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General Biology of Freshwater Prawn, *Macrobrachium lamarrei* (H. Milne-Edwards) of Biratnagar, Nepal

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Abstract

Macrobrachium lamarrei (H. Milne-Edward) is commonly known as "kuncho river prawn," occurring in freshwater ponds and rivers of Biratnagar, Nepal. They are nocturnal species feed voraciously on planktonic organisms, algae, muscles pieces of their own kind or fish etc. *M. lamarrei* is a medium-sized prawn ranging from 75-80 mm in length rostrum bears 7-9 teeth dorsally and 5-8 ventrally.

The estimation of fecundity was done following egg counting method from March, 2004 to February, 2005. The mean fecundity ranged from 82-308 in the prawn having mean body length 57-74 mm and mean bodyweight 0.78-1.62 g. The correlation coefficient (r) of the relationship between body length and fecundity, and body weight and fecundity were 0.201 and 0508 respectively, indicating insignificant relationship. The mean fecundity was found to be 183.55 and mean relative fecundity ranged from 82-221.79.

The mature eggs measured 0.54-0.64 mm on its long axis. The suitable temperature recorded during egg laying time was found to be 30 ± 2^0C, Do 10 mgl^{-1} and pH 7.75-8. Marked differences in the morphology and habit of larval stages of prawn ranging from length of body to number of rostral teeth were noted.

Key words: Biratnagar, General biology, *Macrobrachium lamarrei*, Nepal

Introduction

Biology and fishery of prawn have attracted considerable attention of biologists and fish farmers recently due to their great economic importance but the scientific work on prawn is in its infant stage in Nepal, so there exists scanty of information pertaining to taxonomy and diversity of prawn here. However, Shrestha *et al.* (2001) have reported eight species of genus *Macrobrachium* from Kaligandaki and Narayani River. Tiwari (1955) has described the distribution of 34 species of genus *Palaemon* in India and Burma. Many of these *Palaemon* are now described as *Macrobrachium*. The original habitat of the genus *Palaemon* is marine but somewhere they have migrated to fresh water successfully to inhabit there (Tiwari, 1955). The process of adaptation of fresh water is not yet complete because many species are not found in estuaries and still depend on brackish water for breeding. Prawn fishery has been advanced in several countries in the world. In a land locked country, Nepal too; the culture of giant fresh water prawn, *Macrobrachium rosenburgii* has been started by producing post larvae in the laboratory on the experimental basis. This has added some interest to the mind of fisherists and fish farmers to start prawn culture in Nepal.

According to Holthius (1980), 48 species of the genus *Macrobrachium* are consumed as food and hence they are economically important. About half of these species have been examined for their potential suitability for aquaculture (Holthius, 1980; Brown, 1991; Jhingran, 1991; Jayachandran and

Joseph, 1992). Freshwater prawns other than *Macrobrachium rosenbergii* having similar economical as well as commercial value have been studied for their culture and production. However, experimental trails have already been carried out with *Macrobrachium lamarrei* (Singh and Quereshi, 1997).

Freshwater prawns belong to the family Palaemonidae. According to Tiwari (1955), the genus *Palaemon* has marine origin and has acquired freshwater habitat by immigration from the sea to the interior of land through rivers. The process of adaptation of freshwater is not yet complete, because many species are not found in estuaries and still depend on brackish water for breeding. Several species have become completely acclimatized to freshwater and are found in inland rivers and hill-streams.

Macrobrachium lampreys is one of the medium-sized freshwater prawn. Holthius (1980), has provided major location and maximum size of the species and its FAO English name *M. lamarrei* is known as "Kuncho river prawn" which is 69 mm in its maximum size. It is also found in Bangladesh and India. Kuncho river prawn forms an extremely important component of the subsistence catch in Bangladesh. *M. lamarrei* is also found in Indo-west pacific regions, Marian *et al.* (1986).

Biology of prawn

General morphology

Macrobrachium lamarrei (H. Milne-Edward 1937) is a medium-sized freshwater prawn. The males can reach a total length of 80 mm (from the tip of rostrum to tip of telson) whereas, the females up to 75 mm. The body is usually creamy white to light brownish white with greenish brown pigmentation all over the cephalothorax. Like all species of decapod, prawns body consists of two distinct parts cephalothorax and abdomen. The carapace covers over the cephalothorax which is smooth and hard. The rostrum of this species is long reaching beyond the antennal scale. The rostrum is slightly slender. Dorsally rostrum bears 7-9 teeth and 5-8 below. The hepatic spine present on the anterior carapace margin. Five pairs of peraeopods, or true legs present in cephalothorax region. In contrast to the cephalothorax the segmentation of the abdomen is very distinct. This part possesses six segments where each segment bears a pair of ventral appendages called pleopods or swimmerets. The swimmerets of the sixth abdominal somites are stiff and hard, and the telson serves as tail fan (Ismael and New, 2000).

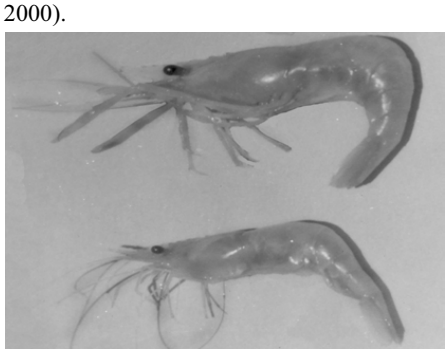


Plate 1. *Macrobrachium lamarrei* (H. Milne-Edward 1937)

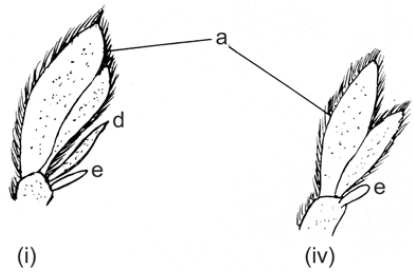
The female, when berried carries very numerous eggs under the abdomen attached with swimmerets. The antennules and antennae of number of crustaceans are considered the most important sites of sensory reception (McLaughlin, 1980). Smooth rounded dorsal body surface present in *Macrobrachium* spp., while penaeids have a simple or complex ridge at the dorsal apex of the abdomen (Finchan and Wickins, 1976).

Food and feeding habits

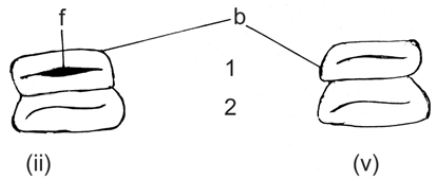
Juvenile and adult prawns are omnivorous and feed frequently and voraciously on a wide variety of food items. According to Chopra (1939), the prawns eat all types of food living or dead what comes on their way. Prawns consume algae, planktonic organisms, small muscle pieces of their own kind or fish etc, which could be held in the chelae of legs are taken. When prawns of different sizes are kept together, the bigger ones did not attack the smaller ones inside the aquarium. When one died or become weak, other attacked and made them as their meal. It is likely that in nature prawns are partly predatory in behavior and keep chasing smaller ones of suitable size that may be caught with in their chelae. Post larvae feed better on pure animal diet than on mixed diet of algae and nauplii, William (1958). The first pair of peraeopod is main organ for capturing food while the massive second pair also helps in capturing large objects or live food.

Sexual dimorphism

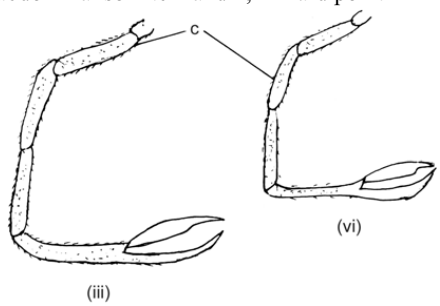
Mature males can be easily recognized by their longer and stronger chelipeds with larger spines than in case of females. Male possesses appendix masculina, a spinous process adjacent to the appendix interna on the endopod of the second pleopod, (Sandifer and Smith, 1985). Mature females have proportionally small body size as well as head and claw (Sandifer and Smith, 1985). They exhibit a typical brood chamber formed by the first, second and third abdominal pleurae. There is presence of central lump on the ventral side of the first abdominal somite in male whereas this feature is absent in female. Sexual differentiation is controlled by the presence of the androgenic hormone, which induce the male characteristics of the genital tract (Charniaux-Cotton and Payen 1985). Females *M. lamarrei* experience a moult known as pre-spawning or pre-mating moult which usually occurs at night.



i- Male, iv- Female, a- Second pleopod, d- Appendix masculine, e- Appendix interna



ii- male, v- Female, b- Ventral view of abdominal somite 1 and 2, f- Hard point



iii- Male, vi- Female, c- Second peraeopod

Plate 2. Secondary sexual characters of *Macrobrachium lamarrei*.

Fecundity

The fecundity can be expressed in a number

of ways. It is the total number of weight of eggs produced by a female during the average life-span. It can also be known by the number of ripening eggs in the ovaries of female before spawning, Shrivastava (1999). In the present communication the term fecundity is referred to the number of eggs borne in the brood pouch during a single spawning act. "The Kuncho river prawn" matures in freshwater condition and the female deposits the eggs in brood pouch, beneath the abdomen formed by the long pleura of the abdominal segments and the first four pairs of pleopods.

The number of eggs shed by different species of the prawn may vary considerably (Bhattacharjee and Dasgupta, 1989; Kurian and Sebastian 1986; Manna and Raut, 1991; Sakuntala, 1976). Individual of the same species produces varying number of eggs depending on their age, length, weight and environmental condition (Bal and Rao, 1990; De, 1980).

The knowledge of fecundity is important in estimating the reproductive potential of brood prawns which in turn, can greatly help the management strategies of prawn hatcheries. The fecundity studies is also helpful in estimating the number of spawners required for producing desired quantity of seeds for farming. Even a few years ago the culture of *M. rosenbergii* in India was haphazard and mostly depended on the supply of seeds from natural source (Laha *et al.*, 1988; Mahapatra *et al.*, 1994b; Mahapatra *et al.*, 1995). Due to the scarcity of scampi seed trails are already been carried out to produce seeds in hatcheries, (Chowdhury *et al.*, 1993; Rajyalaxmi, 1993). Here an attempt has also been made to highlight the relationship of fecundity with length and weight of the prawn to assess the most suitable size group that can be used for seed production.

Development in prawn

The 'Kuncho river prawn' has four phases in its lifecycle: egg larva, post-larva and adult. The fertilization is external and takes place as soon as the eggs are extruded. The newly fertilized eggs are homogenously granulated. All the larval stages are completed inside the freshwater. Histology of the mature eggs were studied which helped in the study of the development of the embryonic as well as the larval development of the prawn which can help to know the nature, habit and habitat for the proper management of the prawn.

Materials and Methods

Collection of specimens

Fertilized female *Macrobrachium lamarrei* belonging to the family Palaemonidae were collected from Singhia ,Kesalia rivers, canals and ponds of Biratnagar with the help of local fishermen and brought to the laboratory of Zoology Department of Post Graduate Campus, Biratnagar. The required numbers of females with fertilized eggs were preserved in 5 % formalin for fecundity study. A few fertilized females were reared in an aquarium providing an aerator in the Zoology laboratory of P.G Campus, Biratnagar. Study of sexual dimorphism, and food and feeding behaviours were studied. Fish muscles and dead trashed prawns were supplied to feed on. Water of the aquarium was changed at an interval of 24 hours.

Study of developmental stages

A few fertilized females were selected from the aquarium and reared in a blue coloured bucket of 20 litre capacity. A small sized aquarium aerator was fitted to supply sufficient amount of oxygen. These females were also fed with food of animal origin. The

females were regularly observed until the eggs turned from dark green to light green and then transparent. When the transparent colour of eggs was seen with two black spots in the eggs then the females were transferred to the medium sized plastic bowl of five liter capacity with a continuous supply of oxygen to lay eggs. The change in the colour of eggs was observed by holding the specimens making their ventral side up and observing the eggs held by the specimens in the pleopods. The temperature and pH of water were recorded regularly during hatching time of the eggs. After laying eggs into water, the females were removed from the bowl. Observation was done to record hatching time

Fecundity

To estimate te fecundity study was carried out during March (2004)-February (2005). Weight and length of the females were recorded before removing eggs from their body. The fecundity was calculated and recorded by removing the egg mass from the femles brood pouch with the help of forceps and counting the whole number of eggs. Since, the number of egg was not so high so, sub-sample method was not used for the estimation of fecundity. Now, the mean of length, weight and fecundity were calculated of nine months as in the rest three months females were not having mature eggs visible to naked eyes.

The trends of relationship between fecundity and body length and fecundity and body weight were estimated by the formula:

$F = a + bX$

For body measurements i.e. X (L and W)

Where, F= fecundity, L= body length, W= body weight, a and b= constants

The coefficient of correlation (r) of each of the relationships was also assessed. In addition to the above studies, the relative fecundity was also calculated by using the following formula:

$$\frac{\text{Total number of eggs in the brood pouch}}{\text{Total weight of prawn}}$$

Results

The prawn described in this paper was identified following the procedures adopted by George {1969) as *Macrobrachium lamarrei* (H. Milne-Edwards, 1937), a freshwater prawn, commonly known as Kuncho river prawn

Stages of development

The fertilized females with dark green coloured eggs in their brood pouch were reared. The dark green colour of eggs turned into light green after seven days and then again turned into transparent white in the next 6-7 days. The transparent eggs possessed two black spots of eye which hatched after 2-3 days. The eye spots were clearly visible externally before hatching (plate III, ii). The mature eggs were slightly elliptical and measured 0.54-0.64 mm on their long axis. The eggs hatched completely after 5-6 hrs of laying. At the time of laying the eggs, the female vigorously move their pleopods so that the eggs dispersed evenly into the water. The temperature measured at the time of egg laying was 30 ± 2^0C, Dissolved oxygen measured was 10 mg/l and pH was 7.75-8.

The hatching is accomplished with increased internal pressure due to increased size of the larva and by the movement of the appendages. The vigorous movement of the mouth parts and thoracic appendages cause rupture of the egg membrane resulting in emergence of the telson first, followed by the head of the larva. The mother prawn moves the pleopods rapidly during hatching to disperse the new hatchling.

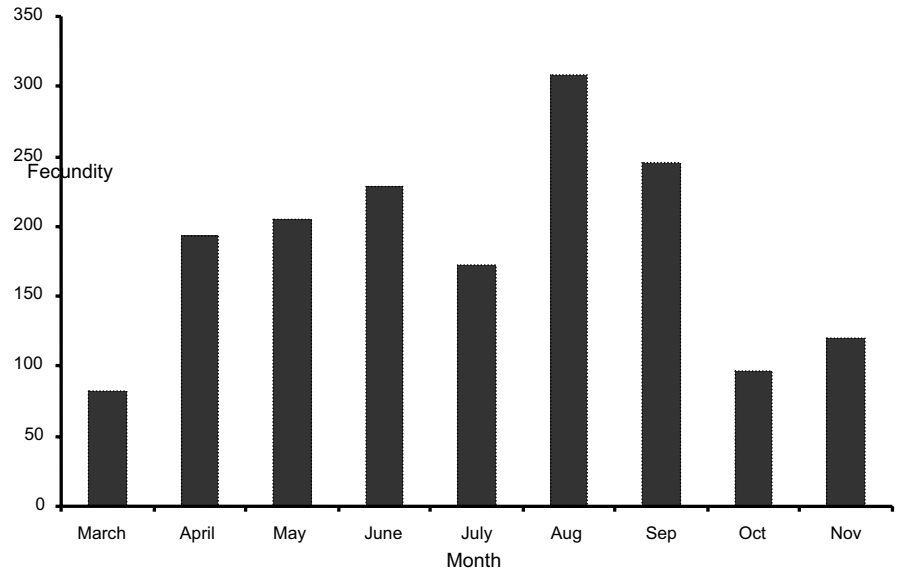


Figure 1. Relationship between month and fecundity.

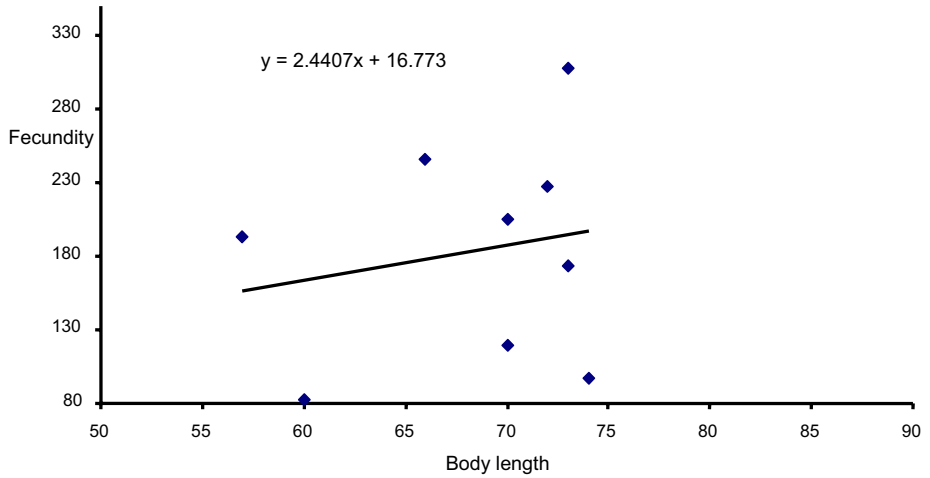


Figure 2. Relationship between body length and fecundity.

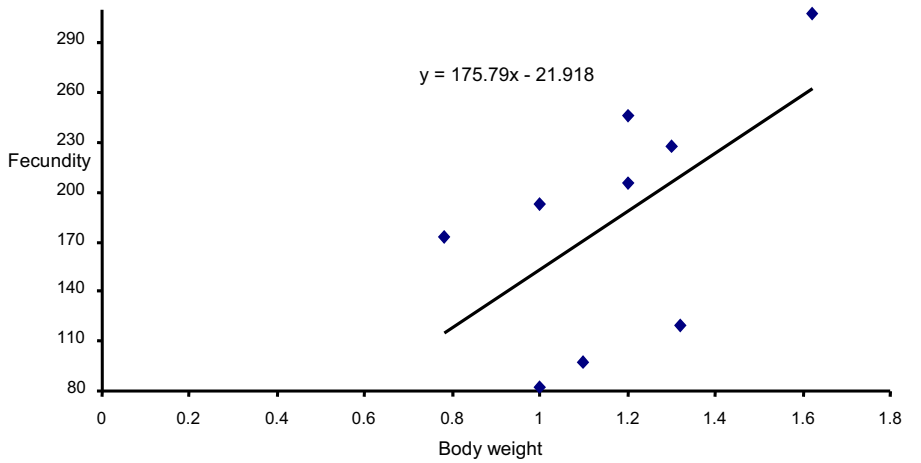


Figure 3. Relationship between bodyweight and fecundity

The newly hatched larva swims actively. The larvae swim close to the surface of water. During the developmental study of the prawn, altogether five different larval stages were recorded

The first stage larvae were collected after 6 hrs of hatching. The first stage larvae measured 8 mm in length. They possessed sessile eyes, very small pleopods, unsegmented antennae and uropods (Plate No 3 i).

Month	Mean Body length (mm)	Mean Body weight (g)	Mean Fecundity	Mean Relative fecundity
March	60	1	82	82
April	57	1	193	193
May	70	1.2	205	170.8
June	72	1.3	228	175.38
July	73	0.78	173	221.79
August	73	1.62	308	190.12
September	66	1.2	246	205
October	74	1.1	97	88.18
November	70	1.32	120	90.90

The second stage larvae after 12 hrs from hatching time measured 8 mm in length. They were with sessile eyes, more developed pleropods than that of the first stage larvae and the uropods as well as telson were also present (Plate 3 ii)

The third stage larvae studied were after 18 hrs right from the hatching time. They measured 9 mm in length. Stalked eyes, developed pleopods and walking legs were recorded from the observation. A telson and one dorsal tooth were also

observed to have developed. (Plate No 3 iii).

The fourth stage larvae measuring 9 mm in length after 24 hrs were having well developed body segments and two rostral teeth (Plate No 3 iv).

Changes in the fifth stage larvae were recorded after 36 hrs of hatching. They also measured 9 mm in length and all the segments and appendages were well developed and three dorsal and two ventral rostral teeth were observed. (Plate No 3 v)

The larvae did not show any change in their morphology in the next 24 hrs and then died, since food was not supplied.

Fecundity

The measurements of different body parameters and fecundity were made and summarized on the table. 1

The mean body length and mean fecundity of *M. lamarrei* ranged from 57-74 mm and 82-308 respectively. The minimum value of mean fecundity was recorded in the specimen with mean body length 60 mm in the month of March and body weight is 1 g for the specimen. Similarly the maximum value was recorded in a specimen with mean body length and mean bodyweight 73 and 1.62 respectively in the month of August. The mean value of mean fecundity was 183.55 and the value of relative fecundity ranged from 82-221.79.

A linear relationship was obtained between body length and fecundity (Figure1) which can be expressed by equation:

$$y = 16.773 + 2.4407x$$

i.e., $F = 16.773 + 2.4407 L$

The correlation coefficient (r) was found to be 0.20117($p>0.45$) which indicates that the relationship is insignificant. The total weight of the specimens studied ranged from 0.78-1.62 g. A linear relationship was observed when total weight was plotted against fecundity (Fig: IX). The relationship can be expressed by the equation:

$$y = -21.918 + 175.79 x$$

i.e., $F = -21.918 + 175.79 W$

The correlation coefficient (r) was found to be 0.508305($p<0.45$) which indicates that the relationship is significant.

Discussion

The rostral formula as described by Dutta (2001) was found to be 7-11/4-8 and by Koshy (1969) 7-10+1-2/4-7 but it was found 7-9/5-8 in the present study. The present finding corroborate the finding of Dutta (2001)

Teeth on dorsal edge present throughout the rostrum Dutta (2001) but in the present study distal part of the rostrum without dorsal teeth. Koshy (1969) has reported that in the chelate leg, particularly in the immobile fingers, wide gaps are found between the 2nd and 3rd, and the 3rd and 4th teeth, but in the present study, the teeth are almost equidistant from each other. Dutta (2001) the first peraeopod: carpus is equal to merus, finger equal to palm and the second peraeopod: merus greater than carpus but the present study shows that the first peraeopod: carpus-greater than merus and palm greater than finger. The second peraeopod merus is smaller than carpus. He reported the maximum size of *M lamarrei* (65 mm long) but in the present study the maximum size recored was 80 mm. It indicated that this prawn is variable in size depending on the geographical position and nature of food available. *M. lamarrei* was extensively recorded from Keshalia and Singhia rivers as well as in the

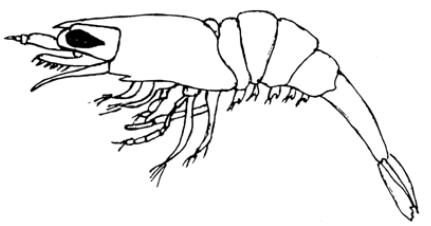
canals and ponds throughout year in Biratnagar during the study period.

Stages of development

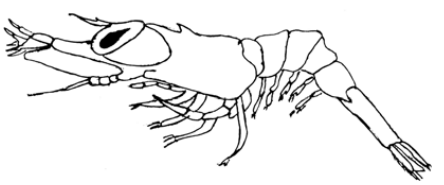
According to Ling (1969), the eggs of *Macrobrachium rosenbergii* are slightly elliptical, long axis measures 0.6-0.7 mm, bright orange in colour, until 2-3 days before hatching when they become grey-black. In the case of *M. lamarrei* eggs were slightly elliptical and mature eggs measured about 0.54-0.64 mm in long axis. The colour of the eggs showed contrast from *M. rosenbergii* since they were dark green when immature and turned into light green and then transparent at the time of hatching. It was observed that the average incubation period in case of *M. lamarrei* was 16 days at 30^0C which is 4-5 days lesser than that of *M.rosenbergii*. The larvae hatch as zoeae in the *Macrobrachium* spp. i.e., they tipically utilize their thoracic appendages to swim, differing from panaeid shrimp which hatch as nauplii that are morphologically less developed and use their cephalic appendages to swim, Ismael and New (2000). The first-stage zoeae are less than 2 mm long (from the tip of the rostrum to tip of the telson) in *M. rosenbergii* but the first stage larvae measure about 8 mm in *M. lamarrei.* The larvae of *M lamarrei* possess sessile eyes and very small pleopod with unsegmented antenna and undeveloped uropod but in *M. rosenbergii larvae* possess only sessile eyes and all other characteristics are absent. It showed that *M. lamarrei does* possess highly developed larval form at the time of hatching than in case of *M. rosenbergii .M. lamarrei* differs greatly with *M. rosenburgii* in the size of the larva and other characteristics(Plate No 3 i ,ii ,iii,iv ,v). In case of *M .lamarrei* the second stage larvae collected after 12 hrs from the time of hatching, were having sessile eyes, more developed pleopods and also showed presence of telson and uropod but in *M. rosenbergii* eyes are sessile while the pleopods appear only after 7-10 days and uropod at 3-4 days and the telson at 5-8 days (Rao and Tripathi, 1993).

The stalked eyed larvae with walking legs and developed pleopods, telson and one dorsal rostral teeth could be seen in 18 hrs larvae in the case of present specimens whereas ,in *M. rosenbergii* the stalked eyes can be seen after 2 days and developed pleopod in 14-19 days. The larvae are of 4.68 mm in total length in 14-19 days but in *M. lamarrei* they measured 9 mm in 24 hrs. Two dorsal rostral teeth appeared in 24 hrs and biramous uropods with setae in case of *M.lamarrei* but the same characters are seen in 4-6 days in *M. rosenbergii*. Three or four dorsal rostral teeth found in17-24 days in *M. rosenbergiii* but this character was found in 36 hrs in *M. lamarrei*. From the above comparison, it was found that *M. lamarrei* possesses short life-span and it grows faster than *M. rosenbergii*. The objective of present resarch was to study the developmental stages only. Although there is a vast difference in the length and breadth between *M. rosenbergii* and *M. lamarrei,* but because of short life-span, *M. lamarrei* can be produced in high densities in a *short* period. Since, some interest is being shown towards the prawn fishery, so this species can also be a part of interest towards prawn culture. As this species possesses good market value and consumed by the local people of Terai so by culturing this species also the demand of prawn can be fulfilled not only in the peak season of capture fishery but also in whole period of the year consistently.

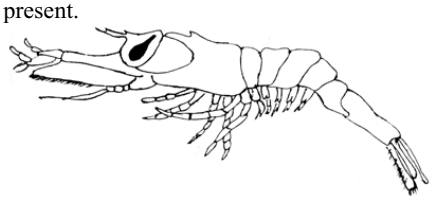
Stage I. Sessile eyes, uropod present.



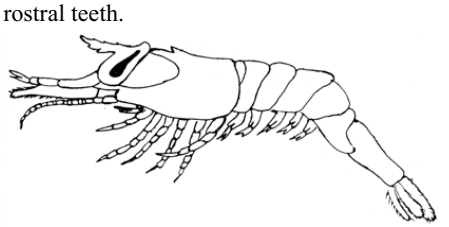
Stage II. Pleopod developed, telson present.



Stage III. Stalked eye, one dorsal teeth present.



Stage IV. All segments developed, two rostral teeth.



Stage V. Endopods of pleopods with appendages internae, three dorsal and two ventral rostral teeth.

Plate 3. Larval stages of *Macrobrachium lamarrei*.

Fecundity

The fecundity of *M. lamarrei* was found to be more closely related to the weight than its length. The breeding season of *M. rosenbergii* was found to be July to September on account of the available monsoon as well as suitable temperature, Ling (1969). Similarly, the breeding season of *M. malcolmsonii* in India is from April to December, with a peak in August to November, depending upon the monsoon. But in the present contest the breeding season of *M. lamarrei* was found to be April to September with a peak period in August and September, depending on monsoon as well as suitable temperature. Althougt the prawn can breed from March to November except rest three months in a year, yet fecundity is very less in the months namely March, October, and November (Figures1, 2 and3). The relationship between month and fecundity, and weight and fecundity ,and length and fecundity are shown in (Figures 1 ,2and 3s) respectively. The fecundity of *M. rosenbergii* ranged from 24225 to 191092 for females of 143 to 235 mm, Mahapatra, *et al*. (1996) (Table 1).

The fecundity of *M. malcolmsonii* has been reported to range from about 3500 to 94000 for females of 54 to 165 mm, Ibrahim (1962), Rajyalaxmi (1980). From the present study on *M. lamarrei,* the fecundity was recorded to range from 82-308 for females of 57-74 mm (Table 1). So, the fecundity of *M. lamarrei* is found to be less in comparison to the monsoon river prawn *M. malacolmsonii* and giant freshwater prawn *M. rosenbergii.*

In *M. rosenbergii,* the egg per gram body

weight is higher (mean 989.57 egg/g) than the eggs per millimeter body length (mean 322.15 eggs/mm). In the present study of *M. lamarrei* also the eggs per gram body is higher (mean 18.84 egg/g) than the eggs per millimeter body length (mean 2.68 egg/mm) (Table 1).

References

Bal, D.V. and K. Rao 1990. *Marine Fisheries of India.* Tata Mac. Graw-Hill Publishing Co. Ltd., New Delhi, 472p.

Bhattacharjee, P.C. and M. Dasgupta 1989. Fecundity of freshwater prawn *Macrobrachium dayanum* (Henderson) from ponds and swamps of Kamrup, Assam, India. *Environment and Ecology* ***7(3)*****:** 724-726.

Brown, J.H. 1991. Fresh water prawns. In: *Production of Aquatic Animals*, *World Animal Science*, C4, (Ed. C.E. Nash), pp. 31-43. Elsevier Scientific Publishing Amsterdam.

Charniaux-Cotton, H. and G. Payen 1985. Sexual differentiation. In: *Biology of Crustacea*, vol 9: Integument, Pigments and Hormonal processes, (Eds. D.E. Bliss and L.H. Mantel), Academic Press New York. pp. 217-300.

Chopra, B.N. 1939. Some food prawns and crabs of India and their fisheries. *J. Bomb. Nat. Hist. Soc.* ***4(2)*****:** 221-234.

De, D.K. 1980. Maturity, fecundity and spawning of post monsoon run of hilsa, *Hilsa ilisha* (Hamilton) in the upper stretches of Hoogly Estuarine System. *J. Ind. Fish. Soc. India.* ***12(1)*****:** 54-63.

Holthius, L.B. 1980. FAO species calalague, shrimps and prawns of the world. An annoted catalogue of species of interest to fisheries. *FAO Fisheries Synopses* ***125(1).*** FAO, Rome.

Ismael, D. and M.B. New 2000. Biology. In: *Freshwater Prawn Culture* (Eds. M.B. New and W.C. Valenti), pp 18-40 Blackwell Science Ltd.

Jay Chandran, K.V. and N.I. Joseph 1992. A Key for the commercially important *Macrobrachium* spp. Of India-with a review of their bionomics. In: *Freshwater prawn proceeding of National symposium on Freshwater Prawns Macrobrachium spp.*, 12-14 Decembuer, 1990, Kochi, (Ed. E.G. Silas), Kerala Agriculture University, Thrissur. pp. 72-77

Jingran, V.G. 1991. *Fish and fisheries of India.* 3rd edn. Hindustan Publishing Corporation (India), Delhi.

Kurian, C.V. and V.O. Sebastian 1986. *Prawns and prawns fisheries of India.* Hindustan publishing corporation, Delhi. 297p.

Ling, S.W. 1969. The general biology and development of *Macrobrachium rosenbergii* (deMan). *FAO. Fish. Rep.* ***(57)3***: 589-606.

Manna, A.K. and S.K. Raut 1991. Clutch size in two shrimp species *Macrobrachium lamarrei* and *M. dayanum*. *J. Environment and Ecology* ***9(2)*****:** 349-351.

Rao, R.M. 1965. Breeding behaviour in *Macrobrachium rosenbergii* (deMan). *Fish. Tech.* ***2(1)*****:** 19-25.

Sandfier, P.A. and T.I.J. Smith 1985. Freshwater prawns. In: *Crustaceans and Mollusk Aquaculture in United States,* (Eds. J.V. Huner and E.E. Brown), AVI publishing, Westport, CT. pp. 63-125.

Shakuntala, K. 1976. A note on changes in egg weight during the early development of *Macrobrachium rude* (Heller). *J. Inland Fish. Soc .India.* ***8***: 109-110.

Sharma, A. and B.R. Subba. 2004. A new report of Prawn*, Macrobrachium altiforns* (Henderson) from Singhia River,Biratnagar,Nepal.*Our Nature* ***2 (2):***33-34.

Shrestha, J., A.S. Tamrakar and D. Edds 2001. Shrimps of Kaligandaki and Narayani rivers. *Bull. Biodiversity*, ***1***: 2.

Shrivastava, C.B.L. 1999. *A text book of fishery Science and Indian fisheries*. Kitab Mahal.

Singh, H. and T.A. Quereshi 1997. Production of freshwater prawn *Macrobrachium lamarrei* at different stocking densities. *Pakistan Journal of Zoology* ***29***: 101-105.

Tiwari, K.K. 1955. Distribution of the Indo-Burmese freshwater prawns of genus *palaemon* (Fabr.) and its bearing on the Satpura hypothesis. In: *Symposium on organic evolution*, *Bull. Nat. Inst. Sci. India 7*: 230-239.