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Availability and Breeding Behaviour of Ganga River Prawn *Macrobrachium gangeticum* (Bate) and *Macrobrachium malcolmsonii* (H.M. Edwards)

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Abstract

Macrobrachium gangeticum and *Macrobrachium malcolmsonii* prawn species are only available from May to October in the middle stretches of the Ganga river around Patna. The size ranged from 65-215 mm and 60-225 mm total length respectively. The number of *M. malcolmsonii* was found comparatively much less than that of *M. gangeticum*. The maximum number of females recorded is in the size range of 95-105 mm and the minimum is 185-205 mm total length *in M. malcolmsonii*. Maturity is attained at size 75 mm total length and above in both species. The incubation period in *M. gangeticum* was recorded in 12-14 days and 14 - 17 days in *M. malcolmsonii*. The color of the eggs in both the species gradually become lighter when the larvae inside the eggs found are fully developed, the color became slight grey. The *M. malcolmsonii* hatches during the night but *M. gangeticum* hatches at late night to day. In this paper, efforts have been made to study the availability and breeding behaviour under natural and controlled conditions of both species. It also attempts to study the spawning, incubation and hatching of said species.

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Introduction

The Ganga river, the largest river in India with 0.861 million km^2 basins having diversified fish fauna and population is considered to be the backbone of capture fishery (Jhingran 1956). Freshwater prawn *M. malcolmsonii, M. gangeticum* and some other species have great aquaculture potential; among them several species are available in the Ganga river, Hooghly and Brahamputra river systems (Kanaujia 2003; Prasad 2005). Occurrence of adult individuals in the lower middle and upper stretches of the Ganga river system indicated the migratory nature of both species *M. malcolmsonii* and *M. gangeticum* beyond 800 km from the estuary, where they grow and attain maturity in the upper reaches and carry developing eggs till the hatching of the zoea stage I. (Ibrahim 1962; Kanaujia *et al*. 2000). The ripe females have conspicuous orange gonads visible through the dorsal and lateral areas of the carapace. Mating usually occurs within 24 hrs, of the pre-spawning moult of the female prawns (Rao 1965; Wickins and Beard 1974). The color of the eggs in *M. gangeticum* is green yellow, and become grey corresponding to embryonic development. It takes around 12-13 days at 28 – 30°C water temperature to hatch out from the eggs (Kanaujia 2003). Aim from studying the availability and breeding behaviour under natural and controlled condition of both species, the spawning, incubation and hatching of larvae to improve the hatchery technology in the inland regions as well as in the Northeast states of the country are also carefully observed.

Materials and Methods

Collection of prawns

The investigation was under taken at the middle stretch of the Ganga river around Patna. The sources of the material were the fishermen's catches. Prawn samples were collected from prawn landing centers. Studies were carried out in the year 2000 and 2001. Verities of prawn species available in the Ganga river were collected from prawn landing centers and identified following Kurian and Sebastian (2001). Larger freshwater prawn i.e. *M. gangeticum* and *M. malcolmsonii* adult males, females and berried females collected from different centers of the river Ganga around Patna

were transported to CIFA, Kausalyaganga, Bhubaneswar, Orissa for the biological study.

Premating molt and breeding behaviour

Then arrival at the CIFA prawn hatchery the matured males, females and berried females were given a dip bath in 0.5 ppm ($KMnO_4$) potassium permanganate solution for five minutes. After that they were reared separately in 2000 L FRP tank, half filled with freshwater to carry out the premating molt and breeding behaviour. A plastic pipe was placed in the tank to serve as a shelter for protection of premating molt females from predators.

Spawning and hatching behaviour

After spawning the berried prawns were removed from the tank and released in 160 L transparent glass aquarium for observation and to study the incubation and hatching behaviors of the prawns. The rearing glass aquarium was half filled with 5 ppt brackishwater. Berried prawns were fed with egg custard and mussel meat twice daily *ad libitum*. Proper aeration, cleaning of the aquarium to remove left out food and metabolites and water exchange were done daily to maintain good water quality. It was observed that the color of eggs changed from yellow to gray during the hatching of the larvae. It was also observed that the hatching of the larvae observed mostly during night. The spent females were removed from the aquarium.

Results and Discussion

Availability of prawn species

Data on *M. gangeticum* adult males and females recorded in the middle stretch of river Ganga around Patna are indicated in tables 1 and 2. The size ranged from 65-215mm. The adult prawns below 65mm were not recorded in this stretch while those above 65 mm sizes were recorded from May to October in the catches. The adults and berried females were recorded from May and continued till the end of October. The occurrence of berried females was observed from the last week of May and their number

Table 1. Size groups and percentage composition of *Macrobrachium gangeticum*

Size group	Males	Females	Total	Percentage	
				Male	Female
65	29	88	117	24.78	75.20
66-70	26	111	137	18.97	81.02
71-75	27	97	124	21.77	78.22
76-80	50	78	128	39.06	60.93
81-85	48	114	162	29.62	70.37
86-90	62	114	176	35.22	64.77
91-95	44	66	110	40.00	60.00
96-100	55	81	136	40.44	59.55
101-105	47	103	150	31.33	68.66
106-110	64	136	200	32.00	68.00
111- 115	42	122	164	25.60	74.39
116-120	45	123	168	26.78	73.21
121-125	63	136	199	31.65	68.34
126-130	24	114	138	17.39	82.60
131-135	22	94	116	18.96	81.03
136-140	30	94	124	24.19	75.80
141-145	32	95	127	25.19	74.80
146-150	55	90	145	37.93	62.06
151-155	56	91	147	38.09	61.90
156-160	78	118	196	39.79	60.20
161-165	48	57	105	45.71	54.28
166-170	108	71	179	60.33	39.66
171-175	82	21	103	79.61	20.38
176-180	80	14	94	85.10	14.89
181-185	52	8	60	86.66	13.33
186-190	38	3	41	92.68	7.31
191-195	20	2	22	90.90	9.09
196-200	16	1	17	94.11	5.88
201-205	15	-	15	100.00	0.0
211-215	12	-	12	100.00	0.0

increased and recorded to be maximum during the middle of the monsoon in August and September. Occurrence of fully matured males, females and berried females were found to be very much related to the rise and fall of floodwater in the river stretch. Size of adult males and females as well as berried females of *M. malcolmsonii* recorded in this stretch ranged from 65 -225 mm (Fig 1). The comparative sex wise ratio of both the species in different size groups recorded during two years is presented in table 2.

Table 2. Comparative sex ratio of *M. malcolmsonii* and *M. gangeticum* catches in different months in the river Ganga around Patna

Months	Total no. of males and females *M. malcolmsonii*	% of males	% of females	Total no. of males and females *M.gangeticum*	% of Males	% of Females
January	-	-	-	-	-	-
February	-	-	-	-	-	-
March	-	-	-	-	-	-
April	-	-	-	-	-	-
May	55	65.4	34.6	88	63.6	37.4
June	154	72.9	27.1	186	76.6	23.4
July	170	16.6	83.4	222	15.6	84.4
August	300	15.4	84.6	288	15.8	84.2
September	185	13.3	87.7	300	10.7	89.3
October	94	18.4	81.6	440	12.4	87.6
November	-	-	-	-	-	-
December	-	-	-	-	-	-

Specimens of both species below 60 mm were not recorded in river Ganga around Patna which is far away from the estuary, since these species complete their larval phase in brackish water (Ibrahim 1962; Rajyalakshmi 1980; Kanaujia 1989; 1999). The total length and weight of *M gangeticum* recorded is from 200-250 mm and 50-100 g in males and 150-200 mm and 35-75 g in females respectively (Tiwari and Holthuis 1996).

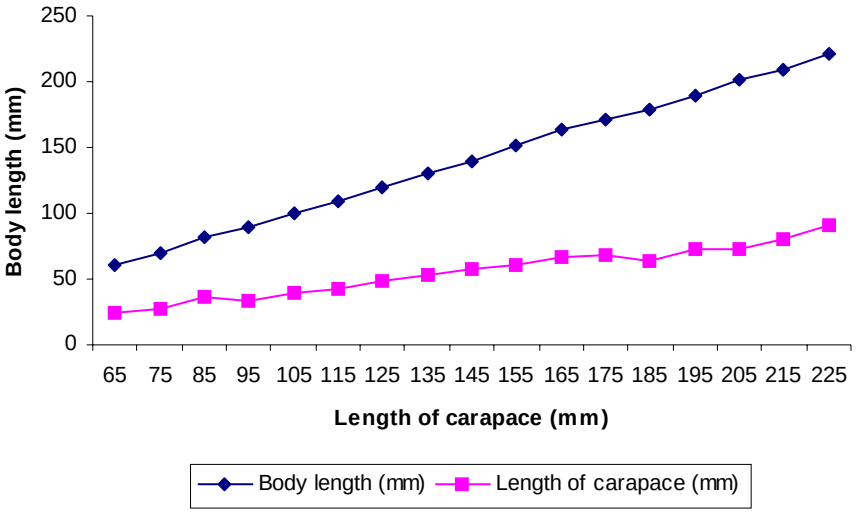

Fig. 1. Body length of *Macrobrachium malcolmsonii* in relation to length of carapace

Maturation and berried females

Matured females found with fully developed and ripe ovaries were observed through transparent carapace. Its abdominal pleurae is bent slightly inwards, the pleopods become slightly distended and arched outward, to form the space between them. Below the abdomen formed as enlarged brood chamber to accommodate a large number of eggs being spawned during breeding. The basal segments of the pleopods especially from the first three pairs were elongated and provided with soft long setae called ovigearous setae, which bears the eggs. These characters and development were observed in females of both the prawn species. The development of gonads in females was matured from April onwards.

The occurrence of berried females and large size adult prawns of this species was very much related to the rise and fall of river water. As indicated in catch composition, the number of *M. malcolmsonii* was found comparatively much less than that of *M. gangeticum*. Therefore, it was much difficult to segregate and assess the contribution towards prawn fishery. *M. malcolmsonii* adult specimens were available in small number during monsoon months. The maximum number of females was recorded in the size range of 95-105 mm and the minimum was in the size range of 185-205 mm (Fig. 1). The ratio of males was found higher in May and June and lower in the rest of the months during the first year and a similar trend was recorded during the second year. The freshly spawned females of *M. gangeticum* found with green yellow eggs and the *M. malcolmsonii* with yellow eggs, observed from the last week of May and maintained it till the end of October. Their number gradually increased with a peak during August and September. Most of the females (55-70%) were either with fully matured gonads or under berried condition. Among the 91-165 mm size group, the number of females was considerably higher than the males. Males in the 170-225 mm size group dominated over the female during premonsoon. However, the number of females increased from there onwards and dominated over the male till the end of monsoon (Tables 1 and 2 and Fig. 1). Both *M. gangeticum* and *M. malcolmsonii* are found to attain maturity at sizes 75 mm and above in the present study of this stretch of the river Ganga, whereas *M. malcolmsonii* was recorded to attain maturity at 83 mm in Hooghly, 68 mm in Godavary river system and 81-85 mm in Kolleru lake (Rajyalakshmi 1980; Rao 1986). However, Ibrahim (1982), and George *et al*. (1998) have recorded a smaller size range from 41-58 mm in the river Godavary, Mahanadi, Cauvery and Ojat (Gujarat). Mohapatra (2001) recorded maturity at 60 mm and above under pond condition of the *M. malcolmsonii* and *M. rosenbergii*. Testicular maturity in *M. gangeticum* and *M. malcolmsonii* are attained at 75 mm, whereas, secondary sexual characters in males are recorded with the presence of apendix masculina observed on the indopods of the second pleopods at 60 mm size.

The occurrence of berried females in both species during last week of May indicated maturation and breeding of the prawn, which continued till the end of October. The number of berried females recorded was higher during the month of August, September, was found to be the peak period for their breeding in this stretch. However, a prolonged breeding period of nine months from April to December with peak during August to November was observed in Kolleru lake by Rao (1986). Ibrahim (1962) made a similar observation in the river Godavary. However, this period was re-

stricted to 6 month from May to October in river Mahanadi and Ganga as well as under pond condition (Kanaujia 1989; 1999; Mohapatra 2001). Rao (1986); Kanaujia *et al*. (1999) and Mohapatra (2001) studied the maturity stages of the ovary in *M. malcolmsonii* and *M. rosenbergii,* and reported four stages of the ovarian development based on the color and size of the ovary in relation to carapace cavity and diameter of the ova.

Premating molt, breeding and spawning

Premating molt occurs in prawns once the ovaries ripen in their carapace cavity so as to transform the prawn into berried stage. This duration for transformation from ripe state to berried state varied within the range of 3 to 5 days with an average of 4 days for *M. gangeticum* and 5 to 7 days with an average of 6 days for *M. malcolmsonii*. After premating moult, the freshly molted female were found weak and sluggish and search for shelter to protect itself from predators. It took a few hours for the new body covering shell to become sufficiently hard. Perhaps the female prawn secreted a kind of hormone during premating moult, which strongly attracted the males for mating. Just after mating the male and female separate from each other and the female moved to a safe place for spawning. At the time of spawning the body of the female were observed to bend forward to keep the contact with the ventral thoracic region to form a U-shaped structure. Therefore, the eggs were extruded directly into the brood chamber passing through the female genital pore found at the base of the third thoracic leg in both species. The eggs were held in bundles like grapes through some thin and elastic membranous substance and adhered tightly to the fine ovegerous setae of the first to fourth pairs of pleopods in both species. The release of eggs from the ovary to the brood chamber was observed to be in a tubular form, which became rounded after leaving the genital pore. The color of freshly spawned eggs in *M. gangeticum* was green yellow, whereas in *M. malcolmsonii* it was yellow (Table 3). In the present study, the breeding process observed in both species has been found similar with other findings recorded in *M. rosenbergii, M. malcolmsonii* and *M. gangeticum* (Ling 1969; Rao 1965; Kanaujia *et al*. 2005). The occurrence of berried females in this stretch of both species at 190 mm in size indicated no migration for breeding, which has also been observed by Ibrahim (1962) in the stretches of Godavary river system. The phenomenon of breeding activity throughout the year in Kolleru lake reported by Rao (1986) indicated that the *M. malcolmsonii* does not perform the breeding migration towards the estuary as reported in *M. rosenbergii*. Although

breeding and embryonic development of both species take place in freshwater under the river system, the newly hatched zoea stage I drifted along with the water current and reached to the estuary and completed their larval stages in brackish water. This has been reported by Ibrahim (1962), Rajyalakshmi (1980), Rao (1986) and Kanaujia (1989; 1999) in *M. malcolmsonii* and Kanaujia (2003) in *M. gangeticum*. Year round mating and spawning in both species occurred easily under captivity, which is similar with natural environment and culture conditions of freshwater and brackish water. Premating periods are rather seasonal, depending on the presence of favorable environmental conditions like monsoon rain and weather temperature. Mating behavior in both species was observed to be similar *with M. malcolmsonii* and *M. rosenbergii* studied earlier by Rao (1965), Ling (1969) and Mohapatra (2001).

Table 3. Major differences between berried females of *M. gangeticum* and *M. malcolmsonii*

Sl. no.	Berried condition	*M. gangeticum*	*M. malcolmsonii*
1	Egg color	Initial –greenish Final – milky brown	Initial –yellowish Final – brownish
2	Incubation period	12 – 14 days	14 – 17 days
3	Hatching time	Started from late night and finished before afternoon of the next day	at night

Incubation and hatching

The berried female cared for the eggs till hatching. During incubation period of both prawn species, variations in important physico-chemical parameters were observed. Water temperature ranged from 28.3 - 30°C, pH 7.6 – 8.5 and salinity was maintained 4 - 6 ppt., for both species. The pleopods were observed to beat back and fourth intermittently to provide aeration for developing embryos. The incubation period in *M.*

gangeticum was recorded at 12-14 days whereas in *M. malcolmsonii* it was 14 – 17 (Table 3). The female carefully removed the dead eggs and foreign materials with the help of its sensitive and versatile first pair of chelate legs. The color of the eggs in both species gradually became lighter, when the larvae inside the eggs were fully developed, the color became light grey.

Once the first stage zoea larvae inside the egg are fully developed, the larva was ready to come out of the eggshell to start active life. The process of hatching was studied through hand lens and compound microscope with the developing embryo removed from the brood sac. This slow process was accompanied by continuous vibration at the mouth of the larva, and stretching of its rolled body, forcing the egg shell to elongate gradually. Vibration at the mouth became more and more vigorous followed by further stretching of the body. About an hour later the thoracic appendages started to vibrate vigorously but intermittently for about a few minutes with increasing length of periopods vibration. This became very vigorous and continuous. The body continued to stretch the rostrum and telson, which was held like a mask covering and protecting the eyes and head, which started pushing outward. Suddenly the eggshell brake and the telson thrashed out followed by the head, and with a forceful flex and stretch of the body the hatched zoea larvae started swimming actively in the water column. Both species were observed to breed four times and the number of eggs in the first breeding is found less, but increased moderately in the second and third breeding but then reduced again in the fourth breeding.

Freshly spawned eggs of *M. malcolmsonii* are yellow in color which it is yellow green in *M. gangeticum*, orange yellow in *M. rosonbergii* and green in *M. lamarrei* and *M. lamarrei lamarrei* (Uno and Sao, 1969; Kanaujia 2003). The fertilized eggs carried by the females undergo for embryonic development till the hatching of zoea stage I., which appeared within 12-15 days in *M. malcolmsonii* and comparatively less duration (12-13 days) in *M. gangeticum*. Whereas in giant freshwater prawn *M. rosenbergii*, longer period for incubation and embryonic development was reported at 18-25 days (Uno and Sao 1969; Kanaujia *et al.* 2005). The hatching period in *M. malcolmsonii* started mostly during night (24 hrs) and completed before morning (5 – 6 hrs.). This period was prolonged till morning (12 hrs) in *M. gangeticum* and much longer in *M. rosenbergii where* hatching start at night (24hrs) and completed in the 2nd night or 2nd day (24 – 36 hrs) (Ling 1969; Fujimura and Okamoto 1972; Kanaujia 2003; Kanaujia *et al*. 2005).

Conclusion

The growth, maturation, breeding biology and related aspects under the natural riverine system indicated breeding only in restricted periods from May to October. However, breeding may take place year round under a maintained water temperature. These two species are reported to be the second and third largest freshwater prawns available in the Indian riverine system. The comparative results on breeding biology of both species indicate the need for the establishment of a prawn hatchery and culture in the inland regions as well as in the Northeast states of the country where both species are available (Ganga and Brahmaputra rivers).

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