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Comparative larval biology of three *Macrobrachium* species under controlled conditions

Salini Soni, *D R Kanaujia, A N Mohanty, Prasanti Mishra & S N Sethi
Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar 751002, Orissa, India.
*Correspondence: E-mail: drk_cifa@indiatimes.com

Abstract

Three large sized *Macrobrachium* species- viz. *Macrobrachium rosenbergii, M. malcolmsonii* and *M. gangeticum* are available in Indian riverine systems. The study on the seed production and growout of these species are being carried out to develop technologies for commercial application. Hence, the knowledge on comparative larval biology of the three species is extremely important to give a new line for developing hatchery technology for large-scale seed production in different agro-climatic conditions. The present communication deals with comparative study of larval growth and seed production of the three larger species.

Keywords: *Macrobrachium rosenbergii, M. malcolmsonii, M. gangeticum,* seed production, larval biology.

Introduction

Aquaculture has assumed an important global enterprise, and freshwater prawns have become an important fishery commodity all over the world (Subrahmanyam 1980). Outbreak of viral diseases witnessed in shrimp farming industry has caused great loss in many southeast and south Asian countries, which prompted many medium and small farmers to look forward for the alternate species other than shrimp such as freshwater prawn (Chandrashekharan & Sharma 1997). Among the freshwater prawns, some of the fast-growing larger *Macrobrachium* species like the giant prawn *Macrobrachium rosenbergii,* Indian river prawn *M. malcolmsonii* and Ganga river prawn *M. gangeticum* are important as they grow to marketable size (50-250g), and contribute to capture fishery in considerable quantities, in the river systems of both east and west coasts of India (Rajyalakshmi 1961).

A few workers have contributed to standardize the hatchery technology for seed production and growout of *M. rosenbergii* (Ling 1969; Fujimura 1974) and to some extent for *M. malcolmsonii* (Subrahmanyam 1974; Rao 1991; Kanaujia & Mohanty, 1992). However, the work in this regard on *M. gangeticum* is still fragmentary since the species is exclusively found in the river Ganga and Brahmaputra and attains a maximum size of 230 mm in natural habitat. Tiwari (1955), Subrahmanyam (1974) and Tiwari & Holthuis (1996) considered *M. gangeticum* to be the third largest *Macrobrachium* species in Indian riverine

system suitable for culture. The present work was aimed at studying the comparative larval biology of the above three species to distinguish their early developmental profiles such as number of larval stages, frequency for attaining subsequent larval stages, duration of larval cycle, and production of postlarvae (PL), along with physicochemical parameters of the medium suitable for larval rearing. This may facilitate to evolve a viable technology to establish multi-species hatcheries of these species.

Materials and methods

The berried females of *M. rosenbergii*, *M. malcolmsonii* and *M. gangeticum* with grey coloured eggs were procured from the experimental farm ponds of Central Institute of Freshwater Aquaculture (CIFA), Kausalyaganga, and were given a prophylactic dip in 5 mg L^{-1} $KMnO_4$ for two minutes, and then maintained separately for hatching in 300 L capacity plastic pools filled with 5 g L^{-1} brackishwater. The spent females were removed from the tanks soon after hatching of the zoea I and then the water level in the tanks of individual species was raised by adding 12 g L^{-1} brackishwater both in *M. rosenbergii* and *M. gangeticum* and 18 g L^{-1} for *M. malcolmsonii*. The larval population was assessed by counting 10 samples from 10 different places in the tank in a 100 ml beaker and the larvae stocked in the rearing tanks. For the rearing of prawn larvae, an airlift bio-filter re-circulatory system was adopted following Kanaujia & Mohanty (1992).

The rearing trials were carried out in triplicates for individual species. The zoea I of *M. rosenbergii* and *M. gangeticum* were fed with newly hatched *Artemia* nauplii twice daily for one week, and that of *M. malcolmsonii* for 15 days. Thereafter, the feed was supplemented with egg custard (prepared with 3 hen's egg, 30 g milk powder, two *Reju-calcium* tablets dissolved in 200 ml water, and steam cooked) and fine particles of mussel meat, at six hourly intervals including *Artemia* nauplii during night hours (between 23 00–24 00 h). Larval rearing tank was cleaned daily to remove the metabolites, left over food and moulted shell. The water level in both larval rearing and bio-filter tanks was maintained by adding fresh brackishwater medium. Water quality parameters such as salinity, water temperature, dissolved oxygen (DO), pH, ammonia and total hardness were monitored at regular intervals by following the methods of APHA (1985). The different larval stages were observed with the help of hand lens and compound microscope. The progressive increase in size of the different larval stages were measured through stage and ocular micrometers. On the occurrence of the first few PL, string shells were hung inside the larval rearing tank to provide shelter and hiding place to newly metamorphosed PL. Once sufficient PL were observed in the tanks, the string shells were lifted out and the PL from the tank were removed before acclimatizing them to freshwater. Thereafter, the PL were counted manually and released in nursery tanks for raising juveniles.

Results and discussion

Physicochemical parameters recorded during larval rearing trials of the three *Macrobrachium* species are presented in Table 1. Nitrogenous compounds, DO, pH, ionic concentration, dissolved metals, salinity, and temperature are the main physicochemical parameters that play

Table 1 Physicochemical parameters of water during larval rearing of the three *Macrobrachium* species

Parameters	*M. rosenbergii*	*M. malcolmsonii*	*M .gangeticum*
Salinity (g L^{-1})	12-16	18-20	12-16
Temperature (°C)	28-30	28-30	28-30
pH	7.8-8.3	7.5-8.5	7.5-8.2
D.O. (mgL^{-1})	5-7	4-6	5-6.5
Total Alkalinity (mgL^{-1})	100-130	100-135	100-125
Ammonical-N (mgL^{-1})	< 0.02	< 0.02	< 0.02

important role in growth, metamorphosis and survival of larvae (Kanaujia & Mohanty 1992). The water temperature varied within a narrow range of 28-30 °C in the present study. New & Singholka (1985) have reported 26-30 °C as the optimum range of water temperature for larviculture of *M. rosenbergii*. Kanaujia & Mohanty (1992) successfully produced postlarvae of *M. malcolmsonii* within an ambient temperature range of 28-31 °C.

Most of the biological parameters of aquatic ecosystems are influenced by pH, which range from 7.5–8.5. New & Singholka (1985) have reported a suitable range of pH between 7.5 and 8.5 in the water during larval rearing of *M. rosenbergii*. Kanaujia & Mohanty (1992) also suggested maintaining water pH within the range of 7.5 - 8.5. In the present study, DO varied from a maximum of 4.6–7.0 mgL^{-1} and minimum of (4-6 mgL^{-1}) in *M. malcolmsonii*, which might perhaps be due to higher salinity of the rearing medium. Dissolved oxygen is an important parameter not only for respiration but also for maintenance of the most favourable and hygienic environment of the larval rearing medium. Ammonia is the second most important water quality parameter as it is highly toxic to the culture organisms. The average ammonia content was recorded as < 0.02 mgL^{-1} in the present study, which was significantly lower, possibly due to the effective nitrification of chelated ammonia in the rearing medium with the application of Na-EDTA on weekly intervals. Total alkalinity, which denotes the quantity of acid consuming constituents present in the water, ranged from 100-135 mgL^{-1} in the present study. Total alkalinity range from 50-100 mgL^{-1} has earlier been reported as the desirable level for *M. rosenbergii* larvae (Chandraprakash & Reddy 1993).

The progressive increases in size of the three *Macrobrachium* species recorded during larval cycle are shown in Table 2 and Fig. 1 & 2. In the present study, zoea I of *M. malcolmsonii* and *M. rosenbergii* measured about 1.5 mm and 1.8 mm respectively, which was similar to those of a comparative study made on the postlarval production of *M. malcolmsonii* and *M. rosenbergii* by Shenoy *et al.* (1982). The size increase from zoea stage I to V of *M. malcolmsonii* was 0.4 mm, which was found less than those of *M. gangeticum* (1.8 mm) and *M. rosenbergii* (1.6 mm), although it has been observed that zoea V of *M. malcolmsonii* took a comparatively longer duration for attaining stage

Table 2 Size and age of the zoea of the three *Macrobrachium* species at different larval stages and postlarvae

Zoeal	*M. rosenbergii*		*M. malcolmsonii*		*M. gangeticum*	
stages	Age	Size	Age	Size	Age	Size
I	0	1.8	0	1.5	0	1.9
II	4	1.9	2	1.65	1.5	2.2
III	7	2.2	4	1.7	3.0	2.7
IV	9	2.7	7	1.73	4.5	3.3
V	11	3.4	10	1.9	6.0	3.7
VI	17	3.9	18	3.5	11	4.8
VII	19	4.2	20	3.6	13	5.0
VIII	22	4.4	23	4.8	15	5.5
IX	24	5.5	28	6.5	16	6.0
X	26	6.1	31	7.5	18	6.5
XI	29	6.9	34	8.8	20	7.2
PL	30	7.4	40	10	22	8.5

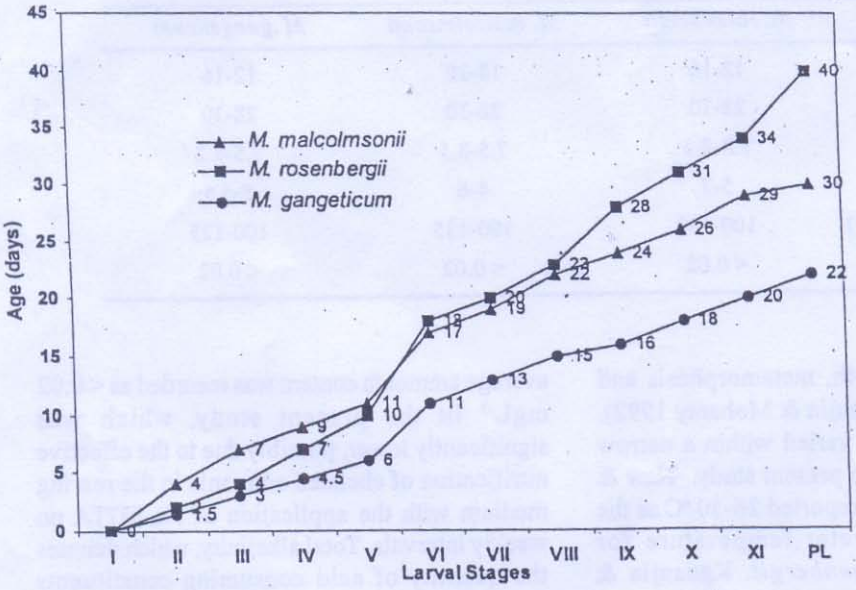

Figure 1 Duration of each larval stage of *Macrobrachium rosenbergii, M. malcolmsonii* and *M. gangeticum* reared in captivity

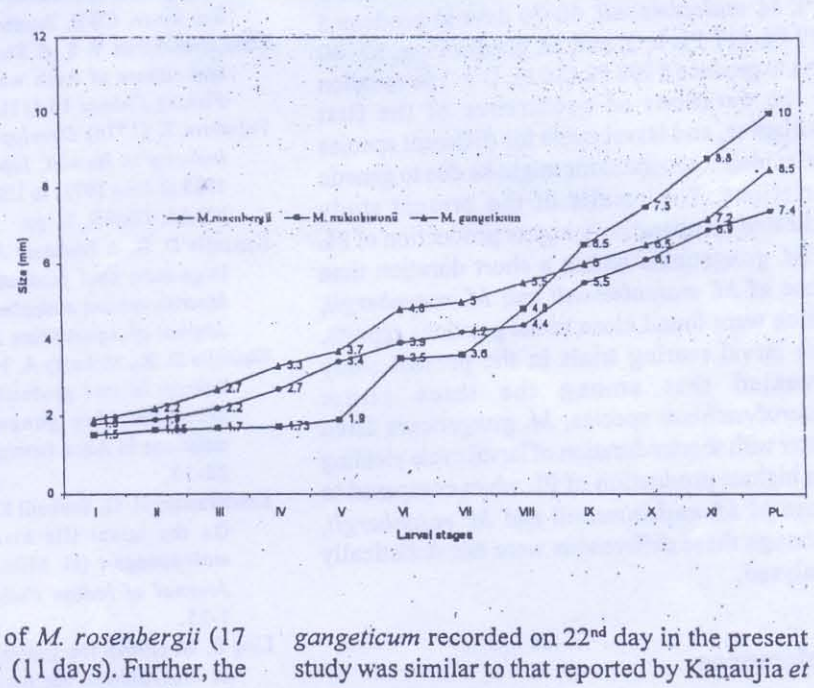

Figure 2 Progressive increase in size of *Macrobrachium rosenbergii, M. malcolmsonii* and *M. gangeticum* larvae reared in captivity

VI (18 days) than those of *M. rosenbergii* (17 days) and *M. gangeticum* (11 days). Further, the duration of the occurrence of first postlarvae in *M. rosenbergii* and *M. gangeticum* was found to be 29-30 and 20-22 days respectively, which is less than that of *M. malcolmsonii* (34-40 days). Kewalramani *et al.* (1971) recorded fifteen moults in 45 days to sixteen larval stages for attaining postlarvae of *M. malcolmsonii* in 70% seawater. Further, Sankolli *et al.* (1984) have reported the occurrence of a first few postlarvae in *M. malcolmsonii* within 40 days, while Rao (1991) and Kanaujia & Mohanty (1992) observed that the larvae of *M. malcolmsonii* pass through eleven zoeal stages before attaining postlarval stage within 39-41 days at salinity and temperature ranging from 18 to 22 g L^{-1} and 27.4 to 32°C, respectively. Further, the same authors obtained the first few postlarvae of *M. malcolmsonii* within 39 - 49 days in diluted seawater and 41 days in artificial seawater. The occurrence of the first few postlarvae in *M. gangeticum* recorded on 22nd day in the present study was similar to that reported by Kanaujia *et al.* (2001) who observed it within 20–22 days.

In the present study, the larvae of *M. rosenbergii, M. malcolmsonii* and *M. gangeticum* were stocked initially at a density of 50 larvae L^{-1}, which yielded postlarval productions of 28, 17 and 30 PL L^{-1}, respectively at the end of the larval rearing trials (Table 3). Stocking density is one of the important criteria for larval rearing and seed production of freshwater prawns. Sick & Beaty (1974) and Ling & Costello (1979) have reported a stocking density of 40 larvae L^{-1} as optimum for *M. rosenbergii* for better survival and production of postlarvae. Rao & Tripathy (1993) recorded a higher stocking density of 500-700 larvae L^{-1} during initial phase, which was reduced to 50-80 larvae L^{-1} in the second phase of larval rearing of *M. rosenbergii*. The growth and survival of postlarvae of *M. malcolmsonii* obtained by Kanaujia & Mohanty (1992), and that of *M.*

Table 3 Comparison of larval rearing trials of three *Macrobrachium* species

Particulars	*M. rosenbergii*	*M. malcolmsonii*	*M. gangeticum*
Stocking density (larvae L^{-1})	50	50	50
Volume of rearing medium (L)	300	300	300
Appearance of first PL (days)	28-31	42-45	20-22
Total no. of PL	8 396	5 099	8 998
Postlarvae L^{-1} (PL L^{-1})	28	17	30
Duration of cycle (days)	30-55	40-70	22-40

rosenbergii by Rao & Tripathy (1993) are in agreement with the present study.

In the present case, *M. rosenbergii* took as long as 30-55 days to produce 8 396 PL (28 PL L^{-1}); *M. malcolmsonii*, 40-70 days to produce 5 099 PL (17 PL L^{-1}); and *M. gangeticum*, 22–40 days to produce 8 998 PL (30 PL L^{-1}). The variation in the durations of occurrence of the first postlarvae, and larval cycle for different species under identical conditions might be due to genetic variations. The results of the present study indicated comparatively higher production of PL of *M. gangeticum* within a short duration than those of *M. malcolmsonii* and *M. rosenbergii*, which were found close to the previous reports. The larval rearing trials in the present study revealed that among the three larger *Macrobrachium* species, *M. gangeticum* fared better with shorter duration of larval cycle yielding the highest production of PL when compared to those of *M. malcolmsonii* and *M. rosenbergii*, although these differences were not statistically analysed.

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