



Maturation and Fecundity of Large Freshwater Prawn *Macrobrachium malcolmsonii* and *Macrobrachium gangeticum* in the Ganga River System in India

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Author's contribution

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

Article Information

DOI: 10.9734/CJAST/2020/v39i2130834

Editor(s):

(1) Dr. Gregory J. Grigoropoulos, Marine Engineering (SNAME) of the National Technical University of Athens (NTUA), Greece.

Reviewers:

(1) Hanaa E. Mahood, University of Al-Qadisiyah, Iraq.

(2) Roshada Hashim, Universiti Sains Islam, Malaysia.

(3) Walisson de Souza e Silva, Federal University of Minas Gerais, Brazil.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/59024>

Original Research Article

Received 17 May 2020
Accepted 22 July 2020
Published 10 August 2020

ABSTRACT

The Ganga is the largest perennial river in India. The prawns' fishery resources are declining in middle stretch of the river Ganga near Patna. The present paper deals with the maturation and fecundity of large size Macrobrachium species like *Macrobrachium gangeticum* (Bate) and *Macrobrachium malcolmsonii* (Edwards) were estimated for the period of two years. Maturity and fecundity of prawn were evaluated according to the size of prawn, ovary and breeding frequency. The initial stage developing ovaries of *M. gangeticum* were observed small & light yellowish green colour but at stage II to mature gonad of *M. gangeticum* were found deep yellow green mass in the carapace, whereas in *M. malcolmsonii* the developing stage of ovaries was observed large yellowish in colour and matured female gonad were found comparatively in large and deep yellow in the carapace. The gravid females observed long setae at the base of genital aperture and 1- 4 pleopodes in both species. After mating, eggs were transferred by both the female prawn from ovary to brood pouch. Berried prawn *M. gangeticum* one week old fertilized eggs were looked as yellowish green finally brown color. Whereas, in *M. malcolmsonii*, one week fertilized eggs were looked as

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yellowish-grey then finally changed deep gray. *M. gangeticum* and *M. malcolmsonii* female releases of eggs, her ovaries displayed either stage resting or zero characteristics. The species of *M. gangeticum* possess minimum of 8000 eggs with size 75 mm and the maximum 76,240 eggs with respective size 190 mm, whereas *M. malcolmsonii* the minimum fecundity observed 8100 eggs with size 75 mm and the maximum fecundity was 81,200 eggs of 190 mm size. The total weights of the eggs per female prawn as well as the mean number of eggs were improved with cumulative length and weight. The breeding frequency of both species were found four times and in first breeding the number of eggs was found slight, but it increased comparatively in second and third breeding and got decreased again in fourth breeding.

Keywords: *Macrobrachium species*; maturation; fecundity; palaemonidae; prawn; Ganga.

1. INTRODUCTION

The Ganga is the largest perennial river in India is reported to have resident population of freshwater prawn *Macrobrachium gangeticum* and also consisting diversified fish, prawn fauna and this population of edible aquatic food is considered as the backbone of capture fishery [1]. The fresh water prawns are highly esteemed as nutritive proteineous food bearing a varying market prize for larger form from Rs 400-600 per kg in India. The large size freshwater prawn *Macrobrachium malcolmsonii* (Edwards) and *Macrobrachium gangeticum* (Bate) belonging to the phylum *Arthropoda* class *Crustacea* order *Decapoda* family palaemonidae inhabiting in Ganga river system exhibit notable different exist between the male and female. It has been moreover noticed that there is significant depletion of the natural stock of these prawns in the Ganga river systems due to many ecological changes [1,2,3,4]. The abdominal pleura of the female prawn form as a brood chamber in which the eggs are bring between laying and hatching [5,6,7,8] reported four stages of maturation based on external examination of discoloration and respective size of the ovaries to the size of cephalothorax. Fecundity is a calculated of the reproductive capacity of organisms which may be fish or prawn, also a population is a function of fecundity of the females [9]. Fecundity studies are also neat for providing estimates for possible recruitment or juveniles obtainable for culture [10]. Fecundity is normally set on by the total number of mature ova in the ovary which are to be discarding in the current season; the number of eggs sustained by a female is pretentious by many factors and potencies by specific attributes at different environments [11]. Fecundity of prawn is usually determined by estimating the number of eggs spawned by given size group of female [12]. Fecundity of crustaceans presented direct relationship with body length, with

carapace length and body weight with gonad weight [13]. The egg mass weight of fish and shell fishes are direct proportional to the length and weight of the animals [14] and [15]. The Ganga river prawns *M. gangeticum* breeding strategies and embryonic development were a brief account of information's noticed by [16,17,6].

In this background, we have assessed an effort have been done to study the growth, maturation and fecundity of two large indigenous *Macrobrachium species* available of the middle stretch in the river Ganga around Patna.

2. MATERIALS AND METHODS

2.1 Study Area and Prawn Collection

Prawns were collected by the help of fisherman using fishing net from the river Ganga at selected prawn landing sites viz. Gandhisetu, Alamganj and Basghat around Patna (Bihar), and data was collected month wise for a period of two years 2000-2001. While collecting the data on prawn landing, species wise segregation was done keeping the prawn specimens in 5% formalin to record the individual composition of total catch Fig. 1. The maturing, adults males and females of 65 – 90 mm total length of the large freshwater prawn species like *M. gangeticum* and *M. malcolmsonii* were carefully transported to Central Institute of Freshwater Aquaculture, (CIFA), Bhubaneswar, Orissa (Latitude 20°11'6"-20°11'45" N. Longitude 85°50'52" – 85°51" E) in live condition covering distance about 900 km. via, road / rail using oxygen packing for biological study.

2.2 Animal Study and Management

After arrival at CIFA, Bhubaneswar the packets were opened and live prawns were released in FRP tanks for conditioning. After that the prawns

were given a dip bath in 0.5-ppm potassium permanganate solution for few minutes before released in aquarium. Then they were reared separately in 180 L transparent glass aquarium filled with freshwater. Fifteen numbers of prawns average size group 75-190 mm to study the maturation stages of ovary and morphological changes, development and growth in prawn. 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. Leftover food and metabolites were siphoned out daily in the morning and 30 % water was exchanged at weekly intervals. An airlift-biofilter device was installed to provide proper aeration in the aquarium, [17]. Growth and gonadal maturation were observed in both

species daily visually with the help of hand net and lens. The total length of the individual berried prawn of all the groups was recorded from the tip of rostrum to the tip of telson to the nearest accuracy. Breeding (means occurrence of berried prawns) in both the prawn species in the Ganga river near Patna was recorded from May to October as is evident from the occurrence of berried females in the catch. For fecundity study the berried prawns were weighted before and after the release of the eggs. From the berried prawn, egg samples were removed by forceps and blotted with filter paper to remove the excess of water. After that that eggs were collected, weighed and counted Fig. 1. The fecundity was estimated by the method of [18].



a. Bereeid prawn *Macrobrachium gangeticum*



b. Collection & packing of prawn near Patna



c. Measurements of prawn at CIFA



d. Collection of *Artemia nauplii* for larval feeding



e. Observation of eggs & larvae development



f. larval feeding at Prawn hatchery CIFA

Fig. 1. Prawns collection, measurements, breeding biology at landing sites & CIFA, Hatchry

2.3 Data Analysis

The primary data recorded the size group structure, fecundity, maturity during this study were processed for selected statistical parameters (i.e mean, range simple tabular percentage analysis was done. Statistical analysis was done by using Microsoft Excel 2007 software.

3. RESULTS AND DISCUSSION

In the present study the data shows that the different developmental stages of ovaries of *M. gangeticum* and *M. malcolmsonii* and the number of eggs in these freshwater prawns were related to the size group is presented in Tables 1, 2 and Figs. 1 & 2. The female reproductive system consists of a pair of elongated and somewhat flattened ovaries laying over the dorsal side of the carapace [6]). The female's gonadal developments of both species were found from April onwards. The freshly spawned females of *M. gangeticum* had green yellow color eggs whereas yellow color eggs, in *M. malcolmsonii* were observed from the last week of May to the end of October. Their number gradually increased in both said species with a peak during August and September. Most of the females (55-70%) were found either with fully matured gonads or under berried condition. The entire process of ovarian development observed at prawn landing center at Patna as well as in controlled condition in prawn hatchery (CIFA, Bhubaneswar) of both species found more or less same details presented in (Table 1). [19] Reported regarding maturity & spawning of *M. gangeticum* had two peaks of spawning, one in April- May and the other in July-August.

Maturity stages in the female are distinguished on the basis of color, size of ovary in relation to development of setae. This is categorized into five stage (0, I, II, III, IV and V) in both species. In the immature virgin (stage 0) and maturing virgin/recovery of spend (stage 1) condition they were found very small, milky and colorless in *M. gangeticum* whereas in *M. malcolmsonii*, they were found large and yellowish in color which could be easily observed dorsally at the junction between cephalothorax and first abdominal segment. The developing and maturing ovaries at stage I and mature female gonad at stage II of *M. gangeticum* were found yellow green mass whereas in case of *M. malcolmsonii* they were large and deep yellow in color, which occupied the entire dorso lateral region of cephalothorax and clearly visible through the carapace. After that, the integument of prawns were originally

dark became light orange. This indicated that the female is approaching pre-matting molt. The gravid female during stage III had a long setae developed at the base of genital aperture and 1-4 pleopodes in both species. Berried female during stage IV Eggs were transferred from ovary to brood pouch in both the species. In case of *M. gangeticum* one week old fertilized eggs were looked as yellowish green & turned finally brawn color, whereas, in *M. malcolmsonii* one week old fertilized eggs were looked as yellowish with grey then finally deep gray. After the females eggs are released. The ovaries displayed either stage resting or 0 characteristics. Singh and Roy [16] reported, five stages of ovaries recognized on the basis of colour.viz. 1, Pre-mature pink, 2) Early maturing light green, 3) Mature green, 4) Berried greenish brown/yellowish brown and 5) Spent reddish brown. The entire process of ovarian development was found more or less similar to other authors [17,6]. Singh and Roy [16] reported that the major spawning period of females likes in July/ August when most of the animals were found either berried or spent. The maturity attained at the size of 80 mm in the river Ojat of Gujarat reported by Mansuri, et al. [20] whereas in Ganga and Mahanadi river the minimum size to attain maturity is 70 mm [21,22,23,2]. In the palaemonid prawn minimum size at first maturity varies with the species and habitat. The prawn continues its maturing stage either continuously or from time to time depending upon the environmental condition or its age. After maturation ovary develops fully either 36-40 days in freshwater and at this stage prawn prepares for its molting [12,6]. Philip and Subramonium [24] observed that the immature ovary is translucent, flabby and without any pigments and when it is fully matured it extends from the base of rostrum to the first abdominal segment and assumes a dark green color. Damrongphol, et al. [8] found four stages of maturation based on external examination of coloration and relative size of the ovaries to the size of cephalothorax.

Fecundity was defined as the number of eggs laid per hatching that was found to adhere to the female pleopods [25]. The fecundity of *Macrobrachium species* is very variable reported by different researchers. The number of eggs also increases with increase in weight and carapace length [26,27]. The highest fecundity in species of this genus is observed in *M. rosenbergii* and *M. carcinus*, which females can lay between 80,000 and 100,000 eggs in each spawning when they are fully mature.

Table 1. Developmental stages of ovaries of two large size freshwater prawns

Stage	Ovary stages	<i>Macrobrachium gangeticum</i>	<i>Macrobrachium malcolmsonii</i>
0	Immature/virgin	Ovary small & colorless	Small gray and transparent
I	Maturing/virgin and developing	Small, light yellowish green moderately occupied 3/4 th portion of carapace.	Large yellowish and moderately occupied 3/4 th portion of carapace.
II	Matured (ripe)	Large yellow green and occupying the entire space of carapace cavity.	Comparatively large deep yellow and occupied the entire space of carapace cavity.
III	Gravid	Long setae developed at the base of all the pleopodes except 5 th pair, and setae were also observed around the genital aperture at the base of the 3 rd thoracic legs.	Large number of long setae developed at the base of all the pleopodes except 5 th pair, and setae were also observed around the genital aperture at the base of the 3 rd thoracic legs
IV	Berried female	Eggs were transferred from ovary to brood pouch. One week old fertilized eggs looked yellowish green finally light gray color	Eggs were transferred from ovary to brood pouch. One week old fertilized eggs looked yellowish with grey then finally deep gray.
V	Spend /resting	Ovary empty, very small and transparent	Ovary empty, very small, and colorless.

Table 2. Eggs carried by the females of *Macrobrachium malcolmsonii* in relation to the body weight and weight of egg mass

Average Size groups mm	Weight of prawn (gms.)	Weight of egg mass (gms.)	Total number of eggs carried by the female	Body weight in relation to egg mass
75	6.00	1.60	8,100	1 : 3.7
85	7.00	1.50	8,230	1 : 4.6
91	8.00	1.40	8,350	1 : 5.7
95	12.50	2.20	8,400	1 : 5.6
100	14.50	2.50	8,600	1 : 5.8
102	18.90	2.90	9,100	1 : 6.5
112	20.45	3.00	12,590	1 : 6.8
118	16.35	2.80	13,510	1 : 5.8
120	18.50	2.70	15,200	1 : 6.8
125	21.00	3.20	13,400	1 : 6.5
125	20.50	3.50	12,400	1 : 5.8
130	21.00	3.10	15,300	1 : 6.7
130	23.23	4.90	16,320	1 : 4.7
134	32.00	9.10	51,230	1 : 3.5
140	34.50	10.20	55,700	1 : 3.3
145	34.00	12.92	69,200	1 : 2.6
148	48.00	12.00	65,820	1 : 4.0
155	34.00	11.20	55,000	1 : 3.0
165	58.00	13.20	72,200	1 : 4.4
170	48.20	12.95	68,100	1 : 3.7
180	40.00	9.20	49,200	1 : 4.3
185	51.20	11.30	63,200	1 : 4.5
190	72.00	22.50	81,200	1 : 3.2

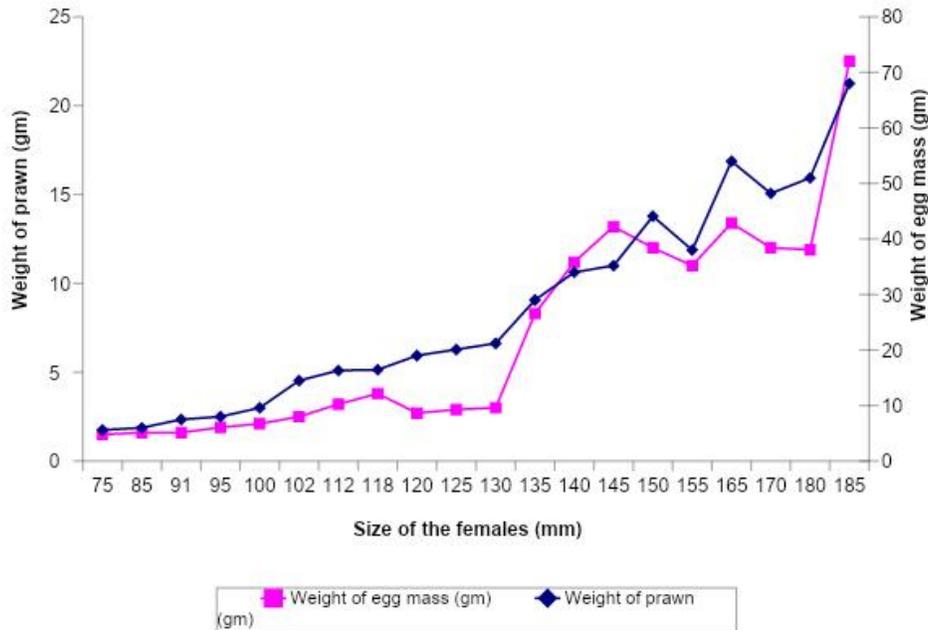


Fig. 2. Size of the females in relation to body weight and weight of egg mass of *Macrobrachium gangeticum*

In the first spawning they can lay not more than 5,000 and 20,000 eggs [28,29] reported that the highest number of eggs observed individually per hatching of *M. amazonicum* was 2,193. They also explained that in *Macrobrachium* species the fecundity is extreme associated with the female age, and that it can increase while the female becomes mature. Fecundity of prawn is usually determined by estimating the number of eggs spawned by given size group of female [12]. Kanaujia, [22] reported that it varies from 40,000 to 1,50,000 eggs depending on the size of the prawn. In the present study, the number of eggs (fecundity) of *M. malcolmsonii* and *M. gangeticum* were assessed by counting of the fertilized eggs carried by the different sizes of berried females in their brood sac. Minimum 8000 eggs in females of 75 mm size and the maximum eggs 76,240 in females of 190 mm size recorded in *M. gangeticum*. Whereas the minimum fecundity in *M. malcolmsonii* 8100 in female of 75 mm size and maximum 81,200 eggs in females of 190 mm size were recorded, details predicted (Table 2 & Fig. 1). The number of eggs carried by a female is related to the size of prawn and their number was reported in *M. malcolmsonii* under different riverine system. Rao [22] recorded 12,556-77440 eggs from the female's prawns of 83-156 mm size in Kolleru Lake.

A maximum fecundity 5100-83000 eggs was reported by [20] in females of 63-204 mm from the Ojat river (Gujarat), while [23] found between 1200-78000 eggs in prawns of 70-195 mm size from the river Ganga around Buxur. Further, a higher fecundity of 80,000 to 1,00,000 eggs has been reported in *M. malcolmsonii* females ranging from 150-165 mm size by George et al. [30] from the river Cauvery. The number of eggs may be more in the first time and may show a tendency to decline in the subsequent brood [15,31]. Mating behavior in both the species observed more or less similar with *M. malcolmsonii* and *M. rosenbergii*. Both the species observed to breed four times and the number of eggs in first breeding is found less, which increases moderately in second and third breeding and reduces again in fourth breeding.

The reproductive potential in the form of fecundity was estimated in *M. malcolmsonii* from the river Ojat of Saurashtra, which ranged from 5,100 to 83,000 numbers of eggs in the berried females of 63 to 204 mm in size [20]. They also reported that the relationship of body length with fecundity was significant but it was highly significant between egg mass weight and fecundity. Jee and Kok [32,7] mentioned that the relationship of body length with fecundity was

significant while it was highly significant between weight of egg mass and fecundity the same has been observed in present experiment.

4. CONCLUSION

The species of *M. malcolmsonii* and *M. gangeticum*, biology and related aspects under the natural riverine system indicated it breeding only in the restricted period from May to October in the middle stretch of the river Ganga. The species of *M. gangeticum* possess minimum of 8000 eggs with size 75 mm and the maximum 76,240 eggs with respective size 190 mm, whereas *M. malcolmsonii* the minimum fecundity observed 8100 eggs with size 75 mm and the maximum fecundity was 81,200 eggs of 190 mm size. The total weights of the eggs per female as well as the mean number of eggs were increased with increasing length and weight. It is concluded that the comparative results on maturity and fecundity of both species indicates the needs 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.

ACKNOWLEDGEMENT

The author wishes to express his gratitude to the Director, CIFA, Bhubaneswar for the permission to carry out the research work and guide Dr. D. R. Kanaujia and Dr. A. K. Patra for providing the excellent laboratory facilities.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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