Use of different bottom substrate types for rearing mud crab crablet (*Scylla olivacea*) in nurseries

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**Abstract.** The technology of mud crab hatchery has been successfully implemented, though the survival rate of the larvae, until they reach crablet or juvenile stage, is relatively low. This study focuses on assessing the role of substrates in crablet growth and survival during the nursery. Mud crab crablets with an average initial weight and carapace width of 0.02±0.005 g and 3.43±0.42 mm was stocked into nine fiber tanks with a 30 individual/tank density. A shelter was inserted in the form of 2 black net sheets in each container. The treatment tried was the use of different types of substrates, namely (A) without substrate, (B) sand substrate, and (C) clay substrate. Feeding was done in the morning and afternoon using artificial feed. The results showed that the highest survival was obtained at the treatment without substrate, which was 15.57%, and significantly different (P<0.05) with the treatment of sand substrate and clay substrate. Meanwhile, the highest weight gain was obtained in the clay substrate treatment, which was 1.50g, significantly different from the treatment without substrate and sand substrate. This research demonstrated that the mud crab crablet nursery may be conducted in a container without a substrate if provided with shelter.

**1 Introduction**

Mud crab (*Scylla serrata* Forskal) is one of the fishery resources of high economic value and has the potential to be cultivated. This type of crab has been known in the domestic and foreign markets because of its delicious meat taste and high nutritional value, which contains various essential nutrients [1]. Mud crab meat contains 47.5% protein and 11.20% fat [2]. Increasing consumer demand, especially in the international market, demands sustainable production of mud crabs. So far, the market demand for mud crabs is still primarily met by the results of volatile natural fishing, while the cultivation business only contributes about 10%. This superiority of mud crab has implications for the urgent demands for the intensive development of crab cultivation.

The main determining factor for the success of mud crab cultivation is seed availability. So far, the need for crab seeds is still very dependent on the results of fishing in nature. Hence,
the sustainability of production from their cultivation business is difficult to maintain throughout the year. With such conditions, one way to overcome the problem of providing seeds is to mass-produce seeds through hatchery efforts.

Although the mud crab hatchery technology has been successfully carried out, the survival rate of larvae into seeds is still shallow due to the high level of cannibalism [3–6]. The intense nature of preying on each other was supported by the character of crabs who must molt when experiencing growth. One of the efforts to reduce the level of cannibalism, as reported by [7], that the use of seaweed cells as a medium for transporting mud crabs gave a lower average result of crablet deaths (1%) compared to using wet cloth cells (2%). Meanwhile, [8] reports that cannibalism can be suppressed in one way: by providing shelters in the form of both shelters and suitable base substrates, grading, and reducing the density of larvae during rearing. At the same time, sand and mud as the bottom substrates have been used to maintain Portunidae, such as juvenile *Scylla serrata* [9,10]. While [5] reported that crab seeds raised on sand substrates showed higher survival (41.3%) compared to the survival of seeds grown on mud substrates (29.3%) but did not differ markedly from the survival of seeds raised on coral substrates (34.7%). [11,12] reported that the highest survival in mud crab fry (*S. serrata*) in the crablet stage was obtained on maintenance using a sludge substrate and without shelter. Furthermore, it was explained that caring for mud crab seeds without using substrates results in lower seed survival than sludge substrates.

Based on this fact, efforts were made to increase survival in mud crab crablets using different substrates. This research aimed to determine how other nursery substrates impacted mud crab crablets' survival rate (*S. olivacea*).

## 2 Materials and methods

The research was conducted at the Crab Hatchery of the Research Institute for Brackish Water Aquaculture and Fisheries Extension (RIBAFE) - Maros in Marana. The test animals used in this study were mud crabs measuring an average weight of 0.02 ±0.005 g collected from the hatchery. The stocking density of the crablets was 30 ind./tank and kept for 30 days. The treatment to be tested is the use of different types of substrates, A (without substrate), B (sand), and C (clay), with a subtraction thickness of 3 cm. Sand and clay substrate was obtained around the study site. This study used a completely randomized design (CRD) of each treatment repeated thrice, stocked into nine fiber tanks (50 x 70 x 80 cm). A shelter was inserted in the form of 2 black net sheets measuring 40 x 40 cm in each container. Following the installation of aeration and the stocking of test animals, each tank is filled with water with a salinity of 22 ppt and is 35 cm high.

During the study, the test animals were given powdered artificial feed with a protein content of 42%, fat of 7%, and crude fiber of 3%. At a dose of 100% of the overall weight, the presentation of feeding was carried out two times in the morning at 08.00 and in the afternoon at 16.00. To avoid a decrease in water quality, every morning and evening before feeding, a call for the remaining feed and manure of the test animal was carried out, and a water change of 70% was carried out.

The sand was obtained from the Tiger Shrimp Seed Installation of the RIBAFE in Barru. Meanwhile, the clay was obtained from ponds in the Crab Seed Installation of the Brackish Water Cultivation Research Center in Marana. In addition, water quality observations were also carried out, including salinity, temperature, pH, alkalinity, and dissolved oxygen. Meanwhile, on each substrate, initial and final measurements of the study were also carried out, including organic carbon, organic matter, N Total, iron or Ferro (Fe), and Aluminium (Al) at the BPPBAP Maros Soil Laboratory.

The response of different types of substrates to survival and growth, sampling is carried out once every two weeks by capturing and weighing all the test animals in each tank. The
changes observed during the study include survival rate and growth using the following formula: The Survival Rate (S.R.) for each treatment was computed using the formula suggested by [13]:

\[
SR(\%) = \frac{\text{Final number (ind)}}{\text{Initial number (ind)}} \times 100
\]  

(1)

The growth rate in each treatment was determined based on the formula:

\[
\text{Absolute growth} = \text{Final body weight (g)} - \text{Initial body weight (g)}
\]  

(2)

3 Results and discussion

The impact of employing different substrates on the survival rate of mud crab crablet (S. olivacea) throughout the research was illustrated in Table 1.

<table>
<thead>
<tr>
<th>Table 1. Survival rate and growth of mud crablet for 30 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed parameters</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>Average Initial weight (g)</td>
</tr>
<tr>
<td>Weight gain (g)</td>
</tr>
<tr>
<td>Survival rate (%)</td>
</tr>
<tr>
<td>0.02±0.005</td>
</tr>
<tr>
<td>0.9±1.05a</td>
</tr>
<tr>
<td>15.57±2.1a</td>
</tr>
<tr>
<td>0.02±0.005</td>
</tr>
</tbody>
</table>

Note: Different letters over each treatment indicate a statistical difference (P<0.05; Duncan’s test)

Table 1 showed that crab weight gain at the end of the study showed significantly different results (P<0.05) on all treatments. The highest weight gain was obtained in the C (clay) treatment, about 1.50g. The increased weight gain was suspected that the surviving crabs at the end of the study utilizing artificial feed also given mostly preyed on other crabs because there was a tendency for high weight gain also followed by high mortality (mortality) so that at the end of the study, a reasonably low S.R. was obtained. Cannibalism on the crablet was more influenced by the size of larger predatory crabs, whereas cannibalism on the larger prey crabs was more affected by the shelter available [14]. As [5] reported, rearing mud crab fry (Scylla paramamosain) using a mud substrate results in better carapace width and length growth than coral substrates and sand.

Survival rates (S.R.) at the end of the study also showed differences in all treatments. The highest S.R. obtained from treatment A (without substrate) was about 15.57%, although this result showed a significant difference (P<0.05) with all treatments. This suggested that the use of substrates and counters in tanks for mud crab fishing (S. olivacea) has not been able to increase S.R. Low SR in addition to being caused by cannibalism is also suspected because crablets at the beginning to two weeks after stocking are still in the process of adapting artificial feed [15], so that to meet energy needs and growth, mutual prey occurs, especially for crabs that have just molted.

Within natural populations of brachyuran crabs, it is believed that cannibalism among juvenile-size classes is a significant factor contributing to the mortality of small juveniles that frequently aggregate in structurally complex shelters [14]. As mentioned in [16], one of the efforts to mitigate cannibalism and trigger the growth of mud crab crablet is the provision of appropriate feed in quantity and quality. Furthermore, it was explained that so far, the feed given by mud crab crablet is fresh trash fish and dried shrimp [17]. In the trash, the fish feed has several disadvantages, including spoiling quickly, fluctuating quality, requiring special storage (freezer), and seasonal availability.
However, the S.R. obtained from this study is much higher when compared to the results of the study of [18], which got the highest S.R. of mud crab larvae (S. paramamosain) at 7.8% with the treatment of BPPBAP probiotics containing Bacillus lichenifonia. However, when compared to the results from [5], the highest S.R. of mud crab seeds (S. paramamosain), 23.3%, from the treatment of using sand as a substrate. The occurrence of differences in the results obtained is thought to be because the two types of mud crabs used are different, as well as the containers used.

A drastic decrease in S.R. occurred on day 15 for all treatments until the end of the study (day 30), as shown in Figure 1. This showed that there is a tendency to increase in size and weight that is not uniform because the nature of cannibalism is also getting higher, so in sensing efforts, it is necessary to pay attention to the density at specific sizes and weights must be uniformized, through grading every one week.

The crablet needs safety in the form of enough substrate and shelter to hide after molting because it is more agile as it gets bigger and older. Because of this, in addition to the type and number of shelters in the container, it also needs to avoid being eaten by the theme. As reported by [19], the crab cannibalism trait causes the solitary nature of small-sized individuals to be higher when kept together with larger-sized individuals. The size of the distributed crablet starts from 0.5 g up to 4 g. Descriptively, the treatment frequency of feeding four times tends to be dominated by a larger crablet size. However, the size of 2.5 g dominates the feeding frequency three times.

As reported by [7], the use of seaweed shelter as a medium of transportation for mud crabs gives an average result of less crablet mortality (1%) than using a wet cloth shelter (2%). Thus, comparing container area with the number and type of shelter, substrate, and stocking density can suppress cannibalism. Compared with the research results by [6], the mortality of mud crabs transported by a wet system without shelter (bags filled with water) reached 3% at a density of 50 ind / L and increased to 12% at a density of 150 ind / L.

![SR (%) of Crablet Crabs](image)

**Fig 1.** The survival rate of each sampling during the study

Based on Figure 1. It is noticed that the crablet breeding of mud crabs (S. olivacea) in the tank was attempted for no more than 15 days. Although mud crabs were believed to survive in nature with extreme conditions (e.g., in mud and without water), the water quality parameters for a shrimp culture can guide mud crab farming activities [20].

While mud crabs are traditionally considered to withstand harsh natural conditions (such as surviving in mud without water), the water quality parameters established for shrimp farming can be a reference for mud crab farming practices, as indicated by [20]. Water
quality was a supporting factor that needed to be considered during research, such as temperature, salinity, pH, oxygen, and alkalinity. The results of observations of each of these parameters are illustrated in Table 2.

### Table 2. Range of water quality parameters

<table>
<thead>
<tr>
<th>Substrate Type</th>
<th>Temp (°C)</th>
<th>Dissolved Oxygen (ppm)</th>
<th>pH</th>
<th>Salinity (ppt)</th>
<th>Alkalinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>23.5-30.0</td>
<td>3.52-4.80</td>
<td>7.7-8.5</td>
<td>22-26</td>
<td>130.66-223.66</td>
</tr>
<tr>
<td>B</td>
<td>23.5-30.0</td>
<td>3.58-4.82</td>
<td>7.6-8.5</td>
<td>22-26</td>
<td>143.48-227.66</td>
</tr>
<tr>
<td>C</td>
<td>23.5-30.0</td>
<td>3.79-4.79</td>
<td>7.7-8.3</td>
<td>22-26</td>
<td>135.04-223.66</td>
</tr>
</tbody>
</table>

In general, the water quality condition during the study, as in Table 2, showed that the range value of each parameter observed is still at the optimal range for the growth and survival of mud crabs. As reported by several researchers such as [18,21–23], dissolved oxygen concentration 3.52-6.3 ppm; pH 7.5-8; and salinity 22-34 ppt, can still be tolerated by mud crab larvae, except for the temperature that the optimum temperature for the growth and survival of mud crab larvae were 25-32°C [24,25].

In addition to observations of water quality parameters, observations of substrate quality (sand and clay) were also carried out at the beginning and end of the study. The results of observations of the two substrates can be seen in Table 3. These results of in situ water quality parameters and substrate analysis were generally feasible for mud crabs during the whole culture period [26].

### Table 3. The results analysis of each substrate at the Initial and end of the study

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Initial</th>
<th>After 30 days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Organic carbon (%)</td>
<td>0.33</td>
<td>3.78</td>
</tr>
<tr>
<td>Organic matter (%)</td>
<td>0.57</td>
<td>6.51</td>
</tr>
<tr>
<td>Total N (%)</td>
<td>0.01</td>
<td>0.18</td>
</tr>
<tr>
<td>Fe (ppm)</td>
<td>27.3</td>
<td>409.9</td>
</tr>
<tr>
<td>Al (ppm)</td>
<td>19.1</td>
<td>87.4</td>
</tr>
</tbody>
</table>

### 4 Conclusion

Based on the results of the study, it can be concluded that the mud crab (S. olivacea) in the tank using sand, soil, and no substrate equipped with black waring shelter still gives a relatively low survival rate (>16%). This research also demonstrated that the mud crab crablet nursery may be conducted in a container without a substrate if provided with shelter.

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