Omni-Akuatika, 13 (2): 190 – 198, 2017
ISSN: 1858-3873 print / 2476-9347 online

Research Article

Rearing of Mud Crab, *Scylla tranquebarica* Larvae with Different Stocking Densities

Gunarto[1,]* and Sulaeman[1]

[1)] *Research Institute for Coastal Aquaculture and Fisheries Extention, South Sulawesi, Indonesia*

**Corresponding author: gunartom@yahoo.com*

Received 9 May 2017; Accepted 17 October 2017; Available online 28 November 2017

ABSTRACT

Mud crab (*Scylla tranquebarica*) is an important aquaculture species, especially in Southeast Asian Countries. However, the larval rearing of this species faces problems resulted in low survival caused not only by intensive cannibalism but also by prolonged in larval rearing period. The stocking density during early life stages is proposed to influence the crablet production in the larvae rearing tanks. The objective of this research was to evaluate the effect of stocking densities on larval stage development and crablet production of, S. tranquebarica. Four different initial stocking densities of larvae were tested using 200 L fiber glass tank, namely: A). 30 ind,/L, B). 45 ind./L, C). 60 ind./L and D). 75 ind./L. The larvae were fed on rotifer, Brachionus sp, and Artemia nauplii with addition of commercial diet. Water exchanged in the rearing tank was performed since seven days post hatching (dph) to 20 dph at a rate of 10 to 40%. Larvae from each experimental tank were sampled periodically (2 to 4 days interval) to calculate larvae population, larvae development index (LDI). Megalopa occurrences index (MOI), and crablet production are also calculated. The treatment B and D are showed the highest of LDI and MOI which are significantly different ($P<0.05$) to the other treatments. Furthermore, the highest of crablet production was obtained from treatment D = 495.3±22.48 ind./tank, which was significantly higher ($P<0.05$) compared to treatment A (48.5±4.94 ind./tank), treatment B (167.5±10.61 ind./tank) and treatment C (218.33±10.41 ind./tank). Therefore, the stocking density of 75 ind./L is optimum for S. tranquebarica larvae and recommended to be applied for commercial larvae production in the hatchery.

Keyword*: Production, crablet, stocking density, larvae, Scylla tranquebarica*

1. Introduction

Mud crab, *Scylla* spp is fisheries commodity with high economic value particularly in Asian countries (Keenan, 1999), Eeven if their life's is mostly spent in the mud sediment sorrounding mangrove area which often polluted (Susanto et al., 2014). Because of the movement is limited and easy to catch, almost all mud crab resources in Indonesia are highly exploited. On the other hands, mud crab *Scylla* sp has been cultured in brackishwater pond at several site including in Cenranae region , Bone regency, South Sulawesi. Besides, crab fattening, gonad maturation, and soft shell crab production has also been developed in South East Asian Countries like Indonesia (Herlinah et al., 2015), Malaysia (Hanafiah et al. 2017), Thailand (Lwin and Conley, 2012) and Philippine (Quinitio et al., 2015). However, mud crab seed used are mostly collected from the wild.

The mud crab seed production in hatchery is expected to fulfill the demand of the farmer and minimizing crabbing pressure on the wild population. Research on mud crab seed production conducted by researcher in several countries have discribed different result. For example in Vietnam, the larval rearing of *S. paramamosain* is developed in green water system by the addition of phytoplankton *Chlorella* sp at the density 1-2 million cel/mL (Truong et al., 2007), while in Indonesia the used of rotifer and enriched *Artemia* nauplii with HUFA and vitamin C are introduced by Gunarto dan Herlinah, (2015). In India Thirunavukkarasu et al. (2014) reported that larvae *S. transquebarica* to the crablet stage attain 6,9%. In Malaysia Anuar et al. (2011) megalopa stage of giant mud crab, *S. serrata* metamorphosis to the crablet stage 18%. Furthermore, Gunarto et al. (2013) have obtained megalopa stage of orange mud crab, *S. paramamosain* metamorphosis to the crablet stage at 40.14 %. Even though hard effort to establish hatchery technique for mud crab is being allocated, crablet production currently still fluctuated.

The stocking density of animal in aquaculture systems can affect survival rate (Matthew and Southgate, 2016). In high

stocking density the excessive of feed and metabolic waste will be accumulated in the waters which at the end can reduce larval vitality and in the long run can promote diseases outbreak (Subhashi et al., 2007). Morever, high stocking density in larval rearing will intensify cannibalisms particularly during megalopa stage (Gunarto et al., 2016). It is suggested that the stocking density of mud crab larvae is 30-200 ind./L (Anonimous, 2011). The wide range of larvae stocking density as suggested may indicate the variability of available rearing technique. Truong et al. (2007) reported that the combination between larvae stocking density, the density of given rotifer and *Artemia* nauplii could affect survival rate of *S. paramamosain* larvae. At rotifer density of 30-45 ind./mL and *Artemia* nauplii at 10-15 ind./mL resulted in the good performance of zoea-3 to zoea-5.

In the earlier study, larvae stocking density in mud crab hatchery system in Marana Maros was adjusted to be 100 ind./L (Gunarto and Herlinah, 2015). However, its often showing the problem of un-syncronized time for metamorphosis from zoea-1 to zoea-5 and finally resulted in only a few of larvae succeeded to reach the megalopa stage. It was also showed very low (0.01-0.03 and 0.10) of the Megalopa Occurrences Indices (MOI) in the first two days. (Gunarto et al., 2016a). In the other research when zoea-3 to megalopa stage given *Artemia* nauplii enriched with *Nannochloropsis* sp and HUFA, the MOI was increased to 0.30, while in the treatment without enriched with *Nannochloropsis* sp the MOI value stay at 0.10 (Gunarto et al., 2016b). However, the optimum stocking density on mud crab *S. tranquebarica* larvae rearing fed rotifer and Artemia nauplii enriched with HUFA and *Nannochloropsis* sp are never investigated.The objective of this research was to evaluate the effect of stocking densities on larval stage development which reared fed rotifer and *Artemia* nauplii enriched with HUFA and *Nannochloropsis* sp and also their crablet production.

2. Material and Methods

Time and location

The research is conducted at the Research Institute for Coastal Aquaculture and Fisheries Extention laboratory at Marana Research Station, Maros (4^{o}58'11.47" S, 119^{o}32'07.80" E) during February to April 2016.

Procedure

A total of 12 circular conical tanks each of 250 L in volume was filled with 200 L sterilized saline water (salinity 30 ppt). Healthy of mud crab larvae (indicated with swimming on the water surface) are stocked in each tank with different stocking densities, namely; A). 30 ind./L, B). 45 ind./L, C). 60 ind./L, dan D). 75 ind./L. Each treatment was conducted in three replications. Larvae from zoea-1 zoea-2 were fed HUFA (highly unsaturated fatty acid) enriched rotifer(*Brachionus* sp) at the density of 20-25 ind./ mL. As larvae grow, the food change to HUFA and *Nannochloropsis* sp enriched *Artemia* nauplii at the density of 3-5 ind./mL from larvae zoea-3 to megalopa stage. The HUFA enrichment of rotifer was performed at a dosage of 20 mg/L and artemia was enriched using HUFA at a dosage 200 mg/L and *Nannochloropsis* sp at the density 636 x 10^4 cell/mL (Gunarto and Herlinah, 2016). In addition, larvae from zoea-3 to the megalopa stage were also provided with commercial feed (protein 42 %, lipid 7 %, fiber 3 %, moisture 9 %) as shown in Table 1.

Table 1. Frequencies and dosage of feed given to the mud crab, *S. tranquebarica* larvae reared at different stocking densities

Stadium	Frequencies	Rotifer density (Ind./mL)	*Artemia Nauplii* density (Ind./mL)	Commercial artificial feed
Zoea-1	1	20	-	-
Zoea-2	1	25	-	-
Zoea-3	1	25	3.0	0.25 mg/L
Zoea-4	1	10	4.0	0.25 mg/L
Zoea-5	1	10	4.0	0.25 mg/L
Megalopa	1	-	5.0	0.50 mg/L
Crablet	2			0.10 mg/L

The water exchange in the rearing tank at a rate of 10 to 40% of every two days started at 8 dph to maintain good water quality condition until larvae metamorphosis to the crablet. Larvae sample was taken from each rearing tank once in every three days using a small basin to calculate the population. The number of larvae encountered from different point of water surface, then counted manually before the mean number of larvae/L was calculated. At the same times, 20 individual of larvae were taken from each tank and placed under the microscope to monitor larvae development by identifying the larvae stage (zoea-2, zoea-3, zoea-4, and zoea-5) based on the number of plumose setae and the length of pleopod. To calculate the LDI in each treatment, the scoring technique is applied to each larvae stage, namely; zoea-1=1, zoea-2=2 zoea-3=3, zoea-4=4, zoea-5=5, megalopa = 6. In the example, from the 20 larvae sampled, three piece larvae stage zoea-1; 13 piece larvae stage zoea-2 and four pieces larvae stage zoea-3 are found. The LDI value then calculated using the following equation:

$$LDI = \frac{3x1+13x2+4x3}{20} = 2.05$$

The MOI value was calculated based on the occurrences of megalopa per 100 individual zoea-5 in the thinning tank. Larvae thinned to another bigger tank at zoea-5 aimed at minimize the intensity of cannibalisms among megalopa or megalopa to zoea-5.

In example when the number megalopa found in 100 larvae (zoea-5) is seven, then the MOI value is 0.07. The number of 10 days old of Crab (later called crablet D-10) produced from each treatment is also counted. The other data collected such as water quality including ammonium, nitrite, Total Organic Matter (TOM) and total *Vibrio* sp are also discussed.

Data analysis

Data of LDI, MOI and crablet production from each treatment were compared and tested using varians analysis with Completely Randomized Design (one-way ANOVA) and continuously tested using Tukey test (α=0.05) whenever any significant different among treatments was found. IBM-SPSS-Statistics-24 program was used to that analysis.

3. Result and Discussions

Results

The larvae development showed by the larvae developmental stage, LDI, MOI, and crablet production were significant different ($P<0.05$) among treatment tested. The detail explanation of each parameter is provided below:

Larvae Development

At 5 dph, the fastest larvae development was found in D treatment indicated by the highest numbers of larvae zoea-2 and the lowest numbers of zoea-1. At 9 dph, the slowest larvae development was consistently occurred in A treatment where, larvae stay at zoea-2 and zoea-3 stage, while at the other treatments, a part of larvae population have developed to zoea-4. Contrary, fast larvae development at 13 dph is observed in B treatment where the all larvae have developed to zoea-4 and zoea-5, while zoea-3 still found at the another treatments. Besides, the highest of percentages of zoea-5 and megalopa stage are also shown in B treatment at 17 dph (Figure 1). Normally, mud crab larvae required three days to develop from zoea-2 to zoea-3 and from zoea-3 to zoea-4, while from zoea-4 to zoea-5 and zoea-5 to megalopa each required five days. The stage change from megalopa to crablet need six days. Therefore, the development of larvae from zoea-1 to the crablet stage need only 28 days.

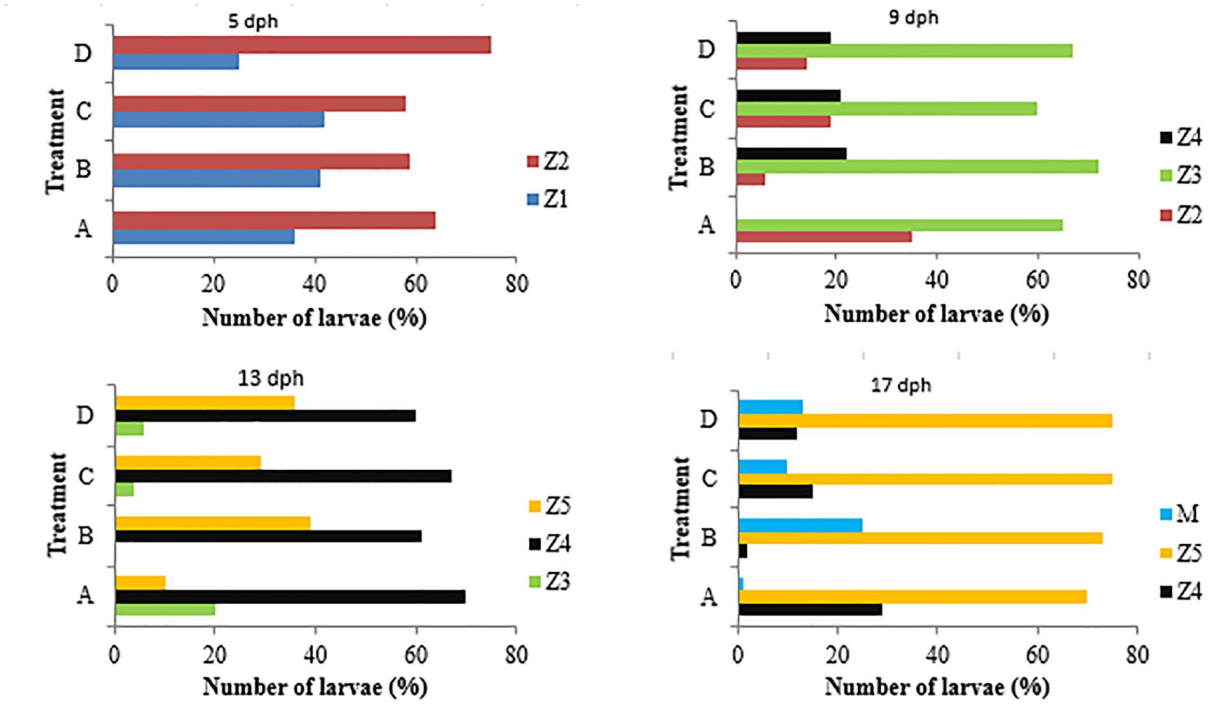

Figure 1. Percentage (%) of larvae stage from zoea-2 to megalopa stage during larvae rearing at different stocking densities (A=30 Ind./L; B=45 ind./L; C=60 ind./L; D=75 Ind./L).

Table 2. The percentages of decreasing of larvae population from zoea-1 to zoea-5 stage when larvae reared with different stocking densities

Treatment	Decreasing of larvae density (%) from zoea-1 to zoea-5				
	zoea-1	zoea-2	zoea-3	zoea-4	zoea-5
A).	0.0	7.8±1.55^{a}	4.8±1.62^{a}	51.2±0.84^{a}	10.1± 3.76^{ab}
B).	0.0	4.4±1.83^{a}	4.7±1.88^{a}	12.4±2.05^{b}	19.6±3.82^{a}
C).	0.0	9.4±2.04^{ab}	20.4±2.49^{b}	13.1±3.27^{b}	5.3±0.29^{b}
D)	0.0	19.9±1.10^{b}	5.5±0.89^{a}	12.9±1.42^{b}	5.4±1.94^{b}

Note: Means with different superscripts in the same column are significantly different at *P-0.05* (Tukey test). (A). 30 ind./L, B). 45 ind./L, C). 60 ind./L, dan D). 75 ind./L).

Table 2 showed that the number of larvae are decreased in population from a stage to another at different percentages. The highest percentage from zoea-1 to zoea-2 was found in D treatment and revealed significant different (P<0.05) with larvae decreasing population in A and B treatments. From zoea-2 to zoea-3 the highest decreasing population was found in C treatment and showed significant different (P<0.05) with A, B and D treatment. At zoea-3 to zoea-4 the highest decreasing larvae population was found in A treatment and showed significant different (P<0.05) with B, C, and D treatment. Whereas at zoea-4 to zoea-5 the highest larvae decreasing population was found in B treatment and showed significant different (P<0.05) with decreasing larvae population in C and D treatment.

Larvae Development Indices (LDI)

The LDI value of each treatment is presented in Table 3. The highest LDI value was found in D treatment when the larvae

developed from zoea-1 to the zoea-2 stage. However, there were not significantly different (P>0.05) with the other treatment. The highest of LDI value of zoea-2 to the zoea-3 is found in B treatment and there were significantly different (P<0.05) with A and C treatment. From zoea-3 to zoea-4 (13 dph) and at the zoea-4 to the zoea-5 larvae development is almost the same intensity in all the treatments except A treatment, while at zoea-5 to megalopa stage, the highest LDI was obtained in B treatment, followed by D, C and the lowest was found in A treatment.

Table 3 showed that stocking density of 45 ind./L (B) resulted the fastest of larvae development, then followed by larvae at the stocking density 75 ind./L (D), 60 ind./L (C) and the lowest was obtained at the stocking density of 30 ind./L (A).

Megalopa Occurrence Indices (MOI)

The MOI value and crablet production of each treatment are presented in Table 4.

Table 3. The Larvae Development Indices (LDI) at different age (dph) of mud crab, *S. tranquebarica* larvae reared at different stocking densities.

Stocking density	**0 dph**	**1 dph**	**8 dph**	**10 dph**	**12 dph**	**14 dph**	**16 dph**	**18 dph**
	Z1	Z1-Z2	Z2-Z3	Z3-Z4	Z3-Z4	Z4-Z5	Z4-Z5	Z-5 and Megalopa
A	1	1.6±0.05^{a}	2.0±0.1^{a}	2.7±0.1^{a}	3.3±0.1^{a}	3.9±0.1^{a}	4.4±0.2^{a}	4.7±0.03^{a}
B	1	1.6±0.00^{a}	2.3±0.2^{bc}	3.2±0.1^{b}	3.5±0.3^{a}	4.4±0.2^{b}	4.9±0.03^{b}	5.2±0.03^{b}
C	1	1.6±0.03^{a}	2.0±0.1^{a}	3.0±0.1^{a}	3.4±0.2^{a}	4.2±0.4^{b}	4.7±0.01^{b}	4.9±0.10^{cd}
D	1	1.7±0.07^{a}	2.1±0.1^{ac}	3.1±0.1^{c}	3.5±0.2^{a}	4.2±0.1^{b}	4.6±0.2^{b}	5.1±0.40^{d}

Note: Means with different superscripts in the same column are significantly different at *P-0.05* (Tukey test). (A). 30 ind./L, B). 45 ind./L, C). 60 ind./L, D). 75 ind./L). Z = zoea.

Table 4. Megalopa Occurrences Indices (MOI) and crablet production of mud crab *S. tranquebarica* larvae reared at different stocking densities.

Treatment	MOI and crablet-D-7 production (Ind./tank)		
	2/3/016 (day 1)* (day 22)**	3/3/016 (day 2)* (day 23)**	15/3/016 Crablet-D-7 (ind./tank) (day 35)**
A).	0.01^{a}	0.04^{a}	48,5±4,9^{a}
B).	0.07^{a}	0.40^{b}	167.5±10.6^{b}
C).	0,05^{a}	0.17^{c}	218.3±10.4^{c}
D).	0.2^{b}	0.44^{b}	495.3±22.5^{d}

Note: Means with different superscripts in the same column are significantly different at P-0.05 (Tukey test). (A). 30 ind./L, B). 45 ind./L, C). 60 ind./L, dan D). 75 ind./L). *: day one counted when started megalopa occurrence in the rearing tank **: day one counted from started of larvae rearing

Table 5. Mean of nitrite, ammonium, TOM concentration and *Vibrio* sp population observed in the tank of mud crab *S. tranquebarica* larvae reared at different stocking densities.

Treatment	Nitrite (mg/L)	Amonium (mg/L)	TOM (mg/L)	*Vibrio* sp population (L cfu/mL) day 20
A	0.04±0.01	0.11±0.01	44.7±1.3	3.79±0.2
B	0.05±0.01	0.38±0.007	47.5±2.6	3.77±0.04
C	0.04±0.02	0.18±0.02	47.2±3.1	3.59±0.01
D	0.05±0.03	0.33±0.09	42.8±0.4	3.78±0.20

Note: (A). 30 ind./L, B). 45 ind./L, C). 60 ind./L, dan D). 75 ind./L).

At the first day (22 dph) the highest MOI value (0.07) was observed in B treatment. However, there were not significantly different (P>0.05) with the other treatments. At the second day of the megalopa occurrence or at 23 dph, the highest MOI value was 0.44 (D) followed B (0.40) and both of them were significantly different (P<0.05) with treatment C (0.17) and A (0.04) (Table 4).

The highest number of crablet (D-10) production was obtained in D treatment (495.3±22.5 ind./tank), and showed significantly different (P<0.05) with crablet production in A (48.5±4.9 ind./tank), B (167.5±10.6 Ind./tank) and C treatment (218.3±10.4 Ind./tank).

Water quality

In this research, the water temperature ranged 27-29^{o}C during larvae rearing in all treatments. The mean of the other water quality parameters during larvae rearing until crablet stage showed in Table 5. Nitrite concentration relatively low during larvae rearing in all treatments, while ammonium, total organic matter (TOM) and total *Vibrio* sp were relatively high during larvae rearing (Table 5).

Discussion

The development of *S. tranquebarica* larvae from zoea-1 to crablet stage D-1 was required 28 days. The larvae in B treatment develop faster compared to the larvae in A, C and D treatments. These results are indicated that larvae rearing at low densities (except A treatment) have promoted better development to the consecutive stage compared to the higher stocking densities, such as in C and D treatment (Figure 1). It's also faster compared to *S. serrata* as reported by Anuar et al. (2011) where zoea-1 develop to crablet stage in 30-32 days. However, it was slower than reported Thirunavukkarasu et al. (2014) in India where *S. tranquebarica* larvae only required 22 days of rearing to reach crablet stage at water temperature 32.5-33 ^{o}C. Earlier research on larvae rearing of *S. paramamosain* at water temperature of 28.7-30.5 ^{o}C reported resulted in higher survival rate of zoea-5 compared to the larvae reared at water temperature 31-33 ^{o}C (Gunarto and Herlinah, 2013). The other research on *S. olivacea* larvae at the water temperature 30-31,5^{o}C resulted higher survival rate of zoea-5 compared than that the larvae reared at water temperature 28-29.5 ^{o}C (Gunarto dan Widodo, 2012). Furthermore, Zeng and Li (1992) reported that optimum water temperature for mud crab larvae rearing is 25-30^{o}C. While Nurdiani and Zeng (2007) recommended that water temperature in mud crab larvae rearing could be 28-30^{o}C. That mean varies time required by larvae to develop until crablet stage. It could depend on the feed fulfillment, water temperature and larvae helth. Thirunavukkarasu et al. (2014) stated that larvae development more influenced by water temperature stability, larvae stocking density, food quality, parasite, and another disease attack.

In this case related to different stocking densities of larvae in the rearing tank could be the feed fulfillment and larvae survival rate are the most factor that influences to the fast larvae development. In this research rotifer density given to the larvae from zoea-1 to zoea-3 was 20-25 ind./mL and started at zoea-3 to megalopa stage was given *Artemia* nauplii at the density 3-5 ind./mL. Truong et al. (2007) claimed that larvae fed rotifer at the density 45 ind./mL resulted in highest larvae survival rate, whereas when larvae fed rotifer at the density 60 ind./mL resulted in faster development. Because of limited rotifer in current research, larvae was only given rotifer at the density 20-25 ind./mL and found that highest larvae

mortality from zoea-1 to zoea-2 in D treatment (Table 2). It indicated that at the higher density of larvae (75 ind./L) required rotifer density should be more than 20-25 ind./mL. At larvae density, 45 ind./L (B) was developed faster compared to the larvae development in another treatment (Figure 1). It also conformed with the highest of LDI value at zoea-5 and megalopa at 19 dph (Table 3). Beside also high value of MOI at the day 2 in B treatment (Table 4). It means that rotifer density at 20-25 ind./mL fed to the larvae during zoea-1 to the zoea-3 stage and *Artemia* nauplii at density 3-5 ind./mL fed to the larvae during zoea-3 to megalopa stage is most suitable to support larvae development at the stocking density 45 ind./L in the rearing tank until develop to the crablet stage. Suprayudi et al. (2002) suggested that larva zoea-1 fed rotifer at the density 30 ind./mL, then increased the number of rotifer to 60 ind./mL. It will be able to support the larvae development at the stocking density 100 ind./L. *Artemia* nauplii also to be given at the high density (10-20 ind./mL) at zoea-4-5 stage (Truong et al., 2007). In this research enhancing of a total number of *Artemia* nauplii given to zoea-4-5 was only five ind./mL. However, in this research, the larvae zoea-3 to megalopa stage was also fed artificial feed at the dosage 0.25-1.0 mg/L. It confirmed with the Serrano and Traifalgar, (2012) reported that *S. serrata* larva zoea-3 to megalopa stage were produced higher amylase, leucine aminopeptidase so that able to digest artificial feed in the stomach.

Earlier research showed that the highest survival rate of *S. paramamosain* larvae at the stocking density of 100 ind./L from zoea-1 to zoea-5 was 40 % (Gunarto et al., 2013). In the current research, the highest of survival rate of zoea-5 (58.6 %) was obtained in B treatment (45 ind./L), followed by D (75 ind./L= 56.3%), C (60 ind./L= 51.8 %) and the lowest in A (30 ind./L= 26.1 %) treatment. The feeding regime used in this research has provided balance nutrition and support larvae with high vitality during critical period at 4 dph resulted in high survival rate. Ribeiro and Jones, (2000) also Davis, (2003) reported that EPA and DHA content in the larvae feed could enhance the larva, megalopa, and crablet development. Takeuchi et al. (2000) also suggested that rotifer and *Artemia* nauplii should be enriched using HUFA before fed to the krustacean larvae.

Gunarto et al. (2016[b]) reported that the highest of MOI value (0.294) at the day 24 and crablet production of 191 ind./tank on the orange mud crab, *S. olivacea* is obtained after the zoea-3 are fed *Artemia* nauplii enriched using HUFA and *Nannochloropsis* sp. Suprayudi et al. (2012) also claimed that molting synchronicity on mud crab larvae is depending on the existence of phospholipids and essential fatty acid in their feed. The *Nannochloropsis* sp and HUFA enriched *Artemia* applied from zoea-3 to megalopa stage was produced crablet at 48.5±4.9/tank; 167.5±10.6 ind./tank; 218.3±10.4 ind./tank dan 495.3±22.5 ind./tank for the stocking density of 30, 45, 60 and 75 ind./L respectively. This performed that stocking density of mud crab larvae related to the crablet production and recommended that stocking density of mud crab larvae at 75 ind./L is ideal for mud crab hatchery operation.

Water quality and total Vibrio sp in the rearing tank

The water quality is very important to maintain of healthy larvae. Water salinity at 28-30 ppt, and after larvae attain megalopa stage the salinity in the rearing tank was reduced to 25 ppt. Nurdiani and Zeng, (2007) reported that larvae *S. serrata* tolerant to the weidth salinity range. When larvae reared at the salinity 20-30 ppt and water temperature at 25-30^{o}C was obtained high survival rate. Gunarto and Herlinah (2013) reported that water temperature optimum for larvae rearing of *S. paramamosain* was 28.7–30.5^{o}C. Hamazaki (2003) reported that optimum water temperature for mud crab larvae *S. serrata* was 29 ^{o}C, while Nurdiani and Zeng (2007) showed that optimum water temperature for larvae rearing of *S. serrata* was 28 – 30 ^{o}C. In the current research, the water temperature was lower namely (27-29^{o}C) than optimum water temperature as reported by Hamazaki (2003).

Water pH relatively stable during larvae rearing at 7.6-8.0. Nitrite concentration very low in all treatment tank (< 0,1 mg/L). The 50% lethal dosage (LD-50) for the nitrite concentration during 96 hours for the larvae *S. serrata* stadium zoea-1, 2, 3, 4, 5 were 41.58; 63.04; 25.54; 29.98; and 69.93 mg/L (Mary et al., 2007). Ammonium concentration in larvae rearing tank at the range of 0.1-0.38 mg/L. It concentration still save to larvae rearing. 50% of the lethal dosage of ammonium concentration during 48 hours for the larvae *S. serrata* zoea-5 stage was 4.05 mg/L, while for the megalopa stage was 6.64 mg/L (Nell et al., 2005).

The water exchanges conducted every two days in larvae rearing seems to be the main

factor influenced to the low of nitrite and ammonium concentration in the rearing tank. However, total organic matter (TOM) (42-47 mg/L) relatively high due to the loading of organic material come from excessive of artificial feed and metabolic activity also die of uneaten rotifer and *Artemia* nauplii. It may impact to the increased of *Vibrio* sp population in the rearing tank.

4. Conclusion

Based on the crablet production at the end of the research, it concluded that the best stocking density found in D treatment (75 ind./L) due to the highest of crablet production, (495.3±22.48 ind./tank) compared the other treatments.

Acknowledgements

This research is financed by the aquaculture research program DIPA 2016, Research and Development Institute for Coastal Aquaculture, Maros. Ministry of Marine Affairs and Fisheries. We would like to thank Sainal and Risal for their assistance during the research.

References

Anonimous. 2011. Hatchery operation *in* Mud Crab Aquaculture. Part 5. *A Practical Manual.* FAO Fisheries and Aquaculture Technical Paper 567. Shelley, C., and A. Lovatelli (Eds). Food and Agriculture Organization of the United Nations, Rome.31-40 pp.

Anuar, H., Hai, T.N., Anil, C., Sukumaran, M. 2011. Preliminary study on the feeding regime of laboratory reared mud crab larva, *Scylla serrata* (Forsskal, 1775). Word Applied Sciences Journal : 14(11):1651-1654.

Davis, J.A. 2003. Development of hatchery techniques for the mud crab, *Scylla serrata* (Forskal) in South Africa Ph.D. Thesis, Faculty of Agricultural and Applied Biological Sciences, Ghent University, Belgia. 163 hlm.

Gunarto, Widodo, A. F. 2012. Pengaruh perbedaan suhu air pada perkembangan larva kepiting bakau, *Scylla olivacea*. Prosiding Indoaqua, Forum Inovasi Teknologi Akuakultur 2012. Puslitbang Perikanan Budidaya. Jakarta. Hlm.: 281-287.

Gunarto, Nurbaya, Zakaria, M. 2013. Pemeliharaan zoea-5 dan megalopa kepiting bakau, *Scylla olivacea* dengan wadah berbeda. Prosiding Konferensi Akuakultur Indonesia 2013. Masyarakat Akuakultur Indonesia. Hlm : 28-36.

Gunarto, Herlinah. 2013. Pemeliharaan larva kepiting bakau, *Scylla olivacea* menggunakan sistem air hijau. Prosiding Forum Inovasi Teknologi Akuakultur 2013. Perakitan Strain dan Pemanfaatan Induk Unggul Kesehatan Ikan dan Lingkungan. Pusat Penelitian dan Pengembangan Perikanan Budidaya, Jakarta. Hlm.:1207-1213. ISBN 978-979-789-046-9.

Gunarto, Herlinah. 2015. Tingkat produksi *crablet* kepiting bakau *Scylla paramamosain* dengan pemberian pakan diperkaya dengan HUFA dan vitamin C pada fase larva. Jurnal Ilmu dan Teknologi Kelautan Tropis 7(2):511-520.

Gunarto., Syafaat, M. N., Herlinah, Parenrengi, A., Mustafa, A. 2016[a]. Aspek biologi dan teknik produksi benih kepiting bakau, *Scylla* spp. Badan penelitian dan Pengembangan Kelautan dan Perikanan. Kementerian Kelautan dan Perikanan. 62 hlm.

Gunarto, Parenrengi, A.,Septiningsih, E. 2016[b]. Crablet of mud crab, *Scylla olivacea* production from the different stage of larvae fed *Artemia* nauplii enriched using *Nannochloropsis* sp. International Journal of Agriculture System 4(2): 132-146.

Hanafiah, F., Waiho, K., Norfaizza, W.I.W., Megat, F. H., Ikhwanuddin, M. 2017. Inter-species mating among mud crab genus *Scylla* in captivity. Aquaculture 471 : 49-54.

Hamasaki, K. 2003. Effects of temperature on the egg incubation period, and survival and developmental period of larvae of the mud crab, *Scylla serrata* (Forskal) (Brachyura: Portunidae) reared in the laboratory. Aquaculture 219: 561-572.

Herlinah, Tenriulo, A., Septiningsih, E., Suwoyo, H.S. 2015. Survival and response molting of mud crab (*Scylla olivacea*) injected with murbey (*Morus* spp.) leave extract. Jurnal Ilmu dan Teknologi Kelautan Tropis 7(1): 247-258.

Keenan, C. P. 1999. Aquaculture of mud crab, genus *Scylla* past, present, and future.

In: *Mud Crab Aquaculture and Biology*. *ACIAR Proceedings*, Vol. 78 (ed. by C. P. Keenan & A. Blacks haw), ACIAR, Canberra. Australia. 9-13pp.

Lwin, M. M., T., N., Conley, D. 2011. My Personal Experience as a Burmese.

Mary, L. S-A., Fe, P-E., Gonzales, G. A. 2007. Acute toxicity of nitrite to mud crab *Scylla serrata* (Forsskal) larvae. Aquaculture Research 38(14): 1495-1499.

Matthew, W., Southgate, P. C. 2016. The effects of stocking density and ration on survival and growth of winged pearl oyster (*Pteria penguin*) larvae fed commercially available micro-algae concentrated. Aquaculture reports (4): 17-21.

Nell, L.L., Fotedar, R., Shelley, C. C. 2005. Effects of acute and chronic toxicity of unionized ammonia on mud crab, *Scylla serrata* (Forsskal, 1755) larvae. *Aquaculture Research,* 36:927-932.

Nurdiani, R. Zeng, C. 2007. Effects of temperature and salinity on the survival and development of mud crab, *Scylla serrata* (Forsskal), larvae. *Aquaculture Research,* 38: 1529-1538.

Quinitio, E. J. T, Libunao, G. X. S., Parado-Estepa, F. D., & Calpe, A. T. 2015. Soft-shell crab production using hatchery-reared mud crab. Tigbauan, Iloilo, Philippines: Aquaculture Department, Southeast Asian Fisheries Development Center; Los Baños, Laguna: Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development Aquaculture extension manual; No. 61. 25 pages. https://repository.seafdec.org.ph/handle/10862/3056?show=full).

Ribeiro, E.A.L.T., Jones. D.A. 2000. Growth and ontogenetic change in activities of digestive enzymes in *Fenneropenaeus indicus* postlarvae. *Aquaculture Nutrition,* 6:53-64.

Serrano, Jr. A. E., Traifalgar, R. F. 2012. Ontogeny and induction of digestive enzymes in *Scylla serrata* larvae fed live or artificial feeds or their combination. AACL bioflux 5(2): 101-111.

Subhashi, S. K., Lipton, A. P., Raj, R. P. 2007. Stocking density dependent bacteria load and its influence on the production of Pear oyster, *Pinctada fucata* (Gould) seed. Indian Journal of Animal Sciences 77: 420-423.

Suprayudi, M.A., Takeuchi, T., Hamazaki, K., Hirokawa. J. 2002. Effect of N-3HUFA content in rotifers on the development and survival of mud crab, *Scylla serrata*, larvae. Suisanzoshoku 50(2): 205-212.

Suprayudi, M.A., Takeuchi, T., Hamasaki, K. 2012. Phospholipids effect on survival and molting synchronicity of larvae mud crab *Scylla serrata*. HAYATI Journal of Biosciences 19(4):163-168.

Susanto, F., Hidayati, N. V., Syakti, A. D. 2014. Assessment of cadmium (Cd) contamination in mud crab (*Scylla* spp) and sediment from Segara Anakan Lagoon, Cilacap, Indonesia. Omni-Akuatika 10 (2) : 60-70.

Takeuchi, T. 2000. A review study on the effect of dietary n-3 highly unsaturated fatty acids on larvae swimming crab *Portunus trituberculatus* and mud crab *Scylla paramamosain*. The proceeding of the JSPS-DGHE International Symposium Fisheries Science in Tropical Area. Bogor Indonesia, Hlm: 244-247.

Thirunavukkarasu, N., Nesakumari, S. A., Shanmugam, A. 2014. Larva rearing and seed production of mud crab *Scylla transquebarica* (Fabricius, 1798). International Journal of Fisheries and Aquatic Studies 2 (2) : 19-25.

Truong, T., N., Mathieu, W., Tran, C. B., Hoang, P. T., Nguyen, V. D., Sorgeloos. P. 2007. Improved techniques for rearing mud crab *Scylla paramamosain* (estampador 1949) larvae. Aquaculture Research 38:1539-1553.

Zeng, C., Li. S. 1992. Effects of temperature on survival and development of the larvae of *Scylla serrata*. Journal of Fisheries of China 16**:** 213–221.