

On the early development of phyllosomas of *Ibacus ciliatus* (von SIEBOLD) and *Panulirus longipes* (A. Milne EDWARDS)

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In summer of 1960, the writers succeeded to raise the phyllosomas of a scyllarid lobster, *Ibacus ciliatus*, and a spiny lobster, *Panulirus longipes*, up to the fourth stage in glass jars.

As the food of larvae, early nauplii of brine shrimps were used in the same way as adopted by NONAKA *et al.* (1958). Although the first stage larva of *I. ciliatus* has been described in detail by HARADA (1958), there are no information as to the following stages. As far as we know, no reports have appeared as to the larval development of *P. longipes*. In the present paper the early development of *I. ciliatus* and *P. longipes* will be described.

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1. *Ibacus ciliatus* (von SIEBOLD) (Fig. 1. A-D)

On April 19th and June 4th, we obtained the newly hatched phyllosomas of *I. ciliatus* at the Sakurajima Aquarium in Kagoshima Prefecture. The parent animals had been kept about a week in the aquarium tank. A rather good result was obtained in the second batch. The record of ecdyses during the culture is shown in Table 1.

Table 1. Record of ecdyses during culture (*I. ciliatus*)

Date	1st stage		2nd stage		3rd stage		4th stage	
	living	dead	living	dead	living	dead	living	dead
June 4 ¹⁾	20	—	—	—	—	—	—	—
14	10	4	6	—	—	—	—	—
15	2	6	12	—	—	—	—	—
16	0	6	14	—	—	—	—	—
24	0	6	6	6	2	—	—	—
25	0	6	3	6	5	—	—	—
26	0	6	1	7	5	1	—	—
28	0	6	0	7	6	1	—	—
July 2	0	6	0	7	5	1	1	—
3	0	6	0	7	3	2	2	—
4	0	6	0	7	1	4	2	—
6	0	6	0	7	1	4	1	1
8	0	6	0	7	0	5	1	1
10	0	6	0	7	0	5	0	2

Water temperature: 23.5°–28.4°C

1) Larvae hatched out in the aquarium tank. Twenty larvae were divided into four vessels.

In this batch, as shown in the table, the first ecdysis took place in ten to twelve days after hatching-out, mostly within eleven days. The second ecdysis occurred in

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Table 2. The measurements of larvae of *I. ciliatus*.

	1st stage ¹⁾	2nd stage ²⁾	3rd stage ³⁾	4th stage ⁴⁾
Body length	3.05 mm	3.70 mm	4.54 mm	6.00 mm
Length of forebody	1.75	2.40	2.67	3.72
Width of forebody	2.26	2.85	3.74	5.48
Abdomen length	0.53	0.65	0.63	0.80
1st antenna	1.13	1.46	1.93	2.37
2nd antenna	0.53	0.66	0.87	1.20
Eye length	0.93	1.73	2.05	2.53
1st leg	5.00	6.40	8.35	10.60
2nd leg	4.56	6.95	8.80	11.25
3rd leg	5.10	6.45	8.05	9.90
4th leg	4.00	5.48	6.40	8.92
5th leg	0.73	2.05	3.73	5.60

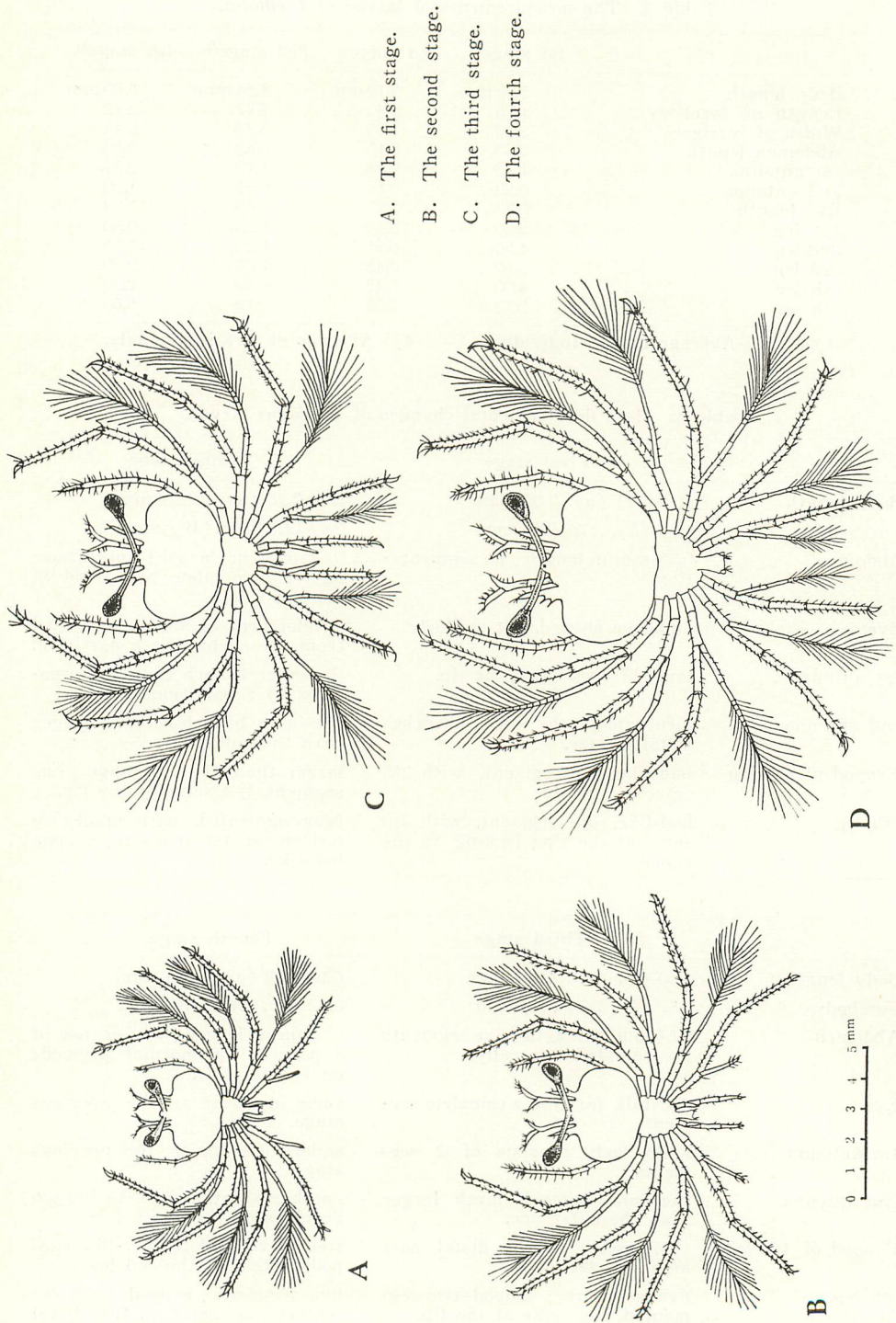
1), 2), 3) Average of five individuals.

4) Average of two individuals.

Table 3. Main developmental changes of *I. ciliatus* larvae.

	First stage	Second stage
Body length	2.75-3.21 (av. 3.00) mm	3.48-3.76 (av. 3.71) mm
Forebody	1.70 (<i>L</i>), 2.26 (<i>W</i>) mm	2.40 (<i>L</i>), 2.85 (<i>W</i>) mm
Abdomen	0.53 mm in length; no segmentation.	0.62 mm in length; appearance of five incomplete partitions on ventral side.
Eye	club-like shaped, not stalked.	development of stalk, separated from the eyeball by a partition.
1st antenna	long, bifurcated at the tip.	the outer branch of the tip separates by a partition.
2nd antenna	bifurcated, the two branches equal in size.	the inner branch becomes larger than the outer one.
Exopod of 4th leg	bud-like, one segment, with 2-3 setae at the tip.	larger than the 1st stage, one segment, 3-4 setae at the tip.
5th leg	bud-like, one segment, with 2-3 setae at the tip; lacking in the exopod.	four-segmented, with small exopod on the 1st segment; exopod bud-like.

	Third stage	Fourth stage
Body length	4.50-4.67 (av. 4.54) mm.	6.10-6.02 (av. 6.06) mm.
Forebody	2.67 (<i>L</i>), 3.74 (<i>W</i>) mm.	3.72 (<i>L</i>), 5.48 (<i>W</i>) mm.
Abdomen	0.64 mm in length; five segments are complete ventrally.	0.8 mm in length; appearance of 4 pairs of primordial pleopods on ventral side.
Eye	eyestalk forming a complete segment.	same in shape as the previous stage.
1st antenna	main body consists of 2 segments.	same in shape as the previous stage.
2nd antenna	the inner branch much larger than the outer one.	another short, spine-like branch develops on the outer side.
Exopod of 4th leg	10-12 setae of the distal part arranged feather-like.	well developed feather-like exopod as that of the 3rd leg.
5th leg	five segments; exopod two-segmented, 3-4 setae at the tip.	five segments; exopod with 7-8 feather-like setae at the distal part.



- A. The first stage.
- B. The second stage.
- C. The third stage.
- D. The fourth stage.

Phyllosomas of *Ibacus ciliatus*. (dorsal view)

Fig. 1. (A—D)

twenty to twenty-four days after hatching-out. Two individuals underwent third ecdysis which took place in twenty-eight and thirty-four days respectively after hatching-out. The measurements of each stage are shown in Table 2. Also, main points of developmental changes from the first stage through the fourth stage are shown in Table 3.

For the first stage larvae, readers are referred to the detailed description of HARADA (1958). In his report, HARADA describes that the fifth legs of the larva are composed of four segments with a budlike exopod on the second segment. On the contrary, in the first stage larvae of the above-stated two batches, the fifth legs are not segmented and exopod cannot be recognized (Fig. 1. A). The cause of this discrepancy remains to be solved.

2. *Panulirus longipes* (A. Milne EDWARDS) (Fig. 2. A-D)

The newly hatched phyllosomas were obtained at the same aquarium on August 1st. The first stage larvae are small in size than those of *I. ciliatus*. They are as a whole similar both in size and shape to those of *P. longipes* which are described by NAKAZAWA (1917), KINOSHITA (1931), and NONAKA *et al.* (1958). A morphological difference of the phyllosoma between *P. longipes* and *P. japonicus* lies in the number of segments of the third leg. According to NAKAZAWA (1917), the first stage larvae of *P. japonicus* have the six-segmented third legs. But the third legs of *P. longipes* are composed of four segments, while a very rudimentary bud-like exopod is attached to the middle part of the second segment (Fig. 2. A). The record of culture is shown in Table 4.

Table 4. Record of ecdyses during culture (*P. longipes*).

Date	1st stage		2nd stage		3rd stage		4th stage	
	living	dead	living	dead	living	dead	living	dead
Aug. 1 ¹⁾	102	—	—	—	—	—	—	—
8	23	67	12	—	—	—	—	—
9	16	69	15	2	—	—	—	—
10	4	72	22	4	—	—	—	—
11	1	73	24	4	—	—	—	—
12	0	74	24	4	—	—	—	—
16	0	74	11	10	7	—	—	—
17	0	74	8	11	8	1	—	—
18	0	74	4	14	6	4	—	—
19	0	74	2	15	6	5	—	—
20	0	74	1	16	5	6	—	—
24	0	74	0	17	3	7	1	—
25	0	74	0	17	2	8	1	—
28	0	74	0	17	1	8	2	—
29	0	74	0	17	1	8	1	1
Sept. 5	0	74	0	17	0	9	1	1
11	0	74	0	17	0	9	0	2

Water temperature: 23.0°-28.0°C

1) Larvae hatched out in the aquarium. 102 larvae were divided into five vessels.

In this batch, as shown in the table, twenty-eight out of a hundred and two larvae underwent the first ecdysis which took place in eight to eleven days after hatchout, mostly within ten days. The second ecdysis occurred in sixteen to twenty days after hatchout, in the majority within eighteen days. The third ecdysis took place in twenty-four to twenty-nine days after hatchout.

The measurements of each stage and main developmental changes from the first stage through the fourth stage are shown in Table 5 and Table 6 respectively.

Table 5. The measurements of each stage larvae of *P. longipes*.

	1st stage ¹⁾	2nd stage ²⁾	3rd stage ³⁾	4th stage ⁴⁾
Body length	1.20 mm	2.06 mm	2.13 mm	2.54 mm
Length of forebody	0.87	1.30	1.46	1.60
Width of forebody	0.73	1.02	1.09	1.14
Abdomen length	0.25	0.27	0.29	0.31
1st antenna	0.47	0.70	0.78	0.86
2nd antenna	0.33	0.47	0.55	0.67
Eye length	0.57	0.90	0.97	1.20
3rd maxilliped	2.05	2.13	2.40	2.55
1st leg	3.48	3.60	3.80	4.13
2nd leg	3.30	3.34	4.40	5.22
3rd leg	2.93	4.27	4.90	5.45
4th leg	—	—	—	0.13

1), 2), 3) Average of five individuals.

4) Average of two individuals.

Table 6. Main developmental changes of *P. longipes* larvae.

	First stage	Second stage
Body length	1.17-1.23 (av. 1.20) mm.	2.01-2.10 (av. 2.06) mm.
Forebody	0.87 (<i>L</i>), 0.73 (<i>W</i>) mm.	1.30 (<i>L</i>), 1.01 (<i>W</i>) mm.
Abdomen	0.25 mm in length, no segmentation.	0.27 mm in length, no segmentation.
Eye	club-like shape, not stalked.	eyestalk separates from the eyeball by a metameric partition.
1st antenna	no branch, 3 small setae at the tip.	same in shape as the previous stage.
2nd antenna	no branch, shorter than the 1st ant. 2-3 small setae at the tip.	same in shape as the previous stage.
3rd maxilliped	five-segmented, developed exopod on the 2nd segment with 4-6 setae at the distal part.	larger exopod with 8-10 setae at the distal part.
3rd leg	the longest leg, 2 times as long as body length; The exopod, very small, on the 2nd segment.	appearance of a partition at the base of exopod; 2-3 setae at the tip of exopod.
4th leg	lacking.	lacking.

	Third stage	Fourth stage
Body length	2.08-2.17 (av. 2.13) mm.	2.50-2.58 (av. 2.54) mm.
Forebody	1.46 (<i>L</i>), 1.03 (<i>W</i>) mm.	1.60 (<i>L</i>), 1.14 (<i>W</i>) mm.
Abdomen	0.28 mm in length no segmentation.	0.31 mm in length, four incomplete partitions appear on ventral side.
Eye	a partition appears at the base of the stalk.	same in shape as the previous stage.
1st antenna	a partition appears at the base.	same in shape as the previous stage.
2nd antenna	a partition appears at the base.	same in shape as the previous stage.
3rd maxilliped	same in shape as the previous stage.	same in shape as the previous stage.
3rd leg	the exopod is two-segmented, with 4-6 setae at the tip.	9-10 setae on the distal part of 2nd segment of exopod arranged feather-like.
4th leg	lacking.	the primordium appears.

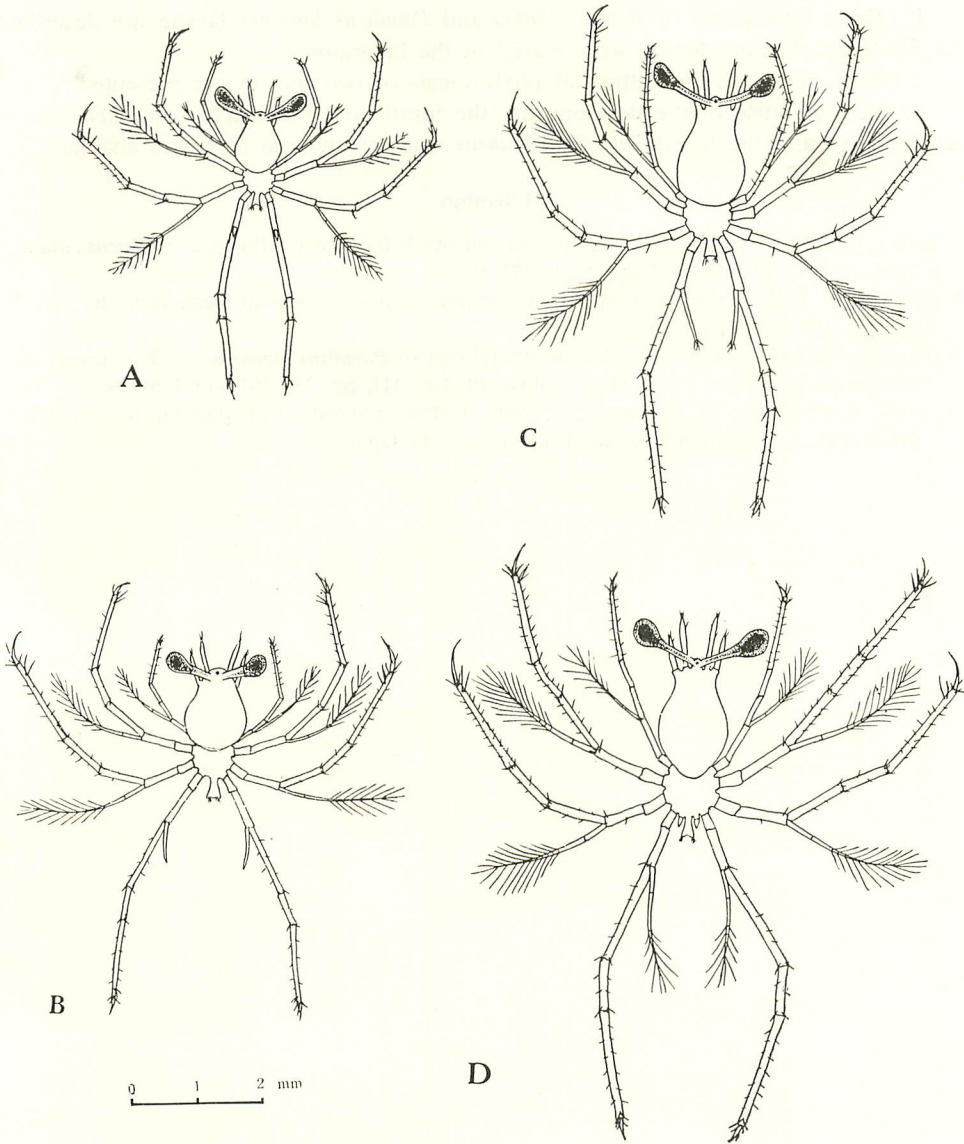


Fig. 2. (A—D)

The dorsal views of phyllosomas of *Panulirus longipes*.

- A. The first stage.
- B. The second stage.
- C. The third stage.
- D. The fourth stage.

Summary

1. Early four stages of *Ibacus ciliatus* and *Panulirus longipes* larvae are described. The newly hatched-out larvae were reared in the laboratory.
2. Some notes on the culture of phyllosomas of two species are presented.
3. In the course of the development, the fourth and the fifth legs in *Ibacus ciliatus* and the third and the fourth legs in *Panulirus longipes* undergo profound changes.

Literature

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