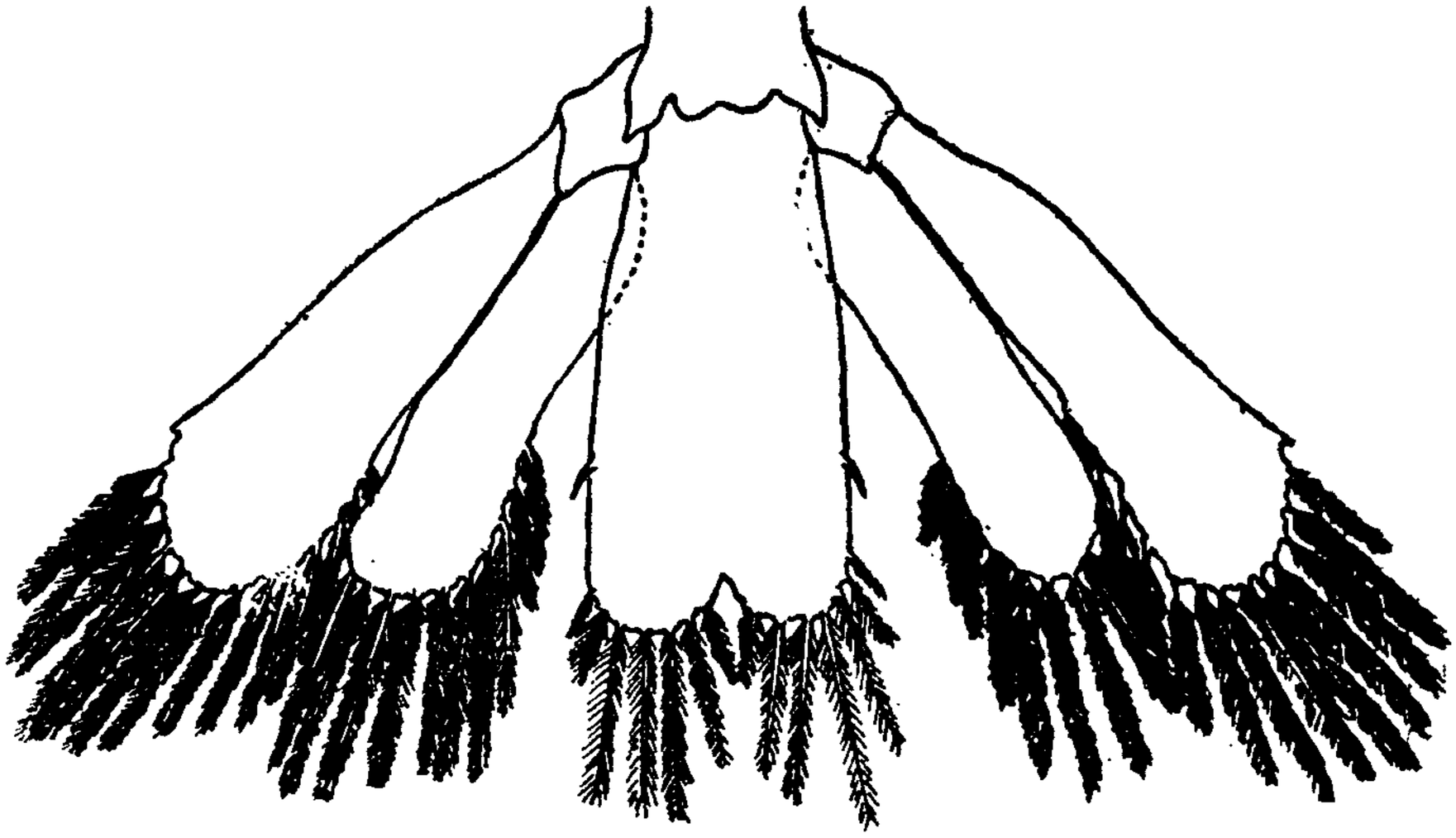

Fig. 15.— *Caridina simoni* (Bouvier) Telson and uropod: fifth zoea stage.

6th Stage - First Post - Zoea (Figs. 10 and 16)

Mean total length 4.62 mm

The telson diminishes in size further and its posterior end becomes narrower and more convex. One posterior pair of plumose setate disappears and another terminal pair at the distal end becomes naked. The rostrum is larger and has 2 dorsal teeth. Dorsal and vetral teeth continue to increase in number with successive moults. Eyes are now large with cylindrical stalks and are completely free from carapace.

Uropods become more prominent than the telson. The exopodites become much more developed than the endopodites and also more convex. The exopodite bears 14-16 plumose setae while the endopodite bears fourteen.

Fig. 10

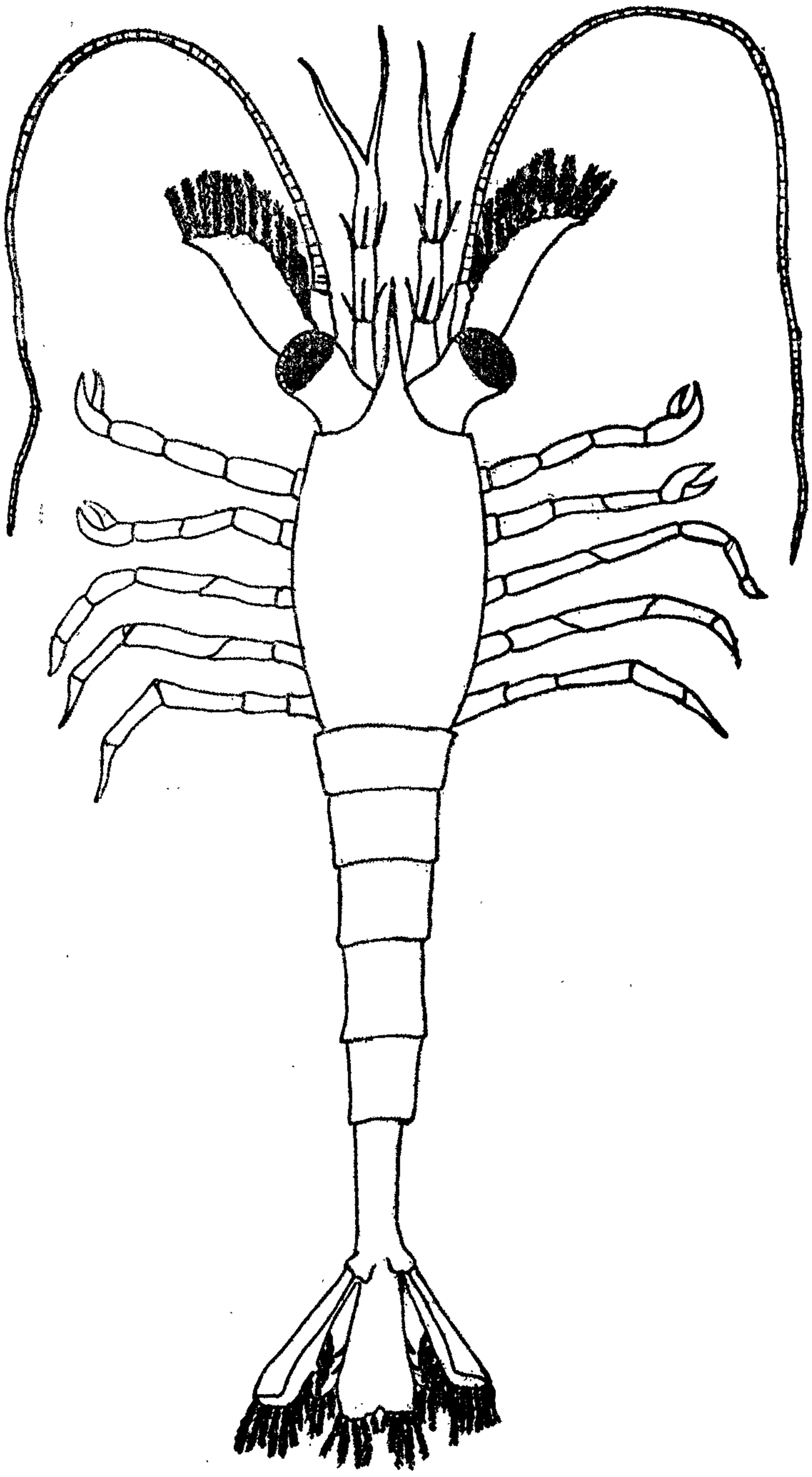

Fig. 10.— *Caridina simoni* (Bouvier) First post zoea stage.

Fig. 16

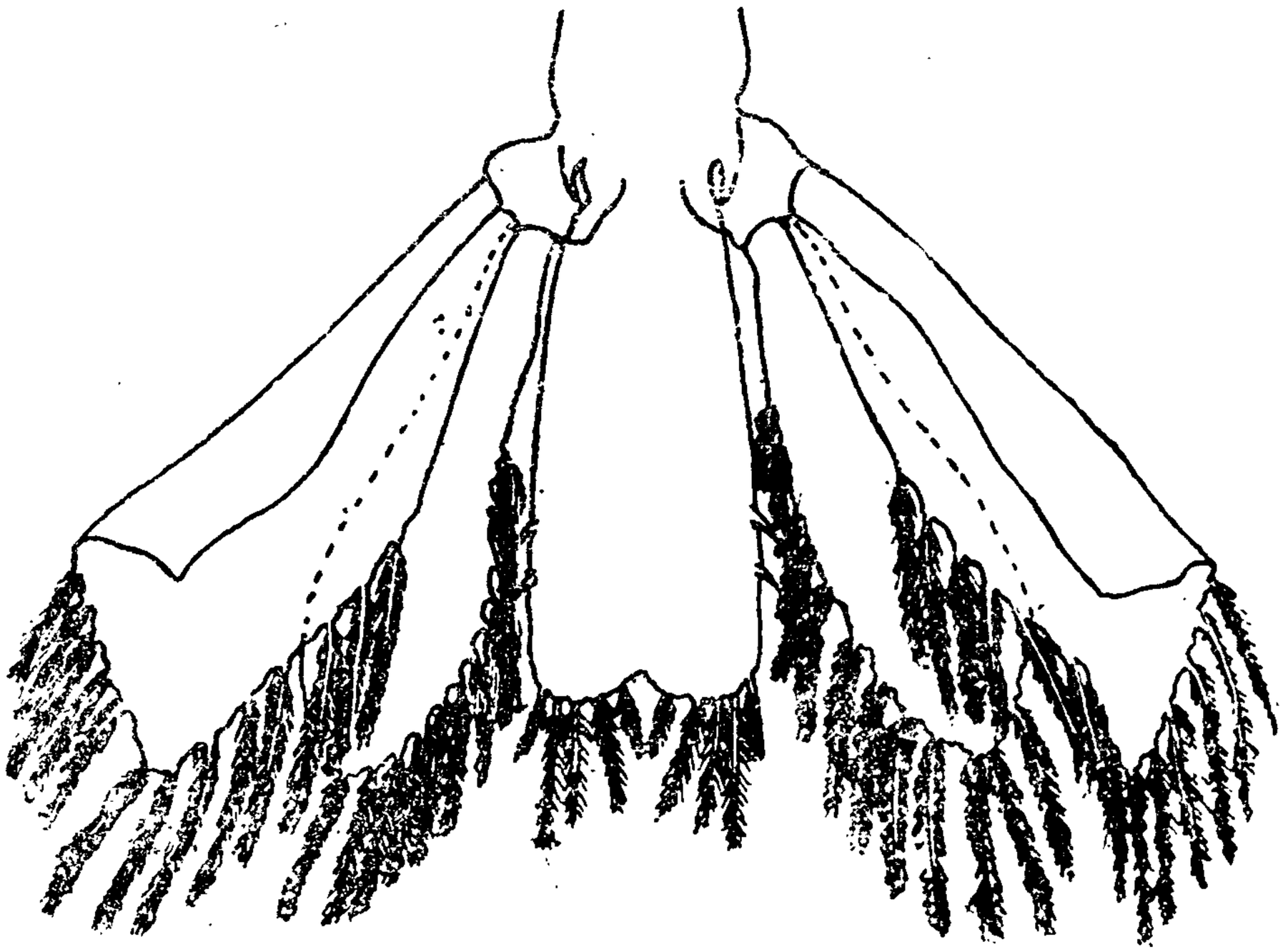

Fig. 16.— *Caridina simoni* (Bouvier) Telson and uropod: first post zoea stage.

Discussion

There have been differences of opinion about the number of stages amongst the forms of decapod species studied. Two reasons have been attributed for these differences.

(i) Employment of different culture conditions.

(ii) Different criteria used for definition of stages.

Broad (1975) indicated that accurate definitions are necessary for staging larval stages. But many authors, for example Boyd and Johnson (1962) found that there are degrees of variation in staging larval stages. Yokoya (1931) identified 8 stages for *Paratya compressa*. But according to recent criteria the number of stages has been found to be four by Hubschman and Rose (1968) using development of uropod and telson as staging criteria under controlled conditions. For observations of postembryonic growth of *Cardina simoni* these same criteria of staging were employed.

The life history of *Cardina simoni* reared in the laboratory was similar to that of other atyid shrimps. The eggs hatch inside the pouch and the small zoea larvae are released from it. At the time of hatching of eggs, the mother nests on an object, and on disturbance it doesn't move instantly. The released zoea larvae stay attached to the abdominal appendages of mother possibly for protection.

A comparison of the developmental stages of *C. aurensis* and *C simoni* is given in Table 4.

TABLE 3

Stage	*Time (hours)*	*No. of Individuals*	*Percentage of survivers*
Zoea I	0	37	100%
Zoea II	27	37	100%
Zoea III	54	37	100%
Zoea IV	78	35	94.6%
Zoea V	105	34	91.9%
Post-Zoea	138	31	83.8%

TABLE 4

Comparison of developmental stages of *C. aurensis* and *C. simoni*

	Caridina nilotica aurensis (From Glaister 1979:)	*Caridina simoni*
Mean number of egg per mass	74	27
Mean dimension of eggs		
Egg length (mm)	0.64	1.26
Egg width (mm)	0.39	0.77
No. of zoeal stages	4	5
Duration of zoeal stages in hours		
First Zoea	72–96	24–30
Second Zoea	48–72	18–36
Third Zoea	120	12–36
Fourth Zoea	72	18–36
Fifth Zoea/First Post Zoea	—	24–42
First Post Zoeal stage	—	—
Mean total length of zoeal stages in mm.		
First Zoea	1.88	2.46
Second Zoea	2.17	3.57
Third Zoea	2.33	3.78
Fourth Zoea	2.68	3.99
Fifth Zoea/First post Zoea	3.10	4.09
First post Zoea	—	4.62

The first zoel stage of *Caridina simoni* is larger than of *C. nilotica aurensis* (2.46 and 1.88 mm respectively) as would be expected from egg dimensions.

Caridina simoni occurs abundantly in streams, ponds and lakes in Western, Southern, Eastern and North Central Provinces of Sri Lanka. This species also shows a high survival rate under natural conditions as well as under the laboratory conditions. Costa (1973) has suggested that this species should be exploited commercially, because of its availability in large numbers in Sri Lanka. Since this species could be easily cultured under laboratory conditions, it is a good candidate for shrimp farming since dried shrimp is a delicay in Sri Lanka. The larval stages could also be exploited to be used as food items for larval forms of other culturable prawns such as *Macrobrachium resenbergii*.

REFERENCES

1. ARUDPRAGASAM, K. D. and H. H. COSTA (1962)
   Atyidae of Ceylon, *Crustaceana* 4:7 - 24

2. BOYD, C. M. and JOHNSON, H. W. (1962)
   Variations in the larval stages of a decapod crustacean *Pleurocodes plainipes* Stimpson (Galathedae) Biol. Bull. (Woods Hole Mass.) **124**, 141 - 152

3. Broad, A. C. (1957)
   Larval development of *Palaemonetes pingis* Holthuis Biol. Bull. (Woods Hole, Mass.) **112**, 144 - 161

4. COSTA, H. H. (1972)
   Results of the Australian-Ceylonese mission of the 1st Zoological Institute of the University of Vienna (Austria) and the department of Zoology of the Vidyalankara University of Ceylon, Kelaniya.
   Part V - Decapoda Caridea Bull. Fish. Res. Stn. Sri Lanka (Cey.) June & Dec. 1972. pp. 127 - 135

5. COWLES, R. P. (1915)
   The habits of some tropical crustaceans II. Philipp. J. Sc. Sect. D. **10**, 11–16.

6. EDMONDSON, C. H. (1935)
   Atyidae of southern Polynesia B. P. Bishop Museum, Occ. Pap. XI (3)

7. GLAISTER, J. P. (1979)
   Post embryonic growth and development of *Caridina nilotica auren;is* Aust. J. Mar. fresh water Res.

8. HUBSCHMAN, J. H. and ROSE J. A. (1968)
   Palaemonetes kadiakensis Rathbun: Postembroyonic growth in the laboratory (Decapoda: Palaemonidae) *Crustaceana* 16, 81 - 87

9. LING, S. W. (1962)
   Studies on the rearing of larvae and juveniles and culturing of *Macrobrachium rosengbreti* (De Man) Indo Pacific Fish council, Current Affairs Bull. No.35, 11 pp.

10, C. J. (1939)
   The larval development of some Peking Caridae- *Palaemonetes* and the *Palaemon* (*Palaemonidae*) 40th Anniv. Pap. Nat. Univ. Peking Vl. i pp. 169 - 204

11. UOKOYA, Y. (1931)
   On the metamorphosis of two Japanese fresh water shrimps, *Paratya compressa* and *Leande paucidens* with reference to the development of their appendages. *J. Coll. Agri. Tokyo. Univ. XI* 75-150