EFFECTS OF REARING WATER AND TANK ON LARVAL SURVIVAL RATE OF WHITE-STRIPED CLEANER SHRIMP *Lysmata amboinensis*

Luc Minh Diep[1], Phung The Trung[1], Vu Đinh Chien[2]

Received: 7.Nov.2017; Revised: 8.Jan.2018; Accepted: 29.Mar.2018

ABSTRACT

The white-striped cleaner shrimp Lysmata amboinensis is a favorite ornamental species in Vietnam and worldwide, but the rearing conditions for larvae of this species has not been studied yet. Therefore, this study was conducted to determine proper conditions for larval rearing of white-striped cleaner shrimp Lysmata amboinensis. The experiment was designed as completely randomized design with 9 treatments, including 3 types of rearing water (disinfected water using chlorine, green-water and biofilter-water) and 3 types of tank (upwelling, Weis and Kreisel tank). Each treatment had 3 replicates, resulting in a total of 27 experimental units. The experimental units were tanks filled with 5L of one of three types of rearing water. The results showed that larval survival was similar among three different water types. Larval survival was higher in Kreisel tanks than in upwelling and Weis tanks. There was no interactive effect between rearing water and tank type on the survival rate of the cleaner shrimp larvae. Therefore, disinfected water (lower operation cost) and Kreisel tank are recommended for rearing of white-striped cleaner shrimps.

Keywords: Lysmata amboinensis, white-striped cleaner shrimp, Kreisel, Weis.

I. INTRODUCTION

The demand of ornamental organisms has been rising rapidly during the last decades with a total annual value of 200-300 million USD [2; 7]. There are many marine species such as finfish, starfish, jellyfish, mollusk and crustacean that are cultured in aquarium nowadays. Among ornamental species, white-striped cleaner shrimp *Lysmata amboinensis* is one of the favourite ornamental species as they have attractive appearance and behavior [5]. This species also has high trading value. For example, the price per individual typically varies from 65-85 USD [8]. However, most of them are caught from coral reefs with unsustainable methods, causing high pressure to natural environment [3].

Although *Lysmata amboinensis* has high market demand and value, there is a lack of studies on the broodstock culture and efforts in rearing larvae are, unfortunately, unsuccessful [8]. Therefore, research on white-striped shrimp production that includes artificial seed production is, no doubt, contributing to satisfy local and global market demand.

However, seed production of white-striped shrimp, as also for other marine crustacean species, is still facing great challenges. This is because the development of crustacean larvae consists of many stages with complex morphological and physiological characteristics [3]. Furthermore, during early larval stages, *Lysmata* are weak swimmers and sensitive to environmental conditions, resulting in a very low survival rate. Therefore, the proper rearing water and tank design may considerably increase the survival.

More generally, there are 3 water systems in rearing crustacean larvae that are static water, raceway water and biofiltered water. Static water is only proper to culture larvae at low density at laboratory scale for some research purposes such as determination of larval characteristics or requirements [1; 9; 10]. Raceway water and biofiltered water could maintain and improve water quality but it is difficult to operate the system for long time [1; 6]. Besides, the larvae could be reared in some types of tanks such as normal tank, upwelling tank, Weis tank and Kreisel tank that have been introduced and recommended to rear ornamental crustacean larvae [4; 10]. Howerver, a proper rearing tank and water system for rearing *Lysmata amboinensis* larvae

[1] Institute of Aquaculture, Nha Trang University
[2] Aquaculture master student, Nha Trang University

had not been reported.

This experiment was designed to determine the effects of rearing water and types of rearing tank on white-striped cleaner shrimp larval mortality. Based on the results, larval rearing performance of *Lysmata amboinensis* could be improved with proper rearing tank and water treatment.

II. MATERIALS AND METHODS

1. Experimental design

The experiment was conducted indoor with a completely randomized design that included 2 factors, rearing water and tank. There were 3 types of water and 3 types of tank, resulting a total of 9 treatments (see detail in Table 1). Each treatment had 3 replicates with a total of 27 trial units.

Experimental units were 5 liter volume tanks with 3 diferent designed systems (see Figure 1). The water inlet and outlet of each tank covered by nets with a mesh size of 100 µm to filter trash and keep the larvae from escaping. Water in rearing tanks was exchanged continuously by a pump that located in a 200 liter volume sum tank. There were 3 storage tanks for 3 systems of water treatment including disinfected water, green water and biofiltered water. Each water system consisted of 9 tanks that included 3 upwelling tanks, 3 Weis tanks and 3 Kreisel tanks connected to the storage tank. Disinfected marine water was use for disinfected water system. The water was disinfected by chlorine a at 30 ppm concentration, strongly aerated for 1 day then exposure under sunlight for another day before use. The microalgae *Nannochloropsis oculata* were used for green-water system with an initial density of 0.8×10^6 cells per mL. Biofilter-water system used orchid net as biofilter material.

Table 1. Detail of the experiment treatments

Treatments	Water treatments			Tank types		
	Disinfected water	Green-water	Biofilter-water	Upwelling	Weis	Kreisel
1	√			√		
2	√				√	
3	√					√
4		√		√		
5		√			√	
6		√				√
7			√	√		
8			√		√	
9			√			√

The larvae used in the experiment were collected from 4 shrimp females. All 4 females were at the same spawning stage. The stocking density of larvae was 5 Zoeas 1 (larvae at stage Zoea 1) per liter (25 individuals per tank).

Figure 1. The experimental design and operation

2. Experimental monitoring

Water temperature, salinity, pH and total ammonia nitrogen in each tank were measured and adjusted daily to meet the larval requirements.

A diet of enriched rotifer was used in all stages of the shrimp larvae. The rotifer were enriched by DHA Protein Selco at 200 ppm concentration before feeding shrimp larvae. The density of rotifer was maintained at 20 individuals per ml by supplying new rotifer daily to compensate for the number of rotifers that had been eaten. From larval stage Zoea 3, they were fed by a mixture of rotifer, early hatched nauplii and artificial feed. The rotifer was supplied at the same density as in previous stages. Early-hatched nauplii *Artemia* were supplied at the density of 1 individual per milliliter tank water per day. A mixture of artificial feed, including 25% Frippak, 25% Lansy and 50% V8-zoea was also used.

3. Data collection

Specific stage and accumulated larval survival rates were calculated for each tank and treatment based on the number of remaining larvae. Specific survival rate in a stage n was the percentage of survived larvae after completing the transformation to stage n + 1 and the number of larvae at beginning of stage n. Accumulated survival was the percentage of survived larvae when finishing the experiment and the initial number of stocking larvae.

The successfully transformed larvae of a stage in a tank were determined when they completely transformed to next stage with no larvae of the previous stage left.

4. Data analysis

Data are presented as mean ± SD. Results were compared by analysis of variance with two factors (two-way ANOVA) followed by the Duncan's test when significant differences were found at the $p < 0.05$. Data analyses were performed with SPSS 20.0 for Windows.

III. RESULTS AND DISCUSSIONS

The survival rate of *L. amboinensis* larvae did not differ among three types of water (disinfected water, green-water and biofilter-water) ($p > 0.05$). The survival rates of the larvae were 71.1 ± 11.6% in disinfected water system, 67.6 ± 14.3% in green-water system and 68.4 ± 12.1% in biofilter-water system for zoea 1 then decreased to 61.3 ± 20.1%, 58.6 ± 23.7% and 54.4 ± 15.7% for zoea 2 stage, 44.2 ± 23.6%, 39.1 ± 30.2% and 31.5 ± 25.4% for zoea 3 stage, respectively. However, all of this difference was not statistically significant among the three water types.

Tank type significantly affected the survival rate of the larvae ($p < 0.05$). The shrimp larvae in later stages had significant higher survival rate in Kreisel tanks than that in upwelling tanks and Weis tanks ($p < 0.05$). Some other studies on ornamental shrimp larval rearing such as Calado et al. (2008) also reported that different tank type affected significantly on the survival rates of *Lysmata seticaudata, L. debelius* and *Stenopus hispidus* [4].

In disinfected water system, the survival rate of larvae in zoea 4 stage was 25.3% in Kreisel tank, 9 times higher than that in upwelling tank (2.7%) and almost 20 times higher than that in Weis tank (1.3%). This result could be seen in Figure 2 where Kreisel treatment was shown significant higher survival rate of larvae compare to the other two treatments.

Survival rate of shrimp larvae was generally highest in Kreisel treatment ($p < 0.01$, see figures 2, 3 and 4), except for larvae reared in in biofilter-water system ($p > 0.05$) whose survival rates only higher in Kreisel in zoe 5, but not in previous stages. Note that although the survival rates of larvae in tank types showed a dependence on the rearing water, the interaction between two factors was not significant ($p > 0.05$). The result of no interaction between tank types and rearing water could be because of the low sample size (only 3 replicates per treatment).

In general, results from all water systems types showed that the higher survival rate of larvae reared in Kreisel suggests that this tank type could be a potential and proper option for rearing *L. amboinensis* larvae. Also, there is no need to treat rearing water in advance by making green-water or using biofilters. The disinfected marine water with low operation cost should be used for white-striped cleaner shrimp larval rearing.

IV. CONCLUSION

There was no significant effect of rearing water system (disinfected, green and biofilter water) on larval survival rate of white-striped cleaner shrimp *Lysmata amboinensis*.

Types of tank significantly affected on the larval survival rate. Generally, highest larval survival rate occurred in Kreisel tank treatments.

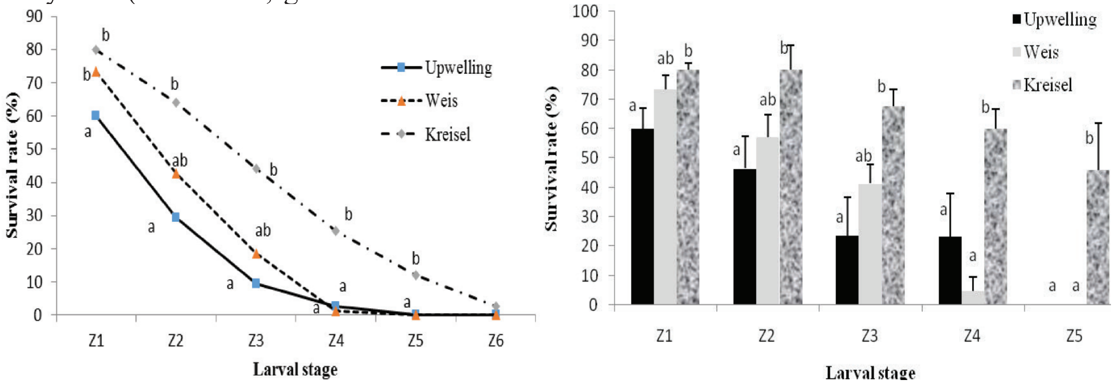

Figure 2. Accumulated survival rate (left) and stage-based survival rate (right) of the larvae in disinfected water treatments

Z1 – Z6 indicate stages of the larvae from Zoea 1 to Zoea 6

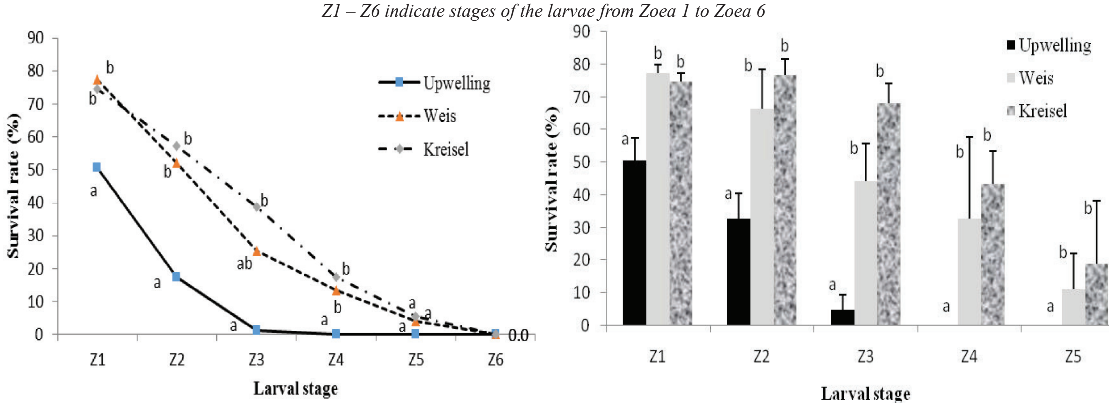

Figure 3. Accumulated survival rate (left) and stage-based survival rate (right) of the larvae in green-water treatments

Z1 – Z6 indicate stages of the larvae from Zoea 1 to Zoea 6

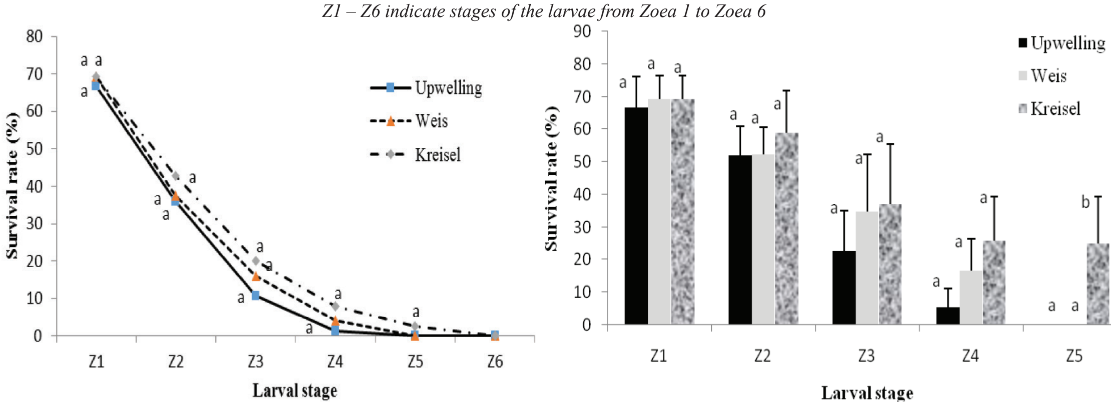

Figure 4. Accumulated survival rate (left) and stage-based survival rate (right) of the larvae in biofilter-water treatments

Z1 – Z6 indicate stages of the larvae from Zoea 1 to Zoea 6

Disinfected water (with low preparation and operation costs) and Kreisel tank should be used in rearing *Lysmata amboinensis*.

ACKNOWLEDGEMENTS

This research was carried out under a project of Nha Trang University funded by The Ministry of Education and Training of Vietnam.

REFERENCES

1. Calado, R., Martin, C., Santos, O. and Narciso, L., 2001. Larval development of the Mediterranean cleaner shrimp *Lysmata seticaudata* (Risso, 1816) (Caridea; Hippolytidae) fed on different diets: Costs and benefits of mark-time molting. *Larvi'01 Fish and Crustacean Larviculture Symposium. European Aquaculture Society (Special Publication)*, 30: 96-99.
2. Calado, R., Figueiredo, J., Rosa, R., Nunes, M.L., Narciso, L., 2005. Effects of temperature, density, and diet on development, survival, settlement synchronism, and fatty acid profile of the ornamental shrimp *Lysmata seticaudata. Aquaculture*, 245: 221 – 237.
3. Calado, R., 2008. Marine ornamental shrimp. *Biology Aquaculture and Conservation*. Wiley-Blackwell.
4. Calado, R., Pimentel T., Vitorino, A., Dionisio, G., Dinis, M.T., 2008. Technical improvements of a rearing system for the culture of decapod crustacean larvae with emphasis on marine ornamental species. *Aquaculture*, 258: 264 – 269.
5. Calado, R., Vitorino, A. Lopes da Silva, T., Dinis, M.T., 2009. Effect of different diets on larval production, quality and fatty acid profile of the marine ornamental shrimp *Lysmata amboinensis* (de Man 1888) using wild larvae as a standard. *Aquaculture Nutrition*, 15: 484–491.
6. Ritar, J., 2001. The experimental culture of phyllosoma larvae of southern rock lobster *(Jasus edwardsii)* in a flow-through system. *Aquacultural Engineering*, 24: 149-156.
7. Tziouveli, K., 2006. Studies on aspects of Reproductive biology - Broodstock conditioning and Larval rearing of the ornamental cleaner shrimp *Lysmata amboinensis*. AIMS@JCU NEWS, 2(4): 4-4.
8. Tziouveli, V. & Smith, G., 2009. Sexual maturity and environmental sex determination in the white-striped cleaner shrimp *Lysmata amboinensis. Invertebrate Reproduction and Development*, 53(3): 155-163.
9. Zhang, D., Lin, J. and Creswell, R., 1997. Larviculture and effect of food on larval survival and development in golden corral shrimp *Stenopus scutellatus. Journal of Shellfish Research*, 16(2): 367-369.
10. Zhang, D., Lin, J. and Creswell, R., 1998. Ingestion rate and feeding behavior of the peppermint shrimp *Lysmata wurdemanni* on *Artemia* nauplii. *Journal of World Aquaculture Society*, 29: 97-103.