Development of Larvae Rearing Techniques for Sustainable Post Larvae Production of Giant Freshwater Prawn in Ponds


Abstract—An experiment on the development of sustainable larval rearing technique for giant freshwater prawn (Macrobrachium rosenbergii) was conducted in earthen ponds for a period of 45 days. Nine glass nylon net hapas (cages) and three ponds were used for this experiment. Larvae were stocked in the experimental hapas at three densities viz., 60,000, 80,000 and 100,000 larvae/m$^2$ in T$_1$, T$_2$ and T$_3$, respectively. The average values of water temperature, dissolved oxygen (DO), pH, salinity, ammonia, and nitrite were 30.18±0.96°C, 5.86±0.82 mg/L, 12.15±0.82 ppt, 96±0.57, 159.5±7.12 mg/L, 0.11±0.05 mg/L and 0.05 ± 0.06 mg/L, respectively. However, the water quality parameters were the same as well as within the suitable levels in all the three treatments for the rearing of M. rosenbergii larvae in ponds. The highest survival rate was obtained in T$_1$ and lowest in T$_3$. There was no significant difference (P>0.05) observed in the survival rates between T$_1$ (61.67%) and T$_2$ (57.88%) but both of them were significantly differed (P<0.05) from T$_3$ (48.47%). The highest number of PL (PL/m$^2$) was produced in T$_3$ (48,470), which was not significantly different from T$_2$ (46,300) but did significant differ (P<0.05) from T$_1$ (37,000). Significantly longer (P<0.05) larval rearing period (day) was observed in T$_1$ (41), followed by T$_2$ (33) and T$_3$ (30), respectively. Although highest number of PL was produced in T$_3$, the cost of production also was highest in this treatment due to increase in stocking density and culture period. A simple economic analysis of the PL production from M. rosenbergii in rearing ponds showed that T$_3$ with a stocking density of 80,000 larvae/m$^2$ generated the highest net profit of 1517.28 US$/m$^2$ followed by T$_1$ (1384.62 US$/m$^2) and T$_2$ (1225.82 US$/m$^2) in this order. The results revealed that the medium stocking of 80,000 larvae/m$^2$ was the best density in respects of production and economic benefits from the rearing of M. rosenbergii larvae in captive ponds.

Keywords—M. rosenbergii, post larvae, pond, larvae

I. INTRODUCTION

Giant freshwater prawn (Macrobrachium rosenbergii de Man, 1879), popularly known as ‘scampi’ is an economically important crustacean species due to its delicious meat, and lower cholesterol and high protein content. The farming of giant river prawn, M. rosenbergii has gained increased interest in recent years, due to its high economic value and therefore, an annual production of over 30,000 t has been achieved through the use of culture practices (FAO, 2010). Freshwater prawn is one of the most popular species in Southeast Asian and South Pacific countries (New and Shingholka, 1985) for its taste, size, high growth, simple feeding habits, success in artificial breeding and high international market demands. Bangladesh has a vast potential for prawn aquaculture. The prawn farming area is expanding very fast in coastal regions, especially in South-western region of Bangladesh; the expansion rate over the last 3 years is about 10% per year. At present the area of prawn and shrimp aquaculture in different categories of land and water bodies is 275,274 ha with an annual production of 118,274 MT in 2012-2013 (DoF, 2014). About 337 million US dollar was earned by exporting 50,333 metric tons of prawn and shrimp products in 2012-2013 contributing 4.9% to the country’s total export earning and 0.833 million peoples are presently involved with prawn farming in Bangladesh (DoF, 2014).

Demand of prawn post larvae (PL) has resulted from the expansion and profitability of prawn farming together with a serious lack of PL availability due to government-imposed bans on the capture of wild PL and the importation of foreign seeds into Bangladesh. Over the past four years, since early 2011, however, serious production problems have affected most of the Bangladeshi prawn hatcheries, forcing them to slow down operations or in many cases close down. In 2010, the total number of prawn hatchery in Bangladesh was 81 but the number was reduced by 23 in 2014 (DoF, 2014). These problems have thus further reduced the supply of prawn seed to the farmers and caused massive financial losses in all phases of the culture cycles, including broodstock management, the hatcheries themselves, grow-out farmers, processors and exporters.

Under these circumstances, development of alternate PL production technique is very essential to save the freshwater prawn sector in Bangladesh. However, rearing of giant freshwater prawn larvae in brackish water ponds to produce quality PL is completely a new technology, which is yet to be developed. This technology would bring a great opportunity to supply low cost and sufficient amount of PL for prawn farming. It might also be helpful to drastically reduce the production cost of PL. With this view, the present research was undertaken to develop a sustainable technology for the production of PL prawn in ponds.

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II. METHODOLOGY

A. Experimental Design

The experiment was carried out at the coastal regions under the Patuakhali district of Bangladesh for a period of 45 days from 05 April to 20 May 2014 to develop the suitable technique for the rearing of giant freshwater prawn, *M. rosenbergii* PL in ponds without captive hatchery condition. Nine glass nylon net hapa (cage) and three ponds were used for this experiment. The size of each hapa was 3m³. The experiment had three treatments, each of which was triplicated and assigned into a completely randomized design (Table I).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Replications</th>
<th>Hapa No.</th>
<th>Pond No.</th>
<th>Stocking densities</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>T₁ R₁</td>
<td>1</td>
<td>1</td>
<td>60,000 larvae/m³</td>
</tr>
<tr>
<td></td>
<td>T₁ R₂</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T₁ R₃</td>
<td>7</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>T₂</td>
<td>T₂ R₁</td>
<td>2</td>
<td>1</td>
<td>80,000 larvae/m³</td>
</tr>
<tr>
<td></td>
<td>T₂ R₂</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T₂ R₃</td>
<td>8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>T₃</td>
<td>T₃ R₁</td>
<td>3</td>
<td>1</td>
<td>100,000 larvae/m³</td>
</tr>
<tr>
<td></td>
<td>T₃ R₂</td>
<td>6</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T₃ R₃</td>
<td>9</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

B. Pond Preparation

Saline water (17 ppt.) was collected from the adjacent river through a filter bag to remove any solid materials and predators of water by using submersible pump. The saline water was kept in a holding pond for settling down. After that the saline water was transferred into larval rearing ponds (LRP). Then freshwater was mixed with saline water to prepare brackish water with a salinity level of 12 ppt. Pond water was treated with lime (1 kg/dec.) and fertilized with triple super phosphate (75g/dec.) & urea (150g/dec.). Then nine experimental hapas (cages) were setup in three ponds. One hatching pond was prepared containing 6 ppt. saline water following above technique and a hapa was placed in this pond for hatching of *M. rosenbergii* larvae.

C. Preparation of Brackish Water

The brackish water (12 ppt.) was bleached with 60% chlorinated bleaching powder at a dose of 12 ppm and aeration was performed for 24h to kill the pathogens. After one day, salt water was treated with 12 ppm sodium thio-sulphate and air was blown for a day to remove the chlorine of bleaching powder. The hyposaline water of hatching pond was also disinfected by using above procedure.

D. Brood Collection and Stocking in Hatching Hapa

Female prawns, bearing gray and dark yellowish eggs were collected from the freshwater Pira river of Borguna district and transported to the experimental ponds, using a plastic drum and pick-up van. Then, the broods were kept in the hatching hapa containing 6 ppt. saline water for the production of larvae after 10-15 minutes of treatment in 50 ppm formalin solution for minimizing contaminations. Air was blown in the hatching pond from the air blower. Hatching hapa was provided with shelters (PVC pipes) to avoid cannibalism. Broods were fed with a mixture of rice and egg custard regularly.

E. Collection and Stocking of Prawn Larvae

Eggs were hatched at night. The larvae of *M. rosenbergii* were collected from the hatching hapa using scope nets of 200 micron mesh size in a plastic bucket. After collection, larvae were treated with 50 ppm formalin solution for 20 minutes to minimize any contamination. Larvae were stocked randomly into nine hapa at the density of 60,000, 80,000 and 100,000 larvae/m³ in T₁, T₂ and T₃, respectively.

F. Feeding of Prawn Larvae

Five litre containing cylindrical jars were used as *Artemia* hatching jar. At first the jars were washed with formalin water to minimize contaminations with any pathogenic agents. The jars were then filled with 4 litre of saline water (30 ppt.). The pH and temperature of the water was maintained at 7.5-8.5 and 28-30°C, respectively. A total of 12 g *Artemia* cysts were taken in the jars at a rate of 3 g/L, and the water was aerated continuously by air blower. Hatching of *Artemia* cysts were completed after 24 h of incubation. The nauplii were collected by siphoning in a beaker for feeding the prawn larvae. Before feeding *Artemia* nauplii were disinfected by 50 ppm formalin water to avoid contaminations. Larvae were fed with *Artemia* nauplii twice a day at the rate of 5-6 *Artemia*/ml of water. After 10 days of rearing, egg custard together with *Artemia* was supplemented in all the treatments until the end of the experiment to minimize the feeding cost. The ingredients were mixed by a blender and boiled for 30 min. to make a cake. Then, the egg custard was passed through a small meshed net. The smaller particle-sized custard was fed to smaller larvae and as the larvae grew up the custard particle size also increased. Prawn larvae also fed with *Artemia* flake. The ingredients of egg custard are given in Table II bellow:

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Amount</th>
<th>Ingredients</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powder milk</td>
<td>30%</td>
<td>Agar powder</td>
<td>2%</td>
</tr>
<tr>
<td>Egg</td>
<td>35%</td>
<td>Cod liver oil</td>
<td>2%</td>
</tr>
<tr>
<td>Cornflower</td>
<td>10%</td>
<td>Vitamin premix</td>
<td>1%</td>
</tr>
<tr>
<td>Prawn</td>
<td>20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

G. Water Quality Management and Sampling

Water quality parameters such as temperature (°C), dissolved oxygen (mg/L), salinity (ppt.), pH, alkalinity (mg/L), ammonia nitrogen (mg/L) and nitrite nitrogen were recorded throughout the experimental period. Larval health condition and pathogenic attack were checked every day at laboratory using microscope. The larvae were reared up to post larval (PL) stage. Saline water was gradually changed into freshwater within five days after larvae reached to PL stage. At the end of the experiment, all PL were collected and counted and the survival rate was calculated as:

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\text{Survival rate (%) = } \frac{\text{No. of harvested PL}}{\text{No. of stocked larvae}} \times 100
\]

Statistical Analysis

One way analysis of variance (ANOVA) was performed to determine the treatment effects. Significant differences

http://dx.doi.org/10.17758/IAAST.A1114038
between treatments were determined by using Duncan’s Multiple Range Test (DMRT) at 5% level of significance.

Economic Analysis
An economic analysis was performed to estimate the net profit from different treatments. The net return/profit was measured by deducting the gross income from the gross cost per hapa. The benefit cost ratio was also measured as a ratio of gross income to gross cost. A simple economic analysis was performed to estimate the net profit. The cost of inputs was calculated on the basis of whole sale market price of 2014.

III. RESULTS AND DISCUSSION

A. Water Quality Parameters
The average value of water quality parameters viz., water temperature, dissolved oxygen (DO), pH, alkalinity, NH3 and NO2 under different treatments are summarized in Table III. The ranges of water temperature in different treatments during the study period were ranged between 28.4 and 31.7°C. Fluctuation in water temperature was occurred due to changes of weather temperature. Optimal water temperature for rearing of prawn larvae could be ranged from 25 to 30°C (Thang 1993). The range of Dissolved Oxygen was 5.15–6.08 mg/L, salinity was 11.36–12.53 ppt, pH was 7.07–8.22, alkalinity was 156–167 mg/L, ammonia was 0.07–0.17 mg/L and nitrite was 0.03–0.08 mg/L.

The water quality parameters observed during the experimental period were within the acceptable range for the larval rearing of M. rosenbergii (New and Singhokha, 1985). Therefore, the physico-chemical parameters of the pond waters where the prawn larvae were reared did not have any adverse effect on the survival and growth of the larvae.

B. Survival Rate
Production of M. rosenbergii PL under various treatments is presented in Table 4.

The results of this experiment were more or less similar with the above findings. In this experiment the lowest survival rate was found with T3. Although the highest number of PL was produced in T3, the cost of production also was the highest in this treatment due to increase in stocking density and culture period. A simple economic analysis of the PL figures.

The production rates of 37,000±2340 PL/m², 46,300±1710 PL/m² and 48,470±2650 PL/m² with the corresponding survivals of 61.67±3.32%, 57.88±2.29% and 48.47±3.55% were obtained for larvae reared in T1, T2 and T3, respectively. The highest survival rate was obtained in T1 and lowest in T3. There were no significant difference observed in the survival rates between T1 and T2 but both of them did significantly differ (P<0.05) from the survival rate of T3. The highest number of PL (PL/m²) was produced in T3 (48,470), which was not significantly different from T2 (46,300) but did significantly differ (P<0.05) from T1 (37,000). Significantly longer (P<0.05) larval rearing period (day) was observed in T3 (41), followed by T2 (33) and T1 (30), respectively. The reasons behind this might be due to greater completions for food and space in higher stocking densities of larvae. Production costs among the treatments were statistically significant (P>0.05) due to different stocking densities and culture periods. The highest production cost was found in T3 (1259.82 US$/m³) and the lowest was in T1 (512.82 US$/m³).

No previous results were found regarding the giant freshwater prawn larval stocking density, survival rate or PL production techniques in pond rearing systems. However, a lot of works have been done on the larval rearing techniques of M. rosenbergii in hatchery. Ali et al. (2004) found the average survival rates of larvae as 39.44%, 38.88% and 38.33% in different treatments having same stocking densities using biofilter system in hatchery. In this experiment, survival rates were increased due to regular exchange of water in the rearing ponds. Chiranjib et al. (1993) obtained the survival rate of 44.02% in M. rosenbergii, using Artemia as larval feed. BOBP (1993) reported that 50% of PL could be produced in prawn hatchery at a stocking density of 60-80 Zoea-I/L of M. rosenbergii larvae. Similar results were also obtained in a stocking density of 60 Zoea-I/L of M. rosenbergii in backyard hatchery (Pramanik and Haldar, 1996). Hannan and Khondaker (1993) reported that the stocking density of 60-80 M. rosenbergii larvae per litre of water was suitable for PL production in the prawn hatchery. Chiranjib et al. (1999) reported that the survival rate of M. rosenbergii larvae was 42.9% after 28 days of rearing. They found the mortality rate was higher in green water than in clean water and concluded that closed water system is suitable for the larval rearing of M. rosenbergii. Chiranjib et al. (1996) obtained the maximum survival (56.2%) and the highest growth of larvae at a stocking density of 60 larvae per litre. Indulkar et al. (1998) observed the average survival rate of 82.68%, using different feeds in hatchery. Chand et al. (2000) found the survival rates of prawn larvae to be 54.4%, 40.7% and 43.7%. The survival rate of M. rosenbergii larvae were found as 57.91%, 56.81% and 22.87%, using of probiotic as a substitute of antibiotic for post larval production of giant freshwater prawn (Ali and Mahmud, 2012). The results of this experiment were more or less similar with the above findings.

In this experiment the lowest survival rate was found with highest stocking density in T3. Although the highest number of PL was produced in T3, the cost of production also was the highest in this treatment due to increase in stocking density and culture period. A simple economic analysis of the PL
production from *M. rosenbergii* in rearing ponds showed that T2 with a stocking density of 80,000 larvae/m³ generated the highest net profit of $1517.28 US$/m³ followed by T1 ($1384.62 US$/m³) and the lowest in T3 ($1225.82 US$/m³). The results revealed that the medium stocking of 80,000 larvae/m³ was the best density in respects of production and economic benefits from the rearing of *M. rosenbergii* larvae in captive ponds.

IV. CONCLUSION

This is a new technology through which the coastal prawn farmers can be able to easily produce giant freshwater prawn PL with minimum investment. This technology will also facilitate to reduce the collection of PL from natural sources and also will help for conservation of aquatic biodiversity in Bangladesh and the globe to a greater extent. This technology might play an important role for the income generation and livelihood improvement of coastal peoples.

ACKNOWLEDGMENT

This research was funded by infrastructural development and research strengthening (IDRS) project of Bangladesh Fisheries Research Institute.

REFERENCES


