Growth Performance of Blue Swimming Crab Larvae (*Portunus Pelagicus*) At Controled Temperature

Muslimin1, Yusinta Fujaya[2], Dody Dh. Trijuno[2] dan Syafiuddin[3]

[1]Student of Agricultural Postgraduate Program, Hasanuddin University, Makassar, Indonesia
[2]Aquaculture Study Program, Faculty of Marine Affairs and Fisheries, Hasanuddin University, Makassar, Indonesia
[3]Marine Study Program, Faculty of Marine Affairs and Fisheries, Hasanuddin University, Makassar, Indonesia

DOI: 10.29322/IJSRP.9.10.2019.p9442
http://dx.doi.org/10.29322/IJSRP.9.10.2019.p9442

Abstract- The main problem in blue swimming crab hatchery is the low survival rate of larvae, especially in the zoea stage to megalopa. This study aimed to examine the effect of temperature on survival and metamorphosis rate of blue swimming crab larvae (*Portunus plagicus*). The study was run at the Takalar Brackish Aquaculture Fisheries Center, South Sulawesi, Indonesia. Test larval used were stadia zoea-1 of blue swimming crab larvae. The vessel uses an 80 L plastic bucket with 70 L of 32 to 33 ppt sea water. The diet used both Rotifers and Nauplius. The study used a completely randomized design (CRD) consisting of 4 temperature treatments and 4 replications, the temperature was 27, 29, 31 and 33 ^{0}C. Survival data and larval size were analyzed using variance (ANOVA), while the rate of metamorphosis was analyzed descriptively. The results showed that the temperature had a very significant effect (P <0.01) on survival, but it did not have a significant effect (P> 0.05) on the size of the blue swimming crab larvae (*P. plagicus*). The highest survival rate of blue swimming crab larvae was found at 31 ^{o}C, while the best metamorphosis rate was recorded at 29 ^{o}C.

Index Terms- blue swimming crab larvae, metamorphosis, survival rate, temperature

I. Introduction

Blue swimming crab is a commodity that has bright prospects and is increasingly in demand in the world market, hence it is a challenge that encourages every stakeholder to meet the people needs for crabs. However, most people still depend on fishing from wild crab population, where the activity makes the volume of crab exports fluctuates from year to year. This situation is actually a new opportunity in the business of crab farming, therefore, to support crab farming, breeding is needed to meet the supply of juvenile crabs that are ready to be cultivated, and the business of crab farming does not interfere with crab stocks in nature.

The common problems in crab hatcheries are the unavailability of simple crab hatchery technology that is easily applied (Arsenal, 2014), low survival and growth at the larval stage. Most larvae experience high mortality before metamorphosis to reach megalopa due to microbial infection, predation or due to failure to cope with stress due to changes in environmental factors such as temperature, salinity or pH (Talpur and Ikhwanuddin, 2012).

As the first step to increase crab production from aquaculture is the supply of crab juvenile that is ready to be stocked. To produce high survival rate, optimal environmental conditions are required because the frequency of moulting and growth of crabs are highly affected by environmental conditions. Temperature is one of the environmental abiotic factors that affects the survival and metamorphosis rate of the zoea stadia in crab hatchery. Thus, this study was undertaken to determine effects of temperature on survival and metamorphosis rate of blue swimming crab larvae (P. pelagicus).

II. MATERIAL AND METHOD

The research was conducted in Takalar Brackish Aquaculture Fisheries Center, South Sulawesi, Indonesia. The blue swimming crab larvae at zoea-1 stadia was used with a density of 50 larva/L. The crab larvae were stocked in a 80 L plastic bucket with 70 L seawater with the salinity of 32-33 ppt. The diet used were rotifers and Artemia nauplius with the frequency of feeding are suitable to the larval stage. The study was conducted in a completely randomized design (CRD), consisting of 4 different temperatures with 4 replications. The temperature were 27, 29, 31 and 33 ^{0}C. Data of survival and larval size were analyzed by Analysis of Variance (ANOVA), while the rate of metamorphosis was descriptively analyzed.

The parameters observed were survival rate, metamorphosis rate and size of blue swimming crab larvae. The survival rate was calculated using Effendie's formula (1979) :

$S = (Nt / No) \times 100\%$

In which:

S = Survival rate (%)
Nt = The number of larvae at the end of the study (larval)
No = The number of larvae at the beginning of the study (larval)

Metamorphosis rate was measured by blue swimming crab larval stage index using Arshad dkk. (2008), as follows:

$LSI = \{(St \times Lt) + (Si \times Li)\}/Ts$

In which:

LSI = Larval stage index
St = Larval sample for the next stage
Si = Larval sample for the previous stage
Lt = The number of larvae at the next stage

Li = The number of larvae at the previous stage
Ts = Total number of samples

Larva size includes body weight, total length, and body length. Body weight and length measurements were taken at the end of the study. Weight measurements using an analytical balance (0.0000 g), while the measurement of larval length using a microscope. The total length of the larvae was measured from the tip of the rostrum to the end of the telson and body length was measured from the base of the rostrum to the base of the telson.

III. RESULT AND DISCUSSION

RESULT

The mean survival rate of the blue swimming crab larvae Z_1 - Z_4 on four different treatment is shown in Table 1.

Table 1. The survival rate average of the blue swimming crab larvae Z_1 - Z_4 at four different treatments

Treatment (ºC)	Survival Rate (%)
27	19.33 ± 1.11 ^{a}
29	20.75 ± 0.57 ^{a}
31	24.09 ± 0.32^{b}
33	20.83 ± 0.69^{a}

Note: different letters in the same column show significant differences between treatments at the 5% level ($P < 0.05$)

The mean larval stage index of the blue swimming crab larvae Z_1-Z_4 at four different treatments are presented in Table 2.

Table 2. The Larva Stage Index (LSI) average of the blue swimming crab larvae Z_1-Z_4 at four different treatments

Treatment		**Age of Larvae (day)**											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
27 ºC	LSI	1	1	1.1	1.3	1.7	1.7	2.5	2.6	3	3.4	3.6	4.4
	Stadia	Z_1	Z_1	Z_1	Z_1	Z_2	Z_2	Z_2	Z_3	Z_3	Z_3	Z_4	Z_4
29 ºC	LSI	1	1	1.2	1.4	1.6	1.8	2.5	2.7	2.9	3.6	4.0	4.2
	Stadia	Z_1	Z_1	Z_1	Z_1	Z_2	Z_2	Z_2	Z_3	Z_3	Z_4	Z_4	Z_4
31 ºC	LSI	1	1	1.1	1.3	1.7	1.8	2.4	2.7	3.1	3.5	3.9	4.0
	Stadia	Z_1	Z_1	Z_1	Z_1	Z_2	Z_2	Z_2	Z_3	Z_3	Z_3	Z_4	Z_4
33 ºC	LSI	1	1	1.1	1.2	1.6	1.6	2.3	2.7	3.2	3.4	4.0	4.1
	Stadia	Z_1	Z_1	Z_1	Z_1	Z_2	Z_2	Z_2	Z_3	Z_3	Z_3	Z_4	Z_4

The mean size (total length, body length and weight) of the blue swimming crab larvae Z_1-Z_4 for four different treatment are shown in Table 3.

Table 3. The Size average (total length, body length and weight) of the blue swimming crab larvae Z_1-Z_4 in four different treatments

Treatment (ºC)	Total Length (µm)	Body Length (µm)	Body Weight (g)
27	4228.377 ± 167.1991^{a}	2950.858 ± 68.8112^{a}	0.002333
29	4237.424 ± 153.0696^{a}	2989.956 ± 82.3297^{a}	0.002636
31	3819.049 ± 544.4801^{a}	2902.860 ± 364.0756^{a}	0.002600
33	3704.276 ± 553.8385^{a}	2720.609 ± 314.9689^{a}	0.003400

Note: the same letter in the same column shows no significant difference between treatments at the 5% level ($P > 0.05$)

IV. DISCUSSION

The results showed that the temperature significantly affected (P>0.05) the survival rate of blue swimming crab larvae Z_1-Z_4 in each treatment. The best survival rate was found at a temperature of 31 ^{0}C with the survival rate of 24.09 ± 0,32%, while the lowest survival rate was observed at 27 ^{0}C with survival rate of 19.33 ± 1.11%. These results indicate that blue swimming crab larvae tend to be at temperatures that are not too cold or warm.

Temperature is one of the environmental factors that can directly affect the life of aquatic organisms, including blue swimming crab larvae. Temperature can determine the high or low survival rate of crab larvae. According to Zaidin, et.al. (2013), water temperature significantly influences the survival of blue swimming crabs and other marine organisms, where temperature changes have a significant effect on the metabolic rate and activity of other organisms.

Besides, the temperature can affect the high and low solubility of oxygen in the water and the level of oxygen consumption of crab larvae. Changes in environmental factors such as temperature, dissolved oxygen, salinity, and other water quality can affect the time and frequency of moulting and an increase in crustacean size (Setyadi, 2008). Annual temperature variations can affect the peak spawning season which varies between the geographical locations of the waters (de Lestang et.al. 2003). Temperature is one of the important abiotic factors that affect activity, appetite, oxygen consumption, and the rate of crustacean metabolism (Zacharia and Kakati, 2004).

Temperature is one of the most important environmental factors in the rearing of crab larvae, as it has been suggested that temperature can affect larvae in terms of morphology, metabolism, oxygen consumption, food predation rates, growth and development, survival and biochemical composition during their initial stages. (Dahlhoff, 2004; Pepin, 1991; Portner et.al., 2005; Shirley et.al., 1987). In this study, the highest survival rate was found at 31 ° C, while at the temperature of 27, 29 and 33 ° C, a lower percentage of survival rates was observed. A similar study was conducted by Bryars and Havenhand (2006), and they found high survival rates of *P. pelagicus* larvae at 25 ° C, while high mortality was observed at 17 ° C.

Recent studies have found that temperature is an abiotic factor that strongly influences P. pelagicus larvae during larval rearing periods. Temperature not only affects the survival rate, growth rate, metamorphosis rate, and molting period but also affects the development of the lysosome membrane, which affects intracellular digestion (Lima and Pechenik, 1984; Deschaseaux et.al., 2011). Furthermore, Moullac (2000) reports that at 40 ° C is the extreme temperature for larvae, while the optimal temperature ranges from 25-30 ° C results in better survival of crab larvae.

In the present study, the water temperature used during the rearing of blue-swimming crab larvae is in an optimal range for the survival of the crab larvae, which is 27-33 ºC. This refers to the finding of Juwana and Romimohtarto (2000), who stated that the optimal temperature for the megalopa phase of blue-swimming crab larvae ranges from 28 to 34º C. Ikhwanuddin et al. (2012) stated that the optimal temperature for the rearing of P. Pelagicus larvae was 30 ºC.

The measurement of the blue swimming crab larva metamorphosis rate as shown through the Larva Stage Index (LSI) showed that at temperatures of 27, 31 and 33 °C, the crab metamorphosis rate are slow and the larval phase period becomes longer in the Z3 stage, where at the Z3 stage the period reaches 3 days and then changes to Z4 stage, while at a temperature of 29 °C the rate of metamorphosis is faster where the Z3 stage only takes 2 days to reach the Z4 stage. This result was in line with the finding of Baylon et.al., (2001) who conducted studies on mangrove crabs (Scylla serrata), found that during the rearing period, the optimum temperature for the highest metamorphosis rate of S. serrata larvae to megalopa was 26-29 °C.

Furthermore, the results of the study showed that the temperature (treatment) had no significant effect (P> 0.05) on the average size of the crab larvae (Table 3). This shows that at all levels of the treatment, the size of the swimming crab larvae is relatively not different. However, the temperature remains a limiting factor for maintenance of crab larvae, because it affects the survival and rate of metamorphosis. According to Josileen and Menon (2005), the two most important environmental factors that affect moulting and growth in crustaceans are the temperature, quality, and quantity of food. Compared to these parameters, light and salinity are not significantly affect the moulting and intermoult periods which both of these variables are the growth factor of crustacean larvae. Similarly, Susanto et.al. (2003) reported that the length of change in metamorphosis is caused by temperature, feeding patterns and feed nutrients.

The results of the present study also showed that the crab larvae in the zoea stage have a low tolerance to temperature, this is shown by the performance (size and survival) of crab larvae when reared at inappropriate temperature conditions, significantly affect survival rate but do not have a significant effect on the size of the larvae. Temperature is one of several environmental factors that directly affect the life of crustacean larvae, hence temperature can be a determining factor in the survival rate of larvae. According to Reiber and Birchard (1993), the main effect of temperature on the physiology of crustaceans is to increase the rate of intermolecular friction and the rate of chemical reactions.

V. CONCLUSION

Based on the results of the research, it can be concluded that the highest survival of crab larvae (P. pelagicus) was found at the temperature of 31 °C and the shortest metamorphosis rate was observed at the temperature of 29 °C, while the lowest survival rate was at 27 °C. Temperature does not significantly affect the size of the crab larvae.

REFERENCES

[1] Baylon, J.C., A.N. Failaman & E.L. Vengano. 2001. Effect of salinity on survival and metamorphosis from zoea to megalopa of the mud crab *Scylla serrata* Forskal (Crustacea: Portunidae). Asian Fisheries Science. 14:143-151

[2] Bryars, S. R. and Havenhand, J. N. 2006. Effects of constant and varying temperatures on the development of blue swimmer crab (Portunus pelagicus) larve: Laboratory observatons and field predictions for temperate coastal waters. Journal of Experimental Marine Biology and Ecology. 329, 218-229.

[3] Dahlhoff, E. P. 2004. Biochemical indicators of stress and metabolism: Applications for marine ecological studies. Annual Review of Physiology. 183-207.

[4] Deschaseaud, E., Taylor, A. and Maher, W. 2011. Measure of stress response induced by temperature and salinity changes on hatched larvae of three marine gastropod species. Journal of Experimental Marine Biology and Ecology. 397, 121-128.

[5] de Lestang, S., N. G. Hall &I. C. Potter. 2003. Reproductive biologyof the blue swimmer crab (Portunus pelagicus, Decapoda: Portunidae) in five bodies of water on the west coast of Australia. Fish. Bull., 101: 745-757.

[6] Ikhwanuddin, M., M.N. Azra, M.A.D. Talpur, A.B. Abol-Munafi & M.L. Shabdin. 2012. Optimal water temperature and salinity for production of blue swimming crab, Portunus pelagicus 1st day juvenile crab. Aquaculture, Aquaculture, Conservation & Legislation. 5(1):4-8

[7] Josileen, J. dan Menon, N.G. 2005. Growth of the Blue Swimmer Crab, *Portunus pelagicus* (Linnaeus, 1758) (Decapoda, Brachyura) in Captivity. Koninklijke Brill NV, Leiden, Crustaceana 78 (1): 1-18

[8] Juwana dan K. Romimohtarto. 2000. *Rajungan, Perikanan, Cara Budidaya dan Menu Masakan*. Djambatan. Jakarta.

[9] Lima G. M. and Pechenik, J. A. 1985. The influence of temperature on growth rate and length of larval life of the gastropod, Crepidula plana Say. Journal of Experimental Marine Biology and Ecology. 90, 55-71.

[10] Pepin, P. 1991. Effect of temperature & size on development, mortality, and survival rates of the pelagic early life history stages of marine fish. Canada Fisheries Aquatic Wildlife Research Science. 48, 504-518.

[11] Portner, H. O., Storch, D. and Heilmayer, O. 2005. Constraints and trade-offs in climate-dependent adaptation: energy budgets and growth in a latitude cline. Journal of Marine Sciences. 69, 271-285.

[12] Reiber, C. & G.F. Birchard. 1993. Effect of temperature on metabolism and hemolymph pH in the Crab Stoliczia abotti. J. Therm. Biol. 18(1):45-92

[13] Setyadi,I. 2008. Pengaruh Suhu yang Berbeda terhadap Sintasan Larva Rajungan (Portunus pelagicus) di Wadah Terkontrol. Balai Besar Riset Perikanan Budidaya Laut Gondol Bali 7: 1-5.

[14] Shirley, S. M., Shirley, T. C. and Rice, S. D. 1987. Latitudinal variation in the Dungeness crab, Cancer magister: zoeal morphology explained by incubation temperature. Marine Biology. 95, 371-376.

[15] Susanto, B., I. Setyadi, M. Marzuqi, M. Syahidah & I. Rusdi. 2003. Pengaruh Pemberian Pakan yang Berbeda Terhadap Pertumbuhan dan Sintasan Benih Rajungan Portunus sp. Laporan Teknisi Balai Besar Riset Perikanan Budidaya Laut, Gondol Bali.

[16] Zacharia, S and Kakati, V. S. 2004 Optimal Salinity and Temperature of Early Developmental Stages of Penaeus merguensis de Man. Journal Aquaculture 232: 378-382.

[17] Zaidin, M.Z., Effendy, I.J., dan Sabilu, K. 2013. Sintasan Larva Rajungan (*Portunus pelagicus*) Stadia Megalopa Melalui Kombinasi Pakan Alami Artemia salina dan *Brachionus plicatilis*. Jurnal Mina Laut Indonesia, Vol. 1 (1): 112-121

AUTHORS

First Author – Muslimin, Student of Agricultural Postgraduate Program, Hasanuddin University, Makassar, Indonesia, Email:musdradja1967@gmail.com

Second Author – Yusinta Fujaya, Aquaculture Study Program, Faculty of Marine Affairs and Fisheries, Hasanuddin University, Makassar, Indonesia

Third Author – Dody Dh. Trijuno, Aquaculture Study Program, Faculty of Marine Affairs and Fisheries, Hasanuddin University, Makassar, Indonesia

Fourth Author – Dan Syafiuddin, Marine Study Program, Faculty of Marine Affairs and Fisheries, Hasanuddin University, Makassar, Indonesia