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Outdoor Hatchery Larval Biology and Seed Production of Ganga River Prawn *Macrobrachium gangeticum* (Bate)

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Macrobrachium gangeticum (Bate) the third largest freshwater prawn in habitat in the river Ganga and Brahmaputra, which drain into Bay of Bengal. Seed production of this species (*M. gangeticum)* in India is done in indoor hatcheries. An outdoor hatchery system has been developed by the author at ICAR Research Complex for Eastern Region, Patna, in which *M. gangeticum* post larvae are produced. Larval rearing trials for *M. gangeticum* were carried out during the year 2008. The hatchery shades were covered with non transparent polythene sheets at the roof top to avoid direct sunlight. Larvae were reared in brackish water of 8-14 ppt (part per thousand) salinity for growth and development. Ten thousand larvae were stocked in 300 L tank and fed with live nauplii of *Artemia salina* twice in a day and after that 1 or 2 days, green algae developed in the larval rearing tank due to open sunlight, these algae were found to be ingested by larvae. The larvae fed voraciously and grew faster because of availability of green algae in the larval rearing tanks. The larvae passed through 15 molts, showing the characteristics of 11 distinct larval stages. First occurrence of post larvae (PL) has been recorded within 20 days and trial was conducted on the 35 days. The water

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quality parameters viz. water temperature, salinity, pH, dissolved oxygen; total hardness and alkalinity were recorded. Production of PL in trials during rearing was 6,480 and 5,870 with 21.6 and 19.56 PL/L respectively. The result of the present trials, the post larval production and shorter larval duration in *M. gangeticum* indicated the potential of commercial culture and hatchery operation in inland region.

Keywords: Ganga river prawn; M. gangeticum; larval biology; outdoor hatchery.

1. INTRODUCTION

The crustaceans possess a commendable position in view of their culture potential as well as the economic value. Among crustaceans, prawn contributes to major share of the cultured crustacean production being over to 94.6% [1]. Fresh water prawn (FWP) farming is assuming greater importance due to high demand, good price and high returns. The three larger varieties of FWP, i.e. *Macrobrachium rosenbergii* (De man), *M. malcolmsonii* (Edwards), and *M. gangeticum* (Bate) have been considered most important candidate species from the culture point of view Kanaujia [2]. However, the major constraint faced in its development is the availability of adequate quantity and quality of seed [3]. *Macrobrachium* species live in freshwater environments with links to saline water since the larvae of the species require brackish water for complete development [4]. Although prawn seed are available in natural waters to be utilized for stocking in ponds but it has many disadvantages such as greater variations in stage and size, contamination of seed with pathogens and mixed lot of various small species. It is also difficult to get sufficient required quantity of seed during stocking period and there is a great scope for prawn production in innumerous freshwater bodies throughout North India [5] and [6]. The riverine seeds of these FWP species especially *M. gangeticum* has been the only source for its culture in freshwater ponds. In recent time proper culture as a trade has been looked upon with great interest in our country Prasad et al. [7]. However, the decline in the juvenile prawn catches needed the establishment of seed production hatcheries for sustained prawn yield from freshwater ponds Daniels et al. [8] and Prasad et al. [9]. Kanaujia et al. 2001, and Prasad [7], successfully produced *M. gangeticum* seed at CIFA, Bhubaneswar in indoor hatchery system. Subsequently Prasad and Khan [10] reported successful seed production of this species at ICAR, RCER Patna, in indoor hatchery under controled condition. Sebastian [11] reported that in the conventional indoor hatchery system using tanks, post larvae production of *M. rosenbergii* is not stable. It requires close monitoring of nutrition and water quality, tank cleaning. Antibiotics and chemicals are to be used regularly. In view of the increased demand of freshwater prawns in national as well as international markets there in need to develop outdoor hatchery technology for PL production.

In this paper an effort has been made to study the larval biology and seed production of the above said species to distinguish their early development profiles such as, characteristics, stages, duration of larval cycle in an outdoor hatchery system. It has also tried to study especially the management oriented technique for seed production at commercial levels.

2. MATERIALS AND METHODS

The experimental trials were carried out during 2009 using brackish water 5-14 ppt (part per thousand) salinity in outdoor hatchery at ICAR Research complex for Eastern Region, Patna, this outdoor hatchery was set upped by the author [12]. Berried prawns were reared separately in 180 L transparent glass aquarium filled with 5 ppt saline water to study the incubation period and color changes in eggs. The prawns were fed with egg custard and chopped mussel meat twice-daily ad-libitum. Water quality of the aquarium was monitored at regular interval. An airlift-biofilter device was installed to provide proper aeration in the aquarium.

Seawater transported from Puri seashore stored in FRP tank and kept under natural sunlight for 15 days for ageing. Similarly freshwater collected from pond resources and stored in plastic pool and similar treatment procedure was followed. Further, the seawater and freshwater medium were mixed together to prepare the larval rearing medium of desired salinity 10-14 ppt. Rounded plastic pools supported by aluminium lining of 70 cm height and 90 cm diameter. with 350 L. water holding capacity was used for larval rearing trials

and two units of trials were conducted. Larvae were fed at initial stages twice daily morning and evening as live Artemia *nauplii* were given drop by drop with the help of dropper so that all the prawn larvae gets the food. After 1 or 2 days, green algae developed in the larval rearing tank due to open sunlight, these algae were found to be ingested by larvae.

Empty shells of the *Lamellidens marginalis* and *L. corrianus* were stringed one after another using nylon thread (no-2) and plastic beads (6 mm diameter). The size of the shells ranged from 40 to 70 mm in length and 25 to 35 mm in width. The strings of shells were hung into the larval rearing tanks for shelter, feeding of larvae. The larvae were hidden between the shells during metamorphosis. Leftover foods with other debris were siphoned out daily and aeration provided continuously. The larvae were assessed through 10 randomized samples taken in 100 ml beaker counted one by one pouring them from the beaker of water and number of larvae computed to find out the larvae present in the tank. Water quality parameters were maintained for optimum rearing environment and maximize PL production, viz. temperature, dissolved oxygen, total hardness alkalinity and pH were analyzed at regular intervals following the methods of APHA [13]. A refractrometer was used for monitoring the salinity of water during the larval rearing period. Visual as well as microscopic observations were made every day to assess the health, growth, developmental stage and behaviors of larvae. The harvested post larvae were acclimatized in freshwater with gradual removal of saline medium.

3. RESULTS AND DISCUSSION

Prawn larvae transformed from one stage to another and during this process, it undergoes several molting. As a result the body remains soft for sometimes at each molting Prasad et al. [14]. The fertilized eggs were carried by the female for 14 days and hatching started mostly during night and completed morning. However, incubation period may fluctuate depending upon the water temperature reported by Kanaujia and Mohanty [15], Prasad and Singh [6]. The embryonic development and incubation period, in the eggs was accompanied by gradual changes in the colour from green to yellow to milky grey and finally when the larvae inside the eggs developed finally then it became deep grey more or less similar observations were found by Kanaujia et al. [16,17]. In many invertebrates, the degree of tolerance to various physicochemical factors like temperature, salinity and pH varies during ontogeny. The important data on physic-chemical qualities of the test media collected are represented in (Table-1). During the rearing period of larvae, the salinity varied from 08-14 ppt due to rain fall. Salinity indicates the total concentration of all ions in brackish water medium. Kanaujia and Mohanty [15]; Prasad [7] and Mishra [1] have reported that the salinity range between 18-20 ppt was optimum for post larval production of *M. malcolmsonii* and 12-16 ppt for *M. gangeticum* in captivity. No antibiotics were used in the larval rearing period. The physiological responses to salinity would characterize the early zoeae of *M. gangeticum* as strongly euryhaline and are typical of larvae which utilize the estuarine environment during larval development. Water temperature ranged from 28.0-30.0°C. Prawns are temperature dependent cold-blooded animals. The temperature of water regulates the metabolism and growth of various larval stages of prawn [18]; [19]. In the present study, the increase in pH during the larval rearing period was observed and maintained within the range of 7.6-8.3 by periodic application of calculated amount of calcium sulphate and calcium hydrogen phosphate. Kanaujia and Mohanty [15]; Prasad and Singh [19] suggested maintaining the water pH within the range of 7.5 to 8.5. In the present study, the dissolved oxygen ranged between 4.0 – 5.5 mg/l with a very narrow range of variation. The wide variations in DO were reported by Mohapatra [20] as a result of the wide variation in climatic temperature and disruption of power. Total hardness affects the growth of the larvae and mineralization of carapace. Its optimum level needed for larval metamorphosis was reported within a range of 3,800-5,200 mg/L in *M. malcolmsonii,* Kanaujia and Mohanty [15]; Prasad and Kanaujia [21]. In present study, the total hardness ranged from 2,220 – 2,292 mg/L, and alkalinity ranged from 90.2-98.2 mg/L. In present study, the total alkalinity denotes the quantity of acid consuming constituents present in water. Which ranges more or less similar to observation reported by Kanaujia et al. [16] Prasad, [7] and Mishra, [1].

The stocking density, food and water qualities are important factors which influence the larval growth and post larval production under hatchery conditions Prasad [22]. Feeding of newly hatched larvae plays a crucial role in the success of larvae culture, since heavy mortality of early larval stages and asynchronous metamorphosis

occurs when larvae are exposed to starvation after hatching [23,24]. Newly hatched *Artemia* nauplii constitute the principal live food used in larvae culture of crustaceans of commercial value, Barros and Valenti [25]; Araujo and Valenti [26]. However, several others researchers believed that *Artemia* nauplii do not fulfill the nutritional requirements of larvae during the last Zoeal stages and therefore, recommend the use of supplemental diets [8,27,28]. In the present study, larvae initially were fed with Artemia nauplii twice in a day daily during 6 AM and 6 PM for larval rearing period. After 1 or 2 days, green algae developed in the larval rearing tank due to open sunlight, these algae were found to be ingested by larvae and provided a suitable larval environment and contributed to the nutrition also. In conventional indoor hatchery system the larvae were found to feed voraciously and grow faster because of availability of green algae in the larval rearing tanks [11,12]. Prawn in general is reported to be omnivorous depending on both animal and plant matter. Food and feeding habits of gangetic prawn have been described in detail by Roy and Singh (1997). The food items in the stomach of this prawn are composed of blue green algae, green algae, diatoms, fragments of insects and crustaceans and decomposed organic matter etc. In the present investigation the bottom siphoning of larval tank was done daily and 25% warter exchange was done after 4th days. No antibiotics were used in the larval rearing tanks during rearing period.

Table 1. Ranges of phyisico-chemical parameters of water during larval rearing of *Macrobrachium gangeticum* an outdoor hatchery

Parameters	*M. gangeticum*
Salinity	8-14 ppt
Temperature	28-30°C
pH	7.6-8.3
Dissolved Oxygen	04-5.5 mg/l
Total hardness	2220-2292 mg/l
Total alkalinity	90.2-98.2 mg/l

The newly zoea were found transparent or translucent, due to red and blue chromatophore during early stage. However, the colour of this chromatophore were found to fluctuate between some portion of the body following their development. The late stage larvae were very active and displayed darting movements along the side of the tank. The distinguishing characteristics of each eleven stages of this species are more or less similar to those recorded in *M. rosenbergii* and *M. malcolmsonii*. The presence of red chromatophore on the entire merus region and the 2nd chelate legs during stage V to XI is important distinguishing characteristics of *M. gangeticum* which is not found in *M. rosenbergii* and *M. malcolmsonii* [18]; (Prasad and Khan 2008); [16,1]. The growth of larvae, rate of increase in the larval sizes of *M. gangeticum* initiated with 1.7 mm and carapace 0.30 mm, at stage I zoea stage V to VI takes long time and size of the larvae and carapace varied 3.7 &0.62 and 4.9 & 0.78 respectively. The stage IX the size of the larvae mere found 6.5 and its carapace 1.52 attained within 17 days. While attaining to post larval stage between 20-21 the size of PL was found 10.2 mm and carapace was 2.20nn respectively. In between these stages the variations in progressive increase in size and duration for subsequent stages were recorded greatly in this species. The larval development in *M. gangeticum* in all the trials progressed at the same. Soni et al. [29], reported zoea I of *M. malcolmsonii* and *M. rosenbergii* measured about 1.5 mm and 1.8 mm respectively. The growth and development of *M. malcolmsonii* and *M. rosenbergii* have been studied [15,21,19]. The occurrence of first post larvae was recorded on 20th day in detail presented in (Table- 2). The occurrence of first post larvae of most the reports varied from each other's Kanaujia and Mohanty [30] obtained first few post larvae in *M. malcolmsonii* within 40 to 53 days in natural brackish water and on 41st day in artificial seawater, whereas, Rao [18] observed them on 52nd days and Prasad and Kanaujia [21] observed them on 46th days. *M. malcolmsonii* up to Vth larval stages was found within 20.5 days, further the stage VI found to pass through 5 more molts in this species. Whereas, zoea stage XI larvae attained post larval stage within 46 days, the size at post larvae stage in 12.79 mm Prasad and Kanaujia [21]. The larval growth and stages from zoea stage I to zoea stage XI and subsequently attainment of PL stage was not found synchronous during all stages. Eight numbers of larval stages in *M. rosenbergii* have been reported seventeen by Gomez and Kashahara [31].

In the present study, species passed through 11 distinct larval stages, however, the number of molts in FWP ie *M. rosenbergii* and *M. malcolmsonii* found somewhat similar Prasad and Singh [6]; Prasad and Kanaujia [21]. where stage I larvae passed through one molt at each

stage from stage I to V, and 5 molts between stage V- VI, thereafter, the molting frequency recorded one or two at each stages to reach post larval stage. This observation recorded to be different from that of *M. rosenbergii*, where one molt was reported in subsequent stages Mohapatra, [20]; Prasad and Singh [6]. In the present study, the larvae of *M. gangeticum* were stocked initially at a density of 33.33 larvae L^{-1} , which yielded post larval production of 6480 and 5870 total numbers with 21.6 & 19.56 L^{-1} has been achieved within 35 days end of the larval rearing trials . This result provides a wide scope for the establishment of hatcheries there by creating self-employment opportunities. The activity will also contribute to the up gradation of the socio economic conditions of the poor rural masses.

Table 2. Average body & carapace length and age of *Macrobrachium gangeticum* in different larval stages during larvae culture an outdoor hatchery

Stages	*M. gangeticum*		
	Body length (mm)	Carapace length (mm)	Age (days)
I	1.7	0.30	0
II	2.1	0.53	1
III	2.6	0.56	2
IV	3.4	0.38	3
V	3.7	0.62	6
VI	4.9	0.78	8
VII	5.5	0.82	10
VIII	5.9	0.90	12
IX	6.5	1.52	14
X	6.9	1.43	16
XI	8.5	1.95	18
PL	10.2	2.20	20

4. CONCLUSION

It is concluded that outdoor hatchery system suitable and effective larval rearing medium is the key to success of large scale seed production of freshwater prawn. The larval food as green algae may have a bearing on the larval growth faster. Water treatment system is very simple and water quality can be monitored biologically. The duration of larval cycle of *M. gangeticum* was much shorter than that of *M. malcolmsonii*, which have been recorded more than 40-60 days by researchers.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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