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Impacts of Nursing Density on Growth, Survival and Metamorphosis Development of Mantis Shrimp Larvae (*Harpiosquilla harpax*) in Vietnam

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Abstract

The current study was conducted to evaluate effect of larvae density on the growth, survival and development of larvae metamorphosis under nursing conditions. Triplicates of three densities S50, S70 and S90 (50, 70 and 90 larvaes.L^{-1} respectively) were set up in an 80 litter plastic tank system. Larvae were fed on live algae, artemia and artificial feed. All the water parameters were maintained at optimum levels (>5 mg O_2.L^{-1}, pH from 7.5 to 8.5 and salinity from 28-30%). Larvae development was monitored every hour until they finished metamorphosis. Length and survival rate were measured. The results showed that nursing density could impact to growth and survival rate of larvae. Growth of larvae in S50 group was highest and reached 8.34 mm, followed by S70 (8.00 mm) and S90 (7.84 mm). Similarly, S50 showed the highest survival rate (11.05%), higher than that of S70 (6.54%) and S90 (4.36%). The lower density also finished metamorphosis stage earlier (1,007 hours) as compared to S70 and S90 (1,014 and 1,024 hours respectively). However, these differences were not significant. The results showed the possibility of reproduction mantis shrimp larvae on practical farms.

Keywords: Mantis shrimp; *Harpiosquilla harpax;* larvae; Metamophosis; Survival

Introduction

Mantis shrimp or Stomatopods is common name for 412 known species [1], inhabits throughout tropical and subtropical water and can be found in many countries, such as China, India, Indonesia, and Thailand. They prefer to live in burrows or crevices within the intertidal and subtidal zones [2]. Mantis shrimps (Stomatopoda, Crustacea) normally occupied holes in coral [3] and often were found in shallower than 60 m depth [4]. In many areas, they were neglected and considered as bycatch species [2,5] and used to produce fishmeal or discarded to the sea ground [6,7]. Nair and Prabhu [8] stated that 60% of the total exploited mantis shrimp in India were discarded into the sea at the fishing ground to accommodate the commercially important fishes.

Recently, people paid more attention to mantis shrimp because of their high catching production [9] and high nutritive value. It was recognized that many species of mantis shrimp were commercially valuable, such as *Oratosquilla oratoria* and *Squilla sp*. [10,11]. Mantis shrimps gained recognition quite recently as an alternative seafood item. This non-conventional seafood variety constitutes a greater percentage of trawl catches as by-catch and was available round the year [12]. Yedukondala Rao et al. found a high percentage of edible flesh in some mantis species [13] (*Harpiosquilla harpax* and *Oratosquilla anomala)* in difference seasons. The stomatopods *H. harpax and O. anomala* are nutritionally equal to any other food fish and could be used as human food [11]. Kariathil et al. reported that mantis shrimp contained low lipid (3-4%) but high protein (65.00 to 68.59% depended on sex and age). In general, the stomatopods are nutritionally equal to any other fish and could be used as food for human consumption [8,13].

In Vietnam, mantis shrimps (*Harpiosquilla harpax*) are being considered as an economical species. Due to high demand on local market, mantis shrimp tended to be over exploited in manysome regions, make its production decreases and create more pressure to aquaculture for this species. In order to raise this animal on farm, seed avaiability becomes one of the most urgent requirement. However, most of previous studies concentrated to investigation of the resource and distribution [4,7,14]. Some other studies were carried out to describe for gonadal maturity, larvae development of *H. raphidea* in Indonesia, *Oratosquilla oratoria* [15,16]. The most detail description for development of mantis shrimp was done by Steven and Joseph [17] in which reproductive behavior, development of larvae were observed until 50 days old. The larvae were sensitive with high mortality and needed to pass 8 instar stages before reaching to the post-larvae at day 49th. However, that study was carried out with *Gonodactylus bredin* species. Up to date, almost no document related to artificial reproduction, metamorphosis development as well as production of *H. harpax* has been found. Thus, this preliminary trial was one of the first studies to find out suitable nursing density and observe development of the early stage of *H. harpax* larvae which could improve the technique to produce larvae artificially in order to support raising effectively this species in the future.

Materials and Methods

Mantis shrimp larvae collected from a same batch of reproduction were assigned into experiment. Triplicates of three density levels: S50, S70 and S90 (50, 70 and 90 larvaes.L^{-1} respectively) was set up in 80 litter plastic tanks system. The same feed (live feed, dried algae, Lansy, Frippakk from INVE company) and feeding scheme were applied to all treatments (Table 1). Water parameters such as temperature, DO, pH, and salinity) were measured twice daily at 7 AM and 14 PM to ensure all of them were in optimal range for development of larvae. Larvae development was monitored every hour by using a microscope in order

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to determine the changing stage of metamorphosis. The moment of minimum 50% of sampled larvae change to a new stage was recorded. At the same time, 5 samples of 100 mL each were randomly taken to count for the number of larvae to calculate for survival rate. Average length of 30 larvae was measured to evaluate the development larvae. Instar and development of mantis larvae followed the discription by Steven and Joseph [17].

Results and Discussion

The results showed that all water parameters were maintained in optimal range for larvae development. The water temperature fluctuated from 27.5 to 28.5°C, pH varied from 7.75 to 8.03, salnility from 27.5 to 29.0 ppt and DO from 6.16 to 6.58 $mgO_2.L^{-1}$. Althought it has been found any detail study on the development of larvae *H. harpax* yet, observation from this study found that development of *H. harpax* larvae was not much different from *Gonodactylus bredini* species. Their development could be devided into 8 stages, similar to discription in previous studies by Morgan and Provenzano [18] and by Steven and Joseph [17]. It is different from observations in the study on development of *Squilla armata* by Pyne [19] and *Oratosquilla oratoria* by Hamano and Matsuura [16,20] in which, metamorphosis development of larvae was devided into 11 stages (2 stages of propelagic and 9 stages of pelargic). Duration of each star period was reported in the Table 2.

The mean duration of each instar was ranged from 40 to 256 hours. The first three instars was (40-48 hours) much shorter than other later instars. Duration of the first and second instar in this study was (40-48 hours) similar to that of *Gonodactylus bredini* reported by Steven and Joseph [17], or *Squilla armata* reported by Pyne [19]. However, the third instar in this study took 40-46 hours whereas Steven and Joseph [17] reported for only 24 hours. The The longest instar duration was recorded for the seventh instar (247-256 hours). It was in agreement to previous study which stated that the seventh instar could be from 8.0 to 13.2 days [17]. The variation of metamorphosis time might be different between species. It was also influent by nutrition and enviromental quality, especially water temperature. The duration of instar in lower density group (S50) seemed to be shorter in almost all cases, excepted for the third instar where S70 gave slighly shorter duration. However, S50 gave significqntly lower duration of the seventh instar in coomparison to that of S70 abd S90. After 8 instars, larvae in the S50 group needed only 1,007 hours to finish metamorphosis and was the fastest growth. The larvae in S90 group seemed to be the slower development when they always need longer time to finish metamorphosis. Totally, they needed 1,024 hours to finish all metamorphosis and was the slowest growth. But, the difference among treatments were not significant. The total time of metamorphosis in this study was much lower than that reported by Steven and Joseph [17]. Shorter time can reduce risk as well as cost of production, especially if it can bring better growth and survival rate results.

Knowing time of each instar is not only useful information of larvae development, it also can help people in sellecting feed to grow them more effectively and reducing mortality. Growth of the larvae was influented by nursing density. The lower density often gave the higher value of total length in all metamorphosis stages. For example, at the last metamorphosis (eighth stage), growth of larvae in S50 was highest and reached 8.34 mm, followed by S70 (8.00 mm) whereas S90 reached only 7.84 mm. The significant difference was recorded between S50 and S90 since they reached the second stage (Table 3).

The total length of larvae in this study was little higher than *Gonodactylus bredini* in the study of Steven and Joseph [17]. However, it is hard to compare to that results when they reared larvae under different conditions, such as, density, temperature, salinity and food. They fed mantis larvae by only naupli of artemia where more diversity source of live-food and artificial feed were used in current study.

Results of survival rate seemed to be high and similar among treatments at early stage. For example, at the first stage, survival rate were 92.23, 90.44 and 89.36% respectively for S50, S70 and S90 group. Similarly, at the second instar, survival rate were 89.72, 84.35 and 86.48% respectively for S50, S70 and S90 groups (Figure 1). The high survival rate can be explained that when larvae was small, the mass density and requirement for feed was lower. However, when they were bigger, they required more and might decrease survival, especially when the understand about their nutritional requirement was still limited. Larvae survival decreased dramatically between the second and third stage for all treatments. It indicated that larvae were more sensitive and big change in metamorphosis might occur at this period of time led to high mortality. The suvival rate was higher for S50 significantly since larvae reached IV stage, excepted for VI stage. At the end of the

Stages	Amount	Feeding time								Live food
		0 h	3 h	6 h	9 h	12 h	15 h	18 h	21 h	
I	5-8 g	DA	Lan	DA	Lan + VitC	DA	Frip	DA	Lan	*Nanochlorosis sp*: 5-7.10^6 $c.ml^{-1}$
II	8-12 g	DA	Lan	DA	Lan + VitC	DA	Frip	DA	Lan	
III	12-30 g	DA	Lan	DA	Lan + VitC	DA	Frip	DA	Lan	
IV	35-50 g	Frip	Art	Frip	Art	Frip	Art	Frip	Art	*Brachionus sp:* 5-7 $c.ml^{-1}$
V		Frip	Art	Frip	Art	Frip	Art	Frip	Art	
VI		Frip	Art	Frip	Art	Frip	Art	Frip	Art	
VII		Frip	Art	Frip	Art	Frip	Art	Frip	Art	
VIII		Frip	Art	Frip	Art	Frip	Art	Frip	Art	

Note: Art: Artemia; Frip: Fripack; Lan: Lansy; DA: Dried Algae; VitC: Vitamin C

Table 1: Feed and feeding scheme for mantis shrimp in the experiment.

Treatments	Stage								Total time
	I	II	III	IV	V	VI	VII	VIII	
S50	40	46	46	166	168	142	247	152	1,007
S70	42	48	40	162	166	142	256	158	1,014
S90	42	48	42	166	168	145	255	160	1,026

Table 2: Metamorphosis time (hours) of larvae in the experiment.

Stages	S50		S70		S90	
	Length (mm)	Relative Gain (%)	Length (mm)	Relative Gain (%)	Length (mm)	Relative Gain (%)
I	2.80 ± 0.01^{a}	-	2.80 ± 0.01^{a}	-	2.80 ± 0.01^{a}	-
II	3.13 ± 0.01^{a}	11.79 ± 1.01	3.06 ± 0.01^{b}	9.29 ± 0.91	3.00 ± 0.01^{c}	7.14 ± 1.01
III	3.55 ± 0.01^{a}	26.79 ± 1.01	3.47 ± 0.01^{b}	23.93 ± 0.90	3.43 ± 0.01^{c}	22.5 ± 1.10
IV	4.11 ± 0.01^{a}	46.79 ± 1.11	4.06 ± 0.01^{b}	45.00 ± 0.90	3.90 ± 0.01^{c}	39.29 ± 1.10
V	5.34 ± 0.01^{a}	90.71 ± 1.01	5.30 ± 0.01^{b}	89.29 ± 1.00	5.15 ± 0.01^{c}	83.93 ± 1.03
VI	6.41 ± 0.01^{a}	128.92 ± 1.01	6.25 ± 0.01^{b}	123.21 ± 1.12	6.11 ± 0.01^{c}	118.21 ± 1.02
VII	7.37 ± 0.02^{a}	163.21 ± 1.12	7.13 ± 0.01^{b}	154.64 ± 1.13	7.00 ± 0.01^{c}	150.00 ± 1.12
VIII	8.34 ± 0.02^{a}	197.86 ± 1.14	8.00 ± 0.012^{b}	185.71 ± 1.10	7.84 ± 0.02^{c}	180.00 ± 1.56

The different superscripts in the same row indicate for significant difference at $p<0.05$.

Table 3: Total length (mm) and survival rate of larvae at different stages in the trial.

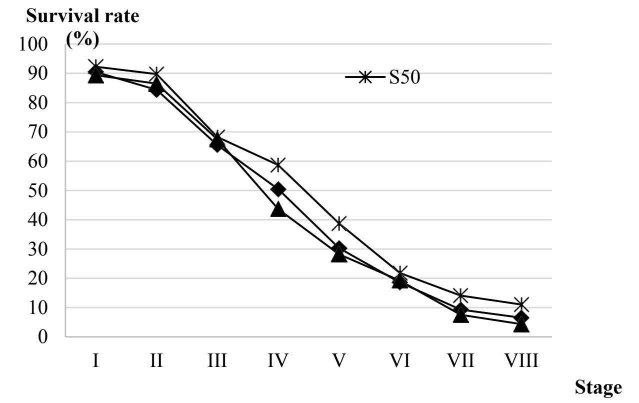

Figure 1: Average survival rate of mantis shrimp larvae at difference stages.

experiment, S50 gave the highest survival (11.05%) significantly higher than S70 (6.54%) and S90 (4.36%). In general, high density led to high mortality of rearing animals.

So far, not many publications on survial of mantis shrimp, especially for *Harpiosquilla harpax* were found. This current study was one of the first study on effect of density on the growth and survival of *Harpiosquilla harpax*. The result of survival rate at the end of the experiment was much higher than that in study by Steven and Joseph Morgan and Goy [17], especially at the lowest density treatment (S50). Steven and Joseph [17] reported that only 1.7% larvae survived when reared at 30°C and 35% of salinity, while above 11% shrimp could survice in this study. Zhang et al. [21] stated that survial of *Litopenaeus vanamei* shrimp was not affted by salinity, but by type of food and environment. However, Araneda et al. [22] and Krummenauer et al. [23] proved that different shrimp mortality was observed in different salinities. Yan et al. [24] reported that reproduction and distribution of *Harpiosquilla harpax* depended strongly on the food availability and environment. Therefore, more study should be continued to confirm these result.

Conclusion

The results showed that, density could impact to growth and suvival rate of shrimp larvae. Growth of larvae in S50 was highest and reached 8.34 mm, followed by S70 (8.00 mm) and S90 (7.84 mm). Similarly, the lower density S50 gave the highest survival (11.05%), higher than that of S70 (6.54%) and S90 (4.36%). This treatment also reached the 8 stage earlier (1,007 hours) as compared to S70 and S90 (1,014 and 1,024 hours respectively). However, these differences were not significant. The better growth performance, survival rate and shorter time of metamorphosis given by low density could lead to higher benefit and less risk for larvae production in practice.

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