Survival rate of mud crab *Scylla olivacea* larvae reared in coloured tanks

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Abstract. The early development of crab larvae is important for larvae hatchery culture of orange mud crab *Scylla olivacea*. Better understandings related to larval development requirements are needed to increase the survival and growth rate of mud crab in hatchery conditions. This study aimed to investigate the effects of background color of the rearing tanks on the survival of *S. olivacea* larvae. Twelve tanks which consisted of four different colors (black, blue, red and orange) were used during the experiment. Zoea-1 stadium of *S. olivacea* was stocked at the density of 50 individuals/L. The larvae were reared until the megalopa stadium. The highest feeding rate (67.18±5.50) and the highest survival rate (21.88±0.35) were found in black-colored tanks. Similarly, the shortest metamorphosis period was obtained from the black-colored tanks. Conversely, the lowest survival and longest metamorphosis period were observed in orange-colored tanks.

Key Words: adaptibility, aquaculture, crustacea, zatchery, zoea.

Introduction. Orange mud crab *Scylla olivacea* has been known as one of the commercial fishery commodities in Indonesia (Yusuf et al 2016). This species is one of common crabs species found in Indonesia, including *Scylla serrata*, *S. tranquebarica* and *S. paramamosain.* It is a sought-after commodity together with other mud crabs species on both local and international markets. It has been a main raw material for several seafood processing industries.

However, the availability of *S. olivacea* in the market is mostly derived from wild capture yield. As a result, the wild population of this commodity is rapidly declining. Although mud crabs grow out unit can be found easily in several places in Indonesia, their larval for grow out still relies on wild capture larvae. Consequently, it causes more pressure on the current state of mud crab wild population. In addition, it has been a major problem for several countries in the world (Thirunavukkarasu et al 2014). Thus, it is very important to promote *S. olivacea* aquaculture.

The availability of crab larvae is an urgent factor for aquaculture. The understanding of biological condition of crab larvae, including the early larval development requirements is needed to improve the mud crab growth and survival rate. For instances, the crab larvae actively respond to changes of light intensity. Moreover, high photokinesis was reported in first zoea stages of *Panopeus herbstii* (Sulkin 1975). light intensity appears to significantly affect the survival, feeding behavior and metamorphosis state of the mud crab. Previous studies mostly focus the effect of rearing water levels on the larval development of *S. serrata.* Therefore, this study aimed to determine the best rearing tanks for *S. olivacea* larvae.

Material and Method

Location. This study was conducted at Larval Rearing Unit of Brackish Water Aquaculture (BPBAP) in South Galesong Subdistrict, Takalar, South Sulawesi Indonesia.

Experimental animals. *S. olivacea* larvae were taken from Hatchery Culture Unit at Bone Regency, South Sulawesi and transported to Larval Rearing Unit at Takalar. The experimental animals were larvae crabs at Zoea-1 stadium. Stocking density for this experiment was 50 larvae/L. The larvae were reared until they reached the megalopa stadium in different colored tanks.

Tanks preparation. Rearing tanks were circular plastic tanks in four different colors (black, blue, red and orange). All tanks were firstly cleaned with chlorine 150 ppm then neutralized with sodium thiosulfate ($Na_2S_2O_3$) at dose of 25 ppm before rinsed with freshwater. All rearing tanks were equipped with aerator for air supply.

Live feed. Rotifer and nauplius artemia were used as live feed in the experiment. Larvae crab (Zoea-1) begun feeding with rotifer (density of 30 ind/mL) at day 1 and after the larvae reached zoea-3 stadium were fed with live feed combination of rotifer and nauplius artemia (density of 5 ind/mL) until the end of the study (megalopa stadium). Feeding was administered twice a day in the morning (07:00 AM) and afternoon (05:00 PM).

Water quality management. The water used in the experiment was firstly treated with biological and physical filter. Water change/refreshment was performed from day 3 (D3) between at a range of 10-20%.

Experimental design. A completely randomized design was applied with 4 treatments and each treatment had 3 replicates. The four treatments were tanks which had different color background as follows: (A) black, (B) blue, (C) red, and (D) orange.

Data collection. Feeding rate, survival, and metamorphosis rate of *S. olivacea* larvae were the parameters collected during the experimental period. As supporting data, measurement of water quality including salinity, temperature, pH, dissolved oxygen, and ammonia were performed. Salinity was measured using handrefractometer, temperature (thermometer), pH (pH meter), dissolved oxygen (DO meter), and ammonia (spectrophotometer). The measurement of salinity, temperature, pH, and dissolved oxygen was conducted twice daily, at 6:00 AM and 06:00 PM. The ammonia levels were measured 3 times during the experiment at the beginning, middle and end of the study.

Feeding rate was calculated using formula as follows:

$$LKP = \frac{PB-PK}{PB} \times 100$$

Where: LKP = Feeding rate (%)
PB = Initial feed (ind)
PK = Final feed (ind)

Survival rate of *S. olivacea* larvae was calculated with formula according to Huynh & Fotedar (2004) as follows:

$$S = \frac{N_t}{N_0} \times 100$$

Where: S = Survival rate (%)
N_o = initial number of larvae
N_t = final number of larvae

The metamorphosis duration was determined based on the length of time for zoea 1 stage until the megalopa stage.

Statistical analysis. Data experiments were statictically analysed by IBM SPSS 20 program. Analysis of variance (ANOVA) were applied for signficant differences ($P<0.05$). Significant difference between treatment were further tested using Tukey test to compare differences between treatments (Steel & Torrie 1993). In addition, the water quality parameters obtained were analyzed descriptively.

Results. The highest feeding rate was obtained in the black-colored tanks (67.18±5.50) which was followed by blue, red and orange colored tanks (Table 1). Similarly, the highest survival rate was shown in the black-colored tanks (21.88±0.35). Moreover, the lowest metamorphosis performance was observed in orange colored tank (12.17±0.21). *S. olivacea* larvae's performance in different experimental variants (black, blue, orange and red colored tanks) are shown in Table 1. Analysis of variance (ANOVA) showed that the color background of the rearing tank had significant effect ($P<0.05$) on feeding rate, survival, and metamorphosis performance of *S. olivacea* larvae.

Table 1

Feeding, survival, and metamorphosis period of *Scylla olivacea* larvae in different coloured tanks

Tanks	*Feeding rate (%)*	*Survival (%)*	*Metamorphosis period (days)*
Black	67.18±5.50[a]	21.88±0.35[a]	18.00±0.00[a]
Blue	56.38±7.49[a]	17.73±0.48[b]	18.67±0.58[b]
Red	33.59±2.08[b]	12.48±0.14[c]	20.67±0.58[c]
Orange	28.79±3.60[b]	12.17±0.21[c]	20.33±0.58[c]

Different letters in the same column showed significant difference between treatments at 5% ($P<0.05$).

The water quality of rearing larval media during experiment period exhibited salinity of 30-31 ppt, temperature of 28-31°C, pH of 7.37-8.34, dissolved oxygen of 4.28-5.17 ppm and ammonia of 0.014-0.018 ppm respectively. The range of water quality parameters recorded was considered at the optimum levels for mud crab larvae requirements according to several studies (Hoang 1999; Ruscoe et al 2004; Kumlu & Kir 2005).

Discussion. The high feeding rate of mud crab larvae in black-colored tanks is considered suitable for the species. It is due to experimental media conditions which are similar with the life conditions of the crab larvae in the natural habitat. Mud crabs incubate their eggs in the dark. In addition, the feeding behavior it is also influenced by the biological nature of crabs as they are nocturnal animals. Hence, larvae eye has a preference to the dark color in the environment. The black color provides a high contrast in order to better visualize live and artificial prey (Mc Lean et al 2008) which has an effect on larval performance. Light transmission and reflection in the black tank are low where upwelling light is very low (Downing & Litvak 1999). Moreover, the feeding it is more efficient in the low light intensity (Rabbani & Zeng 2005) compared to bright colors such as blue, red and orange. However, the haddock fish larvae *Melanogrammus aeglefinus* (Downing & Litvak 1999) and perch larvae *Perca fluviatilis* (Tamazouzt et al 2000) show lower feeding performance in low light intensity.

In the present study, high consumption of feed in low light conditions (black colored tank) directly affected the survival of the mud crab. This is in line with Aslamyah et al (2016) and Karim et al (2016) that survival and growth performance are strongly influenced by macro and micronutrients obtained from food. High feed intake led larvae to gain more energy for survival and growth. Similarly, Rabbani & Zeng (2005) found high survival of larvae of *S. serrata* crabs in low light intensity. Furthermore, the larvae of *Macrobrachium rosenbergii* also was reported to have a significant growth rate in low light intensity (Shelke et al 2010).

In addition, low light intensity media (black-colored tank) also shorten the metamorphic time period of crab larvae. The development of metamorphosis (molting) in crustacean can be initiated by a variety of factors, for instance, the availability of energy capable of accelerating the change of metamorphosis (stadia) from zoea into megalopa (Tahya 2016; Tahya et al 2016ab). Similarly, the larvae (IV stage) of *M. rosenbergii* also significantly have a short time of metamorphosis period (Shelke et al 2010).

Conclusions. Based on the obtained results the highest feeding rate was obtained in black container, compared to blue, red and orange experimental variants. The shortest metamorphosis period was also obtained in the black experimental tank variant, and the lowest value was obtained in the orange-colored containers. In conclusion the most appropriate recommended maintenance medium for the mangrove crab larvae is the black container.

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