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Larval Rearing and Post larval Production of Ganga River Shell Fishes *Macrobrachium gangeticum* and *Macrobrachium malcolmsonii*

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A B S T R A C T

The present paper deals with the comparative larval biology and post larval production of *Macrobrachium malcolmsonii (*Edwards*)* and *Macrobrachium gangeticum* (Bate) were studied under captive using 10-19 ppt brackish water to provide information needed for commercial hatchery technology. The incubation period *M. gangeticum* 12-13 days, whereas 12-15 days was found in *M. malcolmsonii.* Ten thousand larvae of both species were stocked in 300 L tanks and fed with live *Artemia nauplii*, egg custard and mussel meet. The water quality parameters were found within suitable ranged. Larvae showing characteristics of 11 distinct larval stages and size range of zoea larvae stage I^{st} to XI, 1.85 mm to 10.58 mm *M. malcolmsoni*, whereas the size of *M. gangeticum* larvae ranged 1.80 mm to 7.29mm.The first post larvae of both species recorded within 22 days & 47 days and trials were concluded on the 49^{th} day & 63 day respectively. Production of PL in six trails (three for each) during the first year for *M. gangeticum* 2854, 3099, and 3249, with 14.27, 15.49 and 16.24 PL L^{-1} whereas in case of *M. malcolmsonii* 2513, 2236 and 2124 with 12.56, 11.18, and 10.62 PL L^{-1} in trials 1, 2, and 3, respectively. Post larval production in trials 1, 2, and 3 during the second year of *M.gangeticum* was recorded at 2916, 3140 and 3185 with 14.58, 15.80 & 15.92PL L^{-1} whereas in *M. malcolmsonii* at 2020, 2443 and 2433 with 10.1, 12.21 and 12.16 PL L^{-1} respectively. The results on larval biology of both the species indicate the commercial culture and wide scope for the establishments of hatcheries in inland regions.

Introduction

In developing countries like India, the shell fishes like prawns, crabs and molluscan are very important food stuff due to high protein content and its others medicinal & nutritional value Prabhakar and Ray (2009). Almost all the major river system of India from north to south and backwaters of Kerala have been recorded with considerable amount of varieties of freshwater prawns Jayachantran and Indira (2010). In India, the largest species of freshwater prawns that are of interest for aquaculture are *Macrobrachium rosenbergii*, *M. malocomsonii* and *M. gangeticum* respectively, the latter two species are indigenous and can be farmed in monoculture, Mukhopadhyay and Sarangi, (1985); Kanaujia and Mohanty, (2007). The large sized freshwater prawns has great demand for both

in national and international markets andgreat scope for prawn production in innumerous freshwater bodies throughout North India Prasad and Singh (2006). The species of *M. gangeticum* and *M. malocomsonii* are only available from May to October in the middle stretches of the Ganga around Patna reported by Prasad and Kanaujia, (2006), and size ranged from 65-215 mm and 60-225 mm total length whereas weight 5.60-68.00 gms and 6.00–72.00 gms respectively reported by Prasad *et al.,* (2012). The development of hatchery technology of large size *Macrobrachium species* provides abundance scope for its grow out culture for commercial farming (Tiwari and Holthuis, 1996; Kanaujia *et al.,* 2005; Prasad, 2005; Prasad, 2019). The life history of Gangetic and other large sized freshwater prawn species quite interesting because while the adults inhabit freshwater bodies the berried females migrate to low salinity estuarine water for spawning & completion of their larval phase of life and the post larvae migrate back to freshwater areas for growth and maturity reported by (Khair *et al.,* 2000; Prasad, 2007; Bauer and Delahoussaye, 2008; Habashy, 2010; Bauer, 2011).

The riverine seed of these Gangatic prawn species 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. However, the decline in the juvenile prawn catches and increased demand of freshwater prawns in national as well as international markets need to develop hatchery technology for controlled seed production for sustained prawn yield from freshwater ponds.

In this background an effort has been done to study the comparative larval biology and post larval production of the above said large *Macrobrachium* species and also distinguish their larval development profiles such as, characteristics, stages, duration of larval cycle and biology in this paper for seed production at commercial levels.

Materials and Methods

Prawn Collection and Study site

Berried prawnsof 65–90 mm total length of *M. gangeticum* and *M. malcolmsonii* were collected by the help of fisherman using fishing net from the river Ganga near Patna (Bihar) for the period of two years 2000-2001 during breeding season. Prawns were carefully transported to the prawn hatchery at Central Institute of Freshwater Aquaculture, (CIFA), Bhubaneswar, Orissa (Lat. 20°11”46”-20°11”45” N. Long. 85°50”52” – 85°51” E) by using oxygenated plastic begs packing. After prawns were given a dip bath in 0.5-ppm potassium permanganate solution (KM_nO_4) for few minutes. They were reared separately in 180 L transparent glass aquarium filled with 5-8 ppt saline water until hatching. The process of hatching was studied through hand lens and the developing embryo removed from the brood sac observed through compound microscope. An airlift-biofilter device was installed inside the and also provides proper aeration in aquarium. Prawns were fed with egg custard twice-daily *ad-libitum* and leftover food metabolites were siphoned out daily. Seawater collected from Puri seashore to prawn hatchery CIFA and kept under exposure to natural sunlight in FRP tank (Fig. 1).

Experimental set up and animal used

One rounded plastic pool supported by aluminium lining of 70 cm height and 90 cm dia. with 400 L. water holding capacity was used for larval rearing trials. Another plastic drum with 70 cm height and 80 L water holding capacity was used for bio-filter, equipped with an airlift. Two units of three

trials for both species were conducted. Airlift bio-filtration system was adopted following the technique developed and introduced by Kanaujia and Mohanty (1992). After hatching, ten thousand larvae were stocked per tank and salinity of the medium was increased up to 19 ppt gradually by adding hypo-saline water for larval rearing of both species. Water temperature, salinity, dissolved oxygen, total hardness, pH, ammonical nitrogen as were monitored at regular intervals following methods of (APHA, 1985) is given in Table 1 and 2.

Larvae were fed *Artemia nauplii* initially, the larvae were fed twice daily morning between 6-7 am and evening 17-18 pm for 15 days. Thereafter feed was supplemented with mussel meat and egg custard given on interval of every six hours by including live feed *Artemia nauplii* during night at 23 – 24 pm. Left over food and other debris was siphoned out daily, aeration provided continuously.

Study animals and measurements

Microscopic as well as visual observations were made every day to assess the quality of the larvae, their health, survival, growth, developmental stage and swimming behaviors. The general activity of larvae was also observed visually in the tanks. The larval present in 300 L tank were assessed through 10 randomized samples taken in 100 ml beaker from different parts of the tank. The larvae were counted one by one by pouring them from the beaker of water and mean number of larvae computed to find out the larvae present in the tank during rearing cycle. The distinguishing characteristics features, number of larval stages and size from zoea stage l to PL were observed and studied following the guidelines given by (Rao, 1991); Kanaujia and Mohanty (1999) (Fig. 2).

Post larval production and harvesting

The post larvae were observed, then handmade “Strings of shell” were hung in the larval rearing tanks designed by Kanaujia and Mohanty (1992). Post larvae harvested from the tank every day after lifting out the string shells slowly from the tank were kept in tub having 5-6 liters water medium of the same tank.

The harvested post larvae were acclimatized in freshwater with gradual removal of saline medium by show addition of freshwater in one hour duration (Fig. 3).

Results and Discussion

The berried female carried the eggs till the hatching. The embryonic development in the eggs accompanied by a gradually changes in the eggs color form green yellow to grey. During incubation period, water temperature ranged from 28.3-30 ^{o}C, pH 7.5-8.5 and salinity was maintained 5-8 ppt for both species. The incubation period in *M. gangeticum* was recorded 12-13 days whereas in *M. malcolmsonii* 12-15 days. Initial stocking of the larvae in all the twelve trials of both the species during two years werekept uniform (10,000 per tank) but started reducing gradually with the progress of the cycle. The different water quality parameters of the larval rearing trial recorded during 2 years are shown in Table 1 and 2. Temperature: The variation in ambient water temperature during the larval rearing period in *M. gageticum* the SD mean 29.5 ± 0.36 ^{o}C and 29.9 ± 0.22^{o}C recorded during the first year & second year in six experimental trials whereas in *M. malcolmsonii* SD mean, water temperature were found 29.8 ± 0.41^{o}C and 29.9 ± 0.27^{o}C during first and second years respectively. Salinity is the most important factor that influences hatching rhythms of freshwater prawn.

In *M. gageticum* the salinity of larval rearing medium were observed SD mean 16.6 ± 2.83 ppt. and 13.5 ± 1.69 ppt. during the first year & second year in six experimental trials whereas in *M. malcolmsonii* SD mean salinity were found 17.2 ± 2.32 ppt. and 16.5 ± 2.56 ppt. during the first and second years respectively. The pH in larval rearing medium of different trials was maintained through the installation of airlift biofilter re-circulatory system, exchange of water and weekly application of calcium sulphate. However, the SD mean pH was found 7.7 ± 0.10 and 7.6 ± 0.09 during first and second year in *M. gangeticum* whereas in *M. malcolmsonii* were observed 7.6 ± 0.11 and 7.7 ± 0.11 during first and second respectively. Dissolved oxygen (DO): In *M. gangeticum* **t**he oxygen contents of six larval trials during the first and second year were almost similar, and mean ranged 4.3 ± 0.18 mg L^{-1} and 4.3 ± 0.16 mg L^{-1} during first and second, whereas *M. malcolmsonii* were found 4.5 ± 0.19mg L^{-1} and 4.3 ± 0.13mg L^{-1} during first and second respectively. Total hardness (TH): The TH recorded during the first and second year in *M. gangeticum* larval rearing trials 2257.5 ± 16.77mg L^{-1} and 2279 ± 12.0mg L^{-1} whereas in case of malcolmsonii were found 2279 ± 12.0mg L^{-1} and 2277.0 ± 12.21 mg L^{-1} in two years.

Total alkalinity (TA): The variation of TH recorded in first and second year in *M. gangeticum* larval rearing trials 86.7±4.35mg L^{-1} and 86.78±4.37mg L^{-1} whereas in case of *malcolmsonii* were found 91.9 ±3.797mg L^{-1} and 87.9 ±4.02mg L^{-1} during first & second year respectively.

Ammoniacal nitrogen (NH_4): The ammoniacal nitrogen is an important factor, recorded in the six trails during first and second year in *M. gangeticum* was recorded 0.083±0.007 mg L^{-1} and 0.115±0.011mg L^{-1} whereas in case of malcolmsonii were found 0.088±0.01mg L^{-1} and 0.100 ±0.009 mg L^{-1} during first and second year respectively. The characteristics of different developmental larval stages, progressive increase in size during a cycle and duration of each larval stage of both the species in 12 trails presented in (Table 3).

The zoea is planktonic in nature and is photosensitive. The larvae were transparent, translucent and display spot of red and blue chromatophore during the early developmental stages. The newly hatched *M. malcolmsonii* zoea stage 1 larvae recorded with 1.85 mm size, whereas *M. gangeticun* was 1.80 mm. further, the attainment of the stages in *M. malcolmsonii* up to 5^{th} larval stages was found within 20.5 days and *M. gangeticum* 7.0 days. *M. malcolmsonii* attained comparatively less size (2.88 mm) than that of *M. gangeticum* (3.72 mm). Further the stage VI found to pass through 5 more molts in both the species. Where zoea stage XI larvae attained post larval stage within 47 days in *M. malcolmsonii* and this duration was found much shorter in *M. gangeticum* (22 days) (Table 4).

The size at post larvae stage in *M. malcolmsonii* found more (12.79 mm) than the *M. gangeticum* (8.81 mm). The larval growth and stages from zoea stage I^{st} to zoea stage XI and subsequently attainment of PL stage was not found synchronous during all stages. There are several factors which directly of indirectly affect the growth and development of prawn larvae under culture system. The advance larvae of *M. gangeticum* appear more active compared to similar stage of *M. malcolmsonii* whose larvae display 'serene' moving behavior. The larvae of *M. gangeticum* in all their eleven larval stages are active more upside down with their tail up and the head down obliquely into the water column in the tanks. The 'gun down' movement in advanced stage larvae (stage X

and XI) is not extensive as that of *M. malcolmsonii*. The occurrence of first PL was observed on 22nd day and the trails were concluded after 27 days i.e. on 49th day. Daily harvest of PL was done by using string-shell, initiated on the occurrence of first post larvae in the trails. Production of *M. gangeticum* post larvae in three trial during first year recorded 285, 3099 and 3249 with PL per litre (PL/l) was 14.27, 15.49 and 16.24 and the average 3067.3 & 15.3 PL/l of three trials, whereas in second year 2916, 3140 and 3185 with mean 3080.3 ± 144.1 respectively. PL production per litre ranged from 14.58-15.92 with mean value of 15.40 ± 0.6 PL/l respectively (Table 5). In *M. malcomlsonii* first PL was observed on 47th day and trails were concluded after 17 days i.e. on 63 day The PL production of *M. malcomlsonii* found lower than *M. gangeticum*, whereas PL production were recorded during first year 2513, 2236 and 2124 with PL per litre (PL/l) was 12.56, 11.18 and 10.62 an average 2291.5 & 11.3 PL/l of three trials, whereas in second year 2020, 2443 and 2433 with mean 2298.6 ±241.4 and PL production per liter ranged from 10.1- 12.21 with mean value of 11.7 ± 1.4 PL/l respectively (Table 5).

In many invertebrates, the degree of tolerance to various physicochemical factors like temperature, salinity and pH varies during ontogeny Manoj and Appukuttan, (2003). The temperature of water regulates the metabolisms and growth of various larval stages of prawn (Rao, 1991; Prasad and Singh, 2007). The optimum salinity requirement for brooders of large sized Macrobrachium species for better hatching and survival of hatching reported by (Jayalakshmy and Natrajan, 1996; Soundarapandian *et al.*, 2009). In the present study incubation period in *M. gangeticum* was recorded 12-13 days whereas in *M. malcolmsonii* 12-15 days. Incubation period in *M. rosenbergii* ranged from 18-24 days for different size groups of prawn reported by (Habashy, 2010).

Table.1 Average, SD mean water quality parameters of larval rearing trials of *M. gangeticum* during first and second years

First year							
Trial	Water temp. ^{0}C	Salinity ppt	pH	DO mg/l	TH mg/l	TA mg/l	NH4 mg/l
T-1	29.4	16.3	7.7	4.3	2248.3	85.9	0.088
T-2	29.6	16.7	7.7	4.3	2259.4	86.3	0.078
T-3	29.5	16.7	7.7	4.2	2264.7	85.8	0.080
Mean	29.5	16.6	7.7	4.3	2257.5	86.7	0.083
±SD	0.36	2.88	0.10	0.18	16.77	4.35	0.007
Second year							
Trial	Water temp. ^{0}C	Salinity ppt	pH	DO mg/l	TH mg/l	TA mg/l	NH4 mg/l
T-1	29.9	13.3	7.6	4.4	2263.6	90.1	0.125
T-2	29.8	13.4	7.6	4.3	2284.6	87.8	0.106
T-3	29.9	13.8	7.7	4.3	2282.0	82.4	0.115
Mean	29.9	13.5	7.6	4.3	2276.7	86.7	0.115
±SD	0.22	1.69	0.09	0.16	12.80	4.37	0.011

Table.2 Average, SD mean water quality parameters of larval rearing trials of *M. malcolmsonii* during first and second years

First year							
Trial	Water temp. ^{0}C	Salinity ppt	pH	DO mg/l	TH mg/l	TA mg/l	NH4 mg/l
T-1	29.9	17.2	7.6	4.5	2269	91.4	0.083
T-2	29.8	17.3	7.7	4.5	22578	91.6	0.082
T-3	29.8	17.3	7.6	4.5	22691	92.7	0.100
Mean	29.8	17.2	7.6	4.5	22579	91.9	0.088
±SD	0.41	2.32	0.11	0.19	12.00	3.797	0.001
Second year							
Trial	Water temp. ^{0}C	Salinity ppt	pH	DO mg/l	TH mg/l	TA mg/l	NH4 mg/l
T-1	29.9	16.5	7.7	4.3	2266.7	89.9	0.100
T-2	29.9	16.2	7.7	4.3	2280.0	89.6	0.101
T-3	29.9	16.8	7.6	4.3	2284.3	84.1	0.098
Mean	29.9	16.5	7.7	4.3	2277.0	87.9	0.100
±SD	0.27	2.56	0.11	0.13	12.21	4.02	0.009

Table.3 Characteristics of different larval stages of two large *Macrobrachium* species

Stages	***M. malcolmsonii***	***M. gangeticum***
I	Body transparent, telson triangular posterior edge broad, abdomen with six somites and last is not separated from telson. Eyes large sessile.	Eye sessile, body transparent, chromatophore on the basis of the 2nd and 3rd walking legs, Greenish chromatophore seen on Cephalothorax.
II	A pair of supra-orbited and Branchio-stegal spines present. Pleura of abdominal somite developed 1st, 2nd, and 3rd, periopodbiramous 5th periopod uniramous. Eyes large stalk.	Bluish green chromatophore at the mid dorsal, base of 2nd, 3rd, 4th walking leg red. Lower portion of eye stalk very prominent periphery is little brownish. Telson with 8 pair of cilia.
III	Uropod developed, one rostrum teeth appear, 6th abdominal somite separated from telson. Base of walking legs reddish and body light yellowish.	Body transparent, Red chromatophore at anus. Reddish chromatophore at the ischium of 1st, 2nd, 3rdwalking leg. Base of the eye reddish black.
IV	Rostrum with 2 teeth, uropod biramous. Body yellowish. At the base of eye stalk red mid dorsal blue red.	Body white, dot like red region found on basis, and merus portion of 2nd, 3rd walking leg.
V	Red chromatophore at 4thpleopod base. Two rostral teeth.	Body white, red tinge on the ischium and merus of 1st, 2nd and 3rdpereopods.
VI	Body yellowish. Deep red on 4thpleopods extending toward 3rd, pleopod buds appear 2nd, 3rd, 4th more developed.	Red chromatophore at the posterior lateral side of the carapace, at the 4thpleopod and at the merus of 2nd chelate legs.
VII	Pleopodbiramus, chromatophore	Red chromatophore at the merus of 2nd

	extending towards 3rd, and dorsal side.	chelate leg.
VIII	Rostrum with 2 teeth 3-4 spine on 2nd teeth. Pleopod buds with ciliated except 5th Body yellowish, Red chromatophore on 4th, 3rdpeleopod.	Chromaotphore at the merus of the 2nd walking leg and at base of 4thpleopod, Body white little straw colour. Rostrum with 2 teeth 3-spine near 1st teeth.
IX	Appendix interna develop of the endopod of 2nd pleopod. Red chromatophore increases on body.	Appendix interma develop of the indopod of 2ndpleopod. Straw color develops on carapace and red at anus.
X	Rostrum with 2 big and 4 -5 small teeth and 4 spines on 2nd rostrum teeth. Red chromatophore at ventral side covering the 4th, 3rd, and 2ndpleopod.	Body transparent. Red chromatophore on the merus of 2nd walking leg, base of 4thpleopod. Dorsal. Rostrum with 2 big and 3-4 small spines on dorsal side.
XI	Rostrum with 2 big and 10-11 small teeth lower portion of 1st and 2nd teeth serrated 2nd teeth with 5 spine (4 big one small). Red chromatophore at the base of 4th, 3rd and 2ndpleopod.	2 big and 8 small teeth on the dorsal side of rostrum. Lower portion of the 1st and 2nd teeth secreted, 2nd teeth with 3-4 spines. Red chromatophore at merus of 2ndchalate leg and base of 4thpleopod
Post Larvae	Size 12.79 mm All teeth on dorsal side of rostrum equal size, on the dorsal side of the rostrum 10-11 teeth gap, 1st teeth with 4-5 spine, 2nd teeth with 3 spine then 2 spine on each teeth.	Size 8.81 mm, Red chromophore ventral side (5th to 1st pleopods). Dorsal rostrum teeth equal & 10-11 teeth & in continuous row. 4 spine on 1st& 3 spine on 2nd teeth and 2 spine on each teeth.

Table.4 Size and duration of various larval stages of two large Gangetic shell fish *Macrobrachium* species during larvae culture

Stages	*M. malcolmsonii*		*M. gangeticum*	
	Size (mm)	Duration (days)	Size (mm)	Duration (days)
I	1.85	1.85	1.80	1.5
II	2.03	2.03	2.22	2.5
III	2.2	2.2	2.81	3.5
IV	2.45	2.45	3.33	4.5
V	2.88	2.88	3.72	7.0
VI	4.16	4.16	4.34	10.5
VII	5.06	5.06	5.04	13.5
VIII	6.14	6.14	5.52	15.5
IX	7.56	7.56	6.06	17.0
X	9.37	9.37	6.51	18.5
XI	10.58	10.58	7.21	20.0
PL	12.79	12.79	8.81	22.0

Table.5 Post larval production of two large Gangetic *Macrobrachium species*

	Macrobrachium gangeticum				***Macrobrachium malcolmsonii***			
	First year		Second year		First year		Second year	
Trial	Total PL	PL/L	Total PL	PL/L	Total PL	PL/L	Total PL	PL/L
T-1	2854	14.27	2916	14.58	2513	12.56	2020	10.1
T-2	3099	15.49	3140	15.80	2236	11.18	2443	12.21
T-3	3249	16.24	3185	15.92	2124	10.62	2433	12.16
Mean	3067.3	15.3	3080.3	15.40	2291.5	11.3	2298.6	11.7
SD	199.4	1.0	144.1	0.6	200.2	1.0	241.4	1.4

Fig.1 Collections and packaging of adult & berried prawn from Ganga neat Patna

Fig.2 Berried prawn and larval feeding in experimental tanks at CIFA, Prawn Hatchery

Fig.3 Microscopic observation of larvae and harvesting of post larvae at CIFA

The colour of the eggs gradually become yellow to grey and when the larvae inside the eggs found fully developed then became deep grey. Suddenly the eggshell was broken and the telson thrashed out followed by the head, with a vigorous flex, stretch of the body the hatched zoea larvae started swimming actively in water column, these some observations were reported by (Kanaujia and Mohanty, 1999; Kanaujia *et al.*, 2005; Prasad, 2007; Habashy, 2010; Prasad, 2012). During the larval rearing period the salinity varied from 12-16 ppt in *M. gangeticum*, whereas in *M. malcolmsonii* varied from 12-19 ppt. Salinity influence the incubation and hatching rhythum of freshwater prawn, Jayalakshmy and Natrajan, (1996). Kanaujia and Mohanty, (1992); Prasad, (2019) have reported that the salinity range between 18-20 ppt was optimal for the better growth and post larval production of *M. malcolmsonii* and 12-16 ppt for *M. gangeticum*. Lower salinity range may prolong the duration of metamorphosis with a poor survival rate (Rao, 1991; Kanaujia and Mohanty, 1992). In the present study, the increase in pH during the larval rearing period was observed and maintained within the range of 7.5 to 7.7 by periodic application of calculated amount of calcium sulphate. New and Singholka (1985); Prasad and Singh, (2007) have also reported a suitable range of pH ranged 7.5-8.5 during larval rearing of *M. rosenbergii*. In the present study, the oxygen ranged between 4.0-4.7 $L^{-1}$with a very narrow range of variation. The wide variations of DO were reported by (Kanaujia *et al.*, 2005; Prasad and Singh, 2008, Prasad, 2019). Total hardness affects the growth of the larvae and mineralization of carapace. Kanaujia and Mohanty (1992); Kanaujia and Mohanty, 2007) reported higher hardness level 2000-5200mg/l in *M. malcolmsonii* and *M. gangeticum* during larval rearing period.

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 (Simoes, *et al.*, 2002; Calado, *et al.*, 2005). Newly hatched *Artemia nauplii* constitute the principal live food used in larvae culture of crustaceans of commercial value (Barros and Valenti, 2003; Araujo and Valenti, 2007). Some authors believed that *Artemia nauplii* suffice to produce *M. rosenbergii* Post larvae (Devresse *et al.*, 1990; Lavens *et al.*, 2000). However, several others 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 (Daniels *et al.*, 1992).New and Singholka 1985, recommend egg custard from stage III on wards (about the fourth day of culture), while Daniles, *et al.*, (1992) recommend diet supplementation from stage V to VI (between the 8^{th} and 10^{th} days). In present study initially, larvae were fed with *Artemia nauplii* twice daily during 6 am and 6 Pm for one week followed by supplementary feed i.e. egg custard and mussel meat four times a day included during rest period of both species of larvae. The newly hatched zoea stage I was found transparent or translucent, red and blue chromatophore during early stage inof both species. The later stage larvae were very active and display darting movements along the side of the tank, some behaviour was found more or less similar to those of *M. rosenbergii*, Rao, 1991; Prasad and Singh 2006). The distinguishing characteristics of each eleven stages of both species are more or less similar to those recorded in *M. rosenbergii*. The presence of red chromatophore on the entire merus region and the 2^{nd} chelate legs during stage V to XI is important distinguishing characteristics of *M. gangeticum* which is not found in *M. rosenbergii* and *M. malcolmsonii* (Rao, 1991; Prasad and Singh, 2006). The growth of larvae, rate of increase in the larval sizes of *M. gangeticum* and *M. malcolmsonii* initiated

with more or less similar size (1.8 and 1.85 mm) at stage I and size varied from 8.81–12.79 while attaining to post larval stage between 22 and 47 days respectively. In between these stages the variations in progressive increase in size and duration for subsequent stages were recorded greatly in both species. The larval development in *M. gangeticum* and *M. malcolmsonii* in all the trails progressed at the same. The growth and development of *M. malcolmsonii* have been studied (Kanaujia and Mohanty 1992). Prasad and Singh (2008), reported, larvae of *M. rosenbergii* normally takes 1 to 3 days to reach I stage to next stage. The duration of larval cycle of *M. malcolmsonii* was kept for 63 days whereas in *M. gangeticum* it was 49 days. But the occurrence of first post larvae in *M. malcolmsonii* was recorded on 47th and in *M. gangeticum* on 22nd day (Table 3). The occurrence of first post larvae of most the reports varied from each other's Kanaujia and Mohanty (1992) 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 (1991) observed them on 52nd days. The present study revealed that most of the larvae in *M. gangeticum* metamorphosed into post larvae within 49 days of larval cycle. The total production of PL in six trial during first and second years were maximum 3249 in Trial-3 followed by 3185, 3140, 3099, 3140, 2916, and 2855 in trials 6,5,2,4 & 1 @ 14.27, 15,49, 16.24, first year and 14.58, 15.80, 15.92, PL/l in trial 1, 2, 3, 4, 5, 6 respectively. Whereas in *M. malcolmsonii* in six trial during two years recorded maximum 2513 in trial-1 followed by 2443, 2433, 2236, 2124 and 2020 in trials 5, 6, 2, 3, & 4 and PL/l were recorded 12.56, 11.18, 10.62, 10.1, 12.21, 12.16 in trials 1,2,3,4,5, and 6 respectively. Rao (1991); Kanaujia and Mohanty (1992) also reported duration of 60 days or more for the metamorphosis of complete batch of larvae of *M. malcolmsonii*. The comparative results on larval biology of both the species has opened a field for its adoption to the inland regions as well as North-East states of the country where the both the species available in river Ganga and Brahmaputra. They are also larger species, tastier, hardy and possess good market demand like other larger Macrobrachium species.

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