First stage larva of the deep-sea giant shrimp *Sclerocrangon rex* (Decapoda, Caridea, Crangonidae) under laboratory conditions

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**Abstract.**— First stage larva of the deep-sea giant shrimp, *Sclerocrangon rex* is described and illustrated under laboratory conditions. The larvae hatched in the most advanced condition, such as in having stalked eyes, among the congeneric species with abbreviated development. The newly hatched first larvae were staying together by clinging maternal pleopods until the second stage.

**Key words:** larval morphology, *Sclerocrangon*, Crangonidae, abbreviated development

**Introduction**

The crangonid shrimp of the genus *Sclerocrangon* consisted of 8 species (De Grave & Fransen, 2011). In addition, *S. rex* was described recently from eastern Hokkaido, Japan (Komai & Matsuzaki, 2016), and it is the largest species in the family Crangonidae. However, our knowledge on the life history of these deep-sea shrimp, including *S. rex* has been fragmentary and insufficient mainly due to difficulty in collection and rearing them to date. Despite such poor information, it has been known that the larval development of *Sclerocrangon* is abbreviated type with 2 short larval stages, and the brood is cared among the maternal pleopods (Sars, 1890; Birshteyn & Vinogradov, 1953; Williamson, 1960; Makarov, 1968; Guay et al., 2011). In 2017 and 2019, we had a chance to collect berried females of *S. rex*, and successfully obtained newly hatched larvae under laboratory conditions. This paper describes and illustrates the morphology of the first stage larvae.

**Material and Methods**

Ovigerous females were collected from off Rausu, eastern Hokkaido, at depths of 800–1200 m by gill net, from April to June in the years of 2017–2019. The females were transferred to the laboratory at Onahama, Fukushima, and maintained in an aquarium at 3.0°C, near to water temperature in the collection site. We selected one female in good condition from the samples and examined the eggs and the first stage larvae. The female laid about 200 eggs of the early eyespot stage (Fig. 1). The mean egg diameter in the early eyespot stage was $4.14 \pm 0.13$ mm in long axis and $3.73 \pm 0.14$ mm in short axis ($n = 5$); nearly before hatching it was $4.48 \pm 0.31$ mm and $4.38 \pm 0.20$ mm, respectively ($n = 5$).

The larvae were hatched on February 2019. Newly hatched larvae were quickly rinsed in distilled water, then fixed and preserved by 70% ethanol. Judging from the image of living specimens (Figs. 2, 3), the fixed specimens shrunk by 75%, especially in cephalothorax: approximately 85% of living specimens in the carapace length, while 98% in the abdominal length. The larval specimens were dissected under Olympus SZX10 stereomicroscope with fine tweezers or needles. Drawings and measurements were made with aid of a drawing tube attached to an Olympus BX51 and SZX10 microscopes. Carapace length (CL) measured from the post orbital line to the pos-
terior extremity, and abdomen length (AL) from the anterior end of somite 1 to the posterior end of telson. The material used in the present study will be deposited in the Hokkaido University Museum.

Results

Newly hatched larvae were non-swimming, free from maternal body without funiculus as found in the hatchlings of crayfish, while clung to maternal pleopods by the dactyli of pereiopods until the second stage. The color is greenish in the large yolk mass found in the anterior half of carapace, while pale orange in the telson and distal part of appendages (Figs. 2, 3).

Dimensions: $CL = 3.51 \pm 0.34$ mm (range 3.11–3.92 mm, 6 specimens). $AL = 8.32 \pm 0.84$ mm (range 7.30–9.69 mm, 6 specimens).

Carapace (Fig. 4A): Inflated, slightly convex upward, a low mid-dorsal carina on anterior part. Short triangular rostral spine (Fig. 4A1). Eyes stalked, each ommatidium with square facet (Fig. 4A2).

Abdomen: 6 segments plus telson, and segment 1–6 with pleopods. Segment 2 with shallow dorsal groove. Segment 5 without lateral spines. Telson in spatulate from, with 20–22 stout spines on the posterior margin.

Antennule (Fig. 4C): Biramous, inner flagellum 2-segmented, with 3–4 aesthetascs and short simple seta, outer flagellum unsegmented, with a spine terminally.

Antenna (Fig. 4D): Biramous, inner flagellum with short setae, exopod (scaphocerite) spatulate from with short marginal setae.

Mandibles (Fig. 4E): Molar process large, without armatures, well developed; while incisor process reduced, with 2 terminal short spines (Fig. 4E, arrow).

Maxillule (Fig. 4F): Coxal and basal endites with short spines and setae distally, endopod unsegmented process.

Maxilla (Fig. 4G): Endites reduced process. Endopod unsegmented, with 3 sparsely plumose setae distally. Scaphognathite large, with 39–41 marginal plumose setae.

Maxilliped 1 (Fig. 5A): Biramous, unsegmented; endopod about twice long as exopod. Endopod slightly constricted at middle point, with 3 plumose setae on its inner margin and 6 short setae on tip. Exopod with 4 plumose setae on its outer margin.
Maxilliped 2 (Fig. 5B): Biramous, endopod 2-segmented, with serrate spines and simple or plumodenticulate setae, exopod 2-segmented, with 6 plumose setae on tip.

Maxilliped 3 (Fig. 5C): Biramous, endopod stout, 3-segmented, exopod unsegmented, with 4 terminal setae.

Pereiopods: Pereiopod 1 largest, subchelate (Fig. 5D). Pereiopod 2 chelate (Fig. 5E). Pereiopods 4 and 5 with sickle-shaped dactylus (Fig. 5F). All pereiopods with gills, but without exopods.

Pleopods (Fig. 5G): Biramous, exopod large without seta, endopod small bud.

**Discussion**

In decapod crustaceans with abbreviated development, egg size is relatively larger and egg number per clutch is smaller than those of nor-
ormal (‘extended’) development (Rabalais & Gore 1985; Anger 2001). Table 1 compares the size and number of eggs of *Sclerocrangon* species in the previous works together with the present data. Measurements of the eggs in *S. rex* were done both in the early eyespot stage and the nearly before hatching; the mean diameter in long axis was 3.87 mm in the former, 4.82 mm in the latter. The size in the stage nearly before hatching was increased about 120% than that of the early eyespot stage, and this value is near to that of *S. derjungini*, the nearest kin of the present species. This increment rate is also very similar to the developing embryo data of nephropid lobster (Hamasaki & Matsuura, 1987).

Zarenkov (1965) revised the genera *Crangon* and *Sclerocrangon* based on not only morphology, but also ecology and development in crangonid genera. Then, all of *Sclerocrangon* species have abbreviated development in his revision. Among the congeners, *S. rex* release larvae in the most advanced condition, such as stalked eyes at hatching. In addition, the shape of facet on ommatidium is not hexagonal but square (see Fig. 4A2), and this feature is usually found in adult phase in the lobsters (Mishra et al., 2006) and in caridean shrimp. In contrast, the hatchlings have undifferentiated antennal flagella, rudimentary pleopods, undifferentiated telson without uropods, etc. These conditions indicate that the hatchlings are pre-metamorphotic, i.e. larval phase, though they have some adult like features. The abbreviated development of *Sclerocrangon* is ‘direct’ type in a functional sense according to the definitions by previous works (Gore, 1985; Rabalais & Gore, 1985; Anger, 2001), but not direct type in a strict sense such as found in *Spongicola japonicus* (Saito & Konishi, 1999). We regard, therefore, the hatchlings of *Sclerocrangon* is larval stage. The present larvae correspond to the “older larva” of *S. boreas* described by Makarov (1968), while his “young larva” was not observed in our observation. It may be possible that duration of the “young larva” is very short as suggested by him. This inference was also suggested by Shokita et al. (1991) in the abbreviated development of *Macrobrachium niphanae*, and it is possible to apply to the present case.

It has been well known that the mandibles of species of the Crangonidae consist of only molar process in adult form (e.g., Chace, 1992). In the crangonid larvae with normal development type, the incisor process eventually becomes a molar process usually at the megalopa stage (Haynes, 1985; Pessani & Godino, 1991; Jagadisha et al., 2000; Li & Hong, 2004). No previous larval works, however, have mentioned about the mandibles in the abbreviated development such as *Sclerocrangon*. It is confirmed herewith that the very reduced incisor process is present at least in the first larval stage. The surface of mandible is smooth without tooth and the maxillule bears no acute spines or setae, showing the mouthparts are not functional due to non-feeding lecithotrophic nature of the first stage.

In decapods, extended brood care has been

| Species       | Egg size (mm) | Egg number | Reference          |
|---------------|---------------|------------|--------------------|
| *S. derjungini*| 4.85 × 5.00   | 143        | Zarenkov, 1965     |
| *S. zenkevitchi*| 3.72 × 2.00   | 52         | Zarenkov, 1965     |
| *S. ferox*     | 3.00 × 2.20   | 133        | Zarenkov, 1965     |
| *S. boreas*    | 2.75 × 2.85   | 448        | Zarenkov, 1965     |
| *S. salebrosa* | 2.15 × 2.10   | 1735       | Zarenkov, 1965     |
| *S. rex*       | 4.14 × 3.73*1, 4.48 × 4.38*2 | 203 | present study |

*1*: early eyespot stage, *2*: nearly before hatching.
reported from various taxa, but the maternal care beyond the hatching stage is very rare in the ocean (Vogt, 2012). In marine caridean shrimp, it has been known only in Palaemonidae, Alpheidae and Crangonidae (Shokita et al., 1991; Duffy, 1996; Makarov, 1968). Previous larval works on Sclerocrangon mentioned that these larvae cling to the pleopods by their subchelate pereopod 1 and sickle-shaped dactylus of pereiopod 2–5 (Wollebæk, 1906; Makarov, 1968; Haynes, 1985), and this behavior was also found in the present species. The extended brood care of early larval stages, as commented by Makarov (1968), is also found in S. rex. After their hatching, the larvae tend to gather each other, avoiding possible risks in the outer environments, and this behavior would be one of the causes for their staying at interspace of the female pleopods. During brooding eggs, the females did not show active vigorous movements by pleopods as usually found in the other carideans. In addition, it was observed that an ovigerous female still holds several larvae which molted to the second stage. This fact implies that the females concurrently brood larvae in different stage within the same batch. This possibility should be clarified by experimental study and careful observations in the laboratory in future.

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