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Reproductive biology of *Macrobrachium lamarrei lamarrei* (H. Milne-Edwards, 1837) from the Upper Lake, Bhopal, India

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Abstract

The study investigates the vital aspects of reproductive biology: maturation stages of ovaries, spawning season and size at sexual maturity of *Macrobrachium lamarrei lamarrei* (H. Milne-Edwards, 1837). The sampling of *M. lamarrei lamarrei* was conducted from the Upper Lake of Bhopal during the period from January 2014 to December 2015. Five maturation stages were recognized on the basis of coloration of ovaries as well as development and arrangements different stages of ova within the ovary. These stages were designated as immature, maturing, mature, ripe and spent. The data shows *M. lamarrei lamarrei* spawn throughout the year with 2 peaks in a year. The peak spawning activity was observed in May-June and November – December. The results of one way ANOVA showed significant differences for ovarian developmental stages and morphological parameters. The size at onset of sexual maturity when fifty percent of the population was morphologically mature was estimated as (TL50 = 4.70 cm), thus size can be significantly utilized in fisheries management as an indicator for minimum permissible capture size.

Keywords: Reproductive biology, prawn, maturation stages, size at maturity

1. Introduction

Macrobrachium lamarrei lamarrei (H. Milne-Edwards, 1837) is one of the most abundant fresh water prawn species found in the freshwater bodies of Bhopal region. Like other fresh water prawns, the process of reproduction occurs as a series of events from activation, through growth and gametogenesis in the gonads to the spawning of the gametes and recession of gonadal activity. Histological analysis has been widely used to describe ovarian maturation stages (Quintero and Garcia, 1998; Peixoto *et al.*, 2003; Amanat and Qureshi, 2011) [12, 11, 16]. The observation of visual traits, such as ovarian morphology and colour has been made to evaluate female maturation (Castille and Lawrence, 1989). The breeding seasons of the prawns has been determined, by the percentage of mature females present in the catch or by changes in gonadal indices (Garcia, 1985; Erisman *et al.*, 2012) [8, 7]. Two breeding periods have been reported in various fresh water prawns. The female reach first maturity at about 6 months and reach second maturity at about 12 months, which means prawns, may live for about 18 months (Dall *et al.*, 1990) [6]. The objective of this study is to report on the basic aspects of reproductive biology of *Macrobrachium lamarrei lamarrei* from the Upper Lake, Bhopal.

2. Material and Methods

2.1 Collection of animals

Live freshwater prawn, *M. lamarrei lamarrei*, of various maturity stages were observed in the present study during the year 2014 and 2015. Prawns were collected from the Upper Lake of Bhopal, with the help of local fishermen. After hauling the net, *M. lamarrei lamarrei* were separated from the catch and were kept in oxygenated bags, which were then transported to the laboratory. Later, they were segregated according to the sex and maturity stages and were kept in aquariums. The prawns were fed daily with fish meal, until their utilization.

2.2 Morphometric measurements

Morphometric measurements as total length (TL), carapace length (CL), rostral length (RL) and body weight (wt) were measured to the nearest 0.1 cm and 0.01g. The females were considered as immature females as: I (immature), II (maturing) stages, III (nearly matured), IV (fully matured or ripe) and V (spent) stages of ovaries maturation on the basis of coloration of

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the ovary. The percentages of nearly matured, fully matured and spent stages females caught were calculated and recorded to estimate the spawning season. During this study, immature (I) and maturing (II) stages females were grouped as immature females and nearly mature (III), matured (IV) and spent (V) were grouped as mature females. The breeding period was defined as the months in which the percentages of nearly mature, mature and spent ovaries were dominating the immature and maturing females. Monthly data were grouped in seasons following Morrison *et al.*, (1998) as winter (January and February), summer (March to June), monsoon (July and August) and post monsoon (September to December) to observe the seasonal pattern and variability in ovarian maturation stages. The size at first maturity (SFM) was determined by calculating the proportion of mature females groups in each size class (Total length, TL). The size at which 50% individuals attain maturity TL50 was calculated by arranging data to least square regression method (Breteni *et al.*, 2007; Sehar and Qureshi 2011; and Amanat and Qureshi 2011) [4, 16].

2.3 Dissection and Fixation of Tissue (Ovaries)

Prawn species were sacrificed to study internal morphology of the female reproductive system and process of oogenesis was studied in detail by subjecting ovaries for histological investigations. Dissection of testing animals was always carried out between 16:00-18:00 hours to avoid the interference of circadian changes in maturation process (Smith and Ratcliffe, 1980). Female prawns in different maturity stages were identified on the basis of morphological features viz gonadal size and color (Amanat and Qureshi 2011) [16]. Ovaries were carefully taken out and weighed to nearest milligram. GSI (ovarian indices) was calculated as per the method of Giese and Pearse (1974).

2.4 Statistical analysis

One way analysis of variance (ANOVA) with tested treatment arrangement was carried out for differences in ovarian developmental stages (coloration), and morphological characters. The relative growth was studied for total length (TL) as independent variable, and body weight (Wt). Test of significance were accepted as significant at $p = < 0.05$ for statistical analysis.

3. Results

3.1 Ovarian maturation: The reproductive biology of *M. lamarrei lamarrei* was studied by correlating the morphological and histological characteristics and the gonadal developmental stages. The five ovarian maturation stages were recognized from clear pattern and variations in colour, as well as development and arrangements of cells. These

stages were designated as immature (translucent), maturing (light green), nearly mature (green), matured (dark green) and spent (transparent). From the present study it is concluded that oogonia cells found throughout the ovarian development though they were predominated in the immature and spent stages. In the immature stage, oogonia were found as clustered in a well-defined area of the ovarian wall along the gonad, known as the “zone of proliferation” (Fig. 1a). This type of ovary was found in only young and immature prawns. Whereas yolkless oocytes (YOa) cells without nuclear membrane were observed in the maturing (Fig. 1b) and nearly mature (Fig. 1c) stages with less number of oogonia and yolk containing oocytes cells with clear nuclear membrane were found in nearly mature and well organized in the mature stage (Fig. 1d). This stage is considered to be the last stage of maturity before breeding. Matured ovaries were characterized by the presence of fully mature oocytes. After oviposition the ovary was designated as spent, it was observed that ovarian organization disappears, leaving empty spaces by the released oocytes, as well as remains of disintegrating mature oocytes (Fig. 1e).

Relationship between Ovarian developmental stages and weight and size variations: Ovarian maturation shows size variations of different body parts (total length (TL), carapace length (CL), rostral length (RL) of *M. lamarrei lamarrei* (Table 1). The seasonal distribution of size-frequency (TL cm) of immature and mature females show immature females were found in January- February. The results of one way ANOVA for *M. lamarrei lamarrei* showed significant difference for ovarian developmental stages with total length ($F =$, $P < 0.005$), carapace length ($F =$, $P < 0.005$) and rostral length ($F =$ $P < 0.005$)

3.2 Breeding Season: The seasonal distribution of ovarian maturation stages in *M. lamarrei lamarrei* showed the mature and nearly mature ovaries throughout the year, the highest numbers of spent ovaries were found in January and August, where as developing ovaries were found in April and October (Table 3).

Seasonal distribution on the basis of ovary colour and GSI, showed that the mature ovaries, nearly mature, matured and spent (light green, dark green or transparent), were observed during the different seasons throughout the year (Table 1). The stages of nearly mature, matured and spent were shown combined as females either just ready to spawn, spawning or just spawned versus non spawning females (Table 2). The mature females of *M. lamarrei lamarrei* were observed throughout the study period, indicating that *M. lamarrei lamarrei* is a continuous breeder with two breeding peaks (May-June “the major peak” and November-December “the minor peak”).



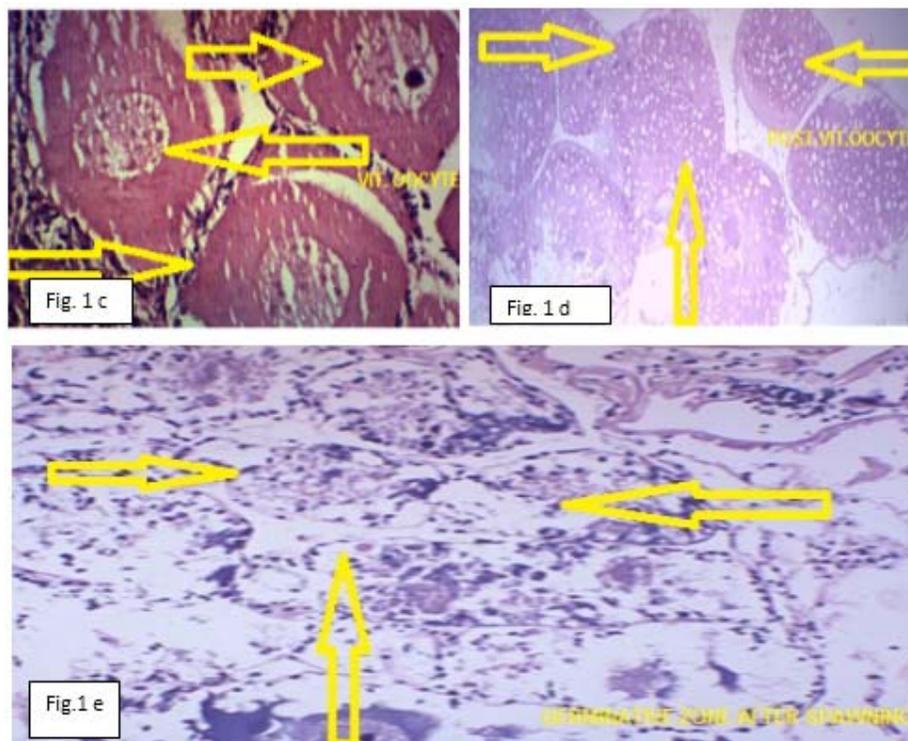


Fig 1: Histological section showing different stages of ovarian maturation of *M. lamarrei lamarrei* (a) Undeveloped stage (b) Developing stage (c) Nearly Ripe stage (d) Ripe stage (e) Spent stage. (ZP = zone of proliferation, O = oogonia, YO₁ = yolky oocytes, YO₂ = yolky oocytes).

Table 1: showing the classification of maturity stages in female *M. lamarrei lamarrei* based on coloration of ovary and GSI.

Ovary Stage	Coloration of Ovary	GSI±SD
Immature ovary Primary oogonia Secondary oogonia Primary oocyte	Transparent	.7944±0.08
Maturing	Light green	1.0321±0.06
Nearly matured	Green	1.7519±0.09
Fully matured or ripe	Dark green	2.3093±0.04
Spent	Transparent	1.4961±0.04

Table 2: showing the descriptive studies of ovarian –development stages of *M. lamarrei lamarrei* from Upper Lake, Bhopal during year 2014 and 2015.

Stage	Mean weight (g) ± SD	Mean length (cm) ± SD	Mean cephalic (cm) length ± SD	Mean rostrum (cm) length ± SD
Group I	0.27 ± 0.09	3.79 ± 0.08	1.22 ± 0.74	0.58 ± 0.07
Group II	0.45 ± 0.08	4.75 ± 0.05	1.45 ± 0.35	0.70 ± 0.1
Group III	0.729 ± 0.07	5.48 ± 0.21	1.58 ± 0.47	0.76 ± 0.44
Group IV	0.82 ± 0.13	5.73 ± 0.09	1.64 ± 0.23	0.85 ± 0.31
Group V	0.87 ± 0.13	5.92 ± 0.09	1.73 ± 0.14	0.91 ± 0.32

Table 3: showing monthly percentage distribution of reproducing and non-reproducing females, *M. lamarrei lamarrei* from Upper Lake, Bhopal during year 2014 and 2015.

Month	Year 2014		Year 2015	
	Reproducing females	Non reproducing females	Reproducing females	Non reproducing females
January	61%	39%	65%	35%
February	54%	46%	57%	43%
March	57%	43%	60%	40%
April	61%	39%	64%	36%
May	73%	27%	70%	30%
June	86%	14%	88%	12%
July	71%	29%	76%	24%
August	57%	43%	61%	39%
September	64%	36%	67%	33%
October	67%	33%	71%	29%
November	79%	21%	78%	22%
December	72%	28%	76%	24%

3.3 Mean Size at Maturity: In the present study, *M. lamarrei lamarrei* was grouped into size classes (3 cm class interval) and the percentage occurrence in various stages of maturity in these groups was estimated. A total of 478 female specimens of *M. lamarrei lamarrei* were investigated during the study, their size ranged from 3.4 to 5.94 cm. Females with immature ovaries had a total length of 3.43 to 4.03 cm. The mature individuals were found to have total length of 4.45 and above.

In the size class, 4.45 to 4.62 cm the percentage of immature individuals was more than the mature ones, and majority attained maturity at about 4.64 to 4.70 cm size. The size at first maturity appears to be near about 4.45 cm total lengths (Table 4): however, the size at which L50 of the population was morphologically mature and the estimated size at onset of sexual maturity was 4.70 cm.

Table 4: Percentage occurrence of female of *M. lamarrei lamarrei* in different stages of maturity in the various size group data collected.

Class Size	Total No. of individuals	Immature (%)	Maturing (%)	Nearly mature (%)	Matured (%)	Spent (%)
3.43-4.03	112	100	-	-	-	-
4.03-4.35	90	100	-	-	-	-
4.35-4.63	98	48.2	51.8	-	-	-
4.63-5.10	50	22	38	21	10	9
5.10-5.50	13	8	23	19	34	16
5.50-5.94	6	-	-	64.3	36.7	-

4. Discussion

During the present study, five ovarian maturation stages were recognized from clear pattern and variations in colour, GSI, development and arrangements of cells in ovarian cycle of female freshwater prawn, *M. lamarrei lamarrei*. These stages were designated as immature (translucent), maturing (light green), nearly mature (green), matured (dark green) and spent (transparent). Similarly, Sultana (1985)^[18] recognized the five developmental stages of ovaries in penaeid shrimps from the Pakistani coastal waters, based on the colour, size of the ovary and histological studies. Other studies related to ovarian histology in other penaeids, suggested five ovarian developmental stages: quiescent, developing, early maturity, ripe and spent (Tuma, 1967)^[19] and immature, developing, early ripe, ripe and spent (Crococ and Kerr, 1983)^[5]. Amanat and Qureshi (2011)^[16] reported the five developmental stages (undeveloped, developing, nearly ripe, ripe and spent) in *Penaeus indicus*.

The results of present study suggest that, the mature ovaries, nearly mature, matured and spent exhibit light green, dark green or transparent colour pattern during the different seasons throughout the year. The stages of nearly mature, matured and spent were shown combined as females either just ready to spawn, spawning or just spawned versus non spawning females. The mature females of *M. lamarrei lamarrei* were observed throughout the study period, indicating that *M. lamarrei lamarrei* is a continuous breeder with two breeding peaks one in May-June, the major peak and another in November-December the minor peak. The spawning periods of penaeid shrimps have been studied for *M. affinis* (Subrahmanyam, 1967; Rao, 1968; Ramamurthy *et al.*, 1975)^[17, 15, 14], *P. indicus* (Rao, 1968; Amanat and Qureshi, 2011)^[15, 16]. In general, spawning activity varied seasonally showing a bimodal pattern. Van Zalinge *et al.* (1987)^[20] studied spawning activity of *P. merguensis* throughout the year with peak spawning activity in April to May and August. Ayub and Ahmed (1992), observed two peaks of spawning major and minor peaks found in *P. merguensis* from January to April and October.

During the present study, mature individuals were found to have total length of 4.45 and above. In the size class, 4.45 to 4.62 cm the percentage of immature individuals was more than the mature ones, and majority attained maturity at about 4.64 to 4.70 cm size. The size at first maturity appears to be near about 4.45 cm total lengths, however, the size at which L50 of the population was morphologically mature and the estimated size at onset of sexual maturity was 4.70 cm. Earlier

in other penaeids, the size for first maturity was reported in *P. indicus* as 134 mm and *M. affinis* as 94 mm by Rao (1968)^[15], in *M. affinis* as 120 mm by Subrahmanyam (1967)^[17], and *M. stebbingi* as 88 mm by Abdel Razeq (1985)^[1], in *P. Merguensis* (De Man, 1887) as 155 mm by Amanat and Qureshi, 2014. The size of target species at maturity can be reduced due to fishing pressure.

One way ANOVA for *M. lamarrei lamarrei* showed the significant difference for ovarian developmental stages with total length ($F =$, $P < 0.005$), carapace length ($F =$, $P < 0.005$) and rostral length ($F = P < 0.005$) during the present study. Sex based size dimorphism in penaeid with larger *paulensis* (Peixoto *et al.*, 2003)^[11]. Despite the great sizes and faster growth rates in females as compared to males. The study of mean length at which prawn spawns and recruitment occurs are important for proper fisheries practice, particularly the cycle of events leading to reproduction and the timing of oviposition (Niamaimandi *et al.*, 2008)^[9].

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6. Reference

1. Abdel Razeq FA. Contribution to the biology of penaeid prawns of the Mediterranean coast of Egypt. J Egypt. Vet. Med. Ass. 1985; 45:17-28.
2. Amanat Z, Qureshi NA. Ovarian maturation stages and size at sexual maturity of *Penaeus indicus* (H. Milne Edwards, 1937) in the lagoon waters of Sonmiani Bay, Balochistan. Pakistan J. Zool. 2011; 43:447-459.
3. Ayub Z, Ahmed M. A description of the ovarian development stages in penaeid shrimps from the coast of Pakistan. Aquacul. Res. 2002; 33:767-776.
4. Bertini G, Braga AA, Fransozo A, Dias MO, Correa A, Freire FAM. Relative growth and sexual maturity of the stone crab *Menippe nodifrons* Stimpson, 1859 (Brachyura, Xanthoidea) in Southeastern Brazil. Brazilian Arch. Bio. Tech. 2007; 50:259-267.
5. Crococ PJ, Kerr JD. Maturation and spawning of the banana prawn *Penaeus merguensis* in Albatross Bay, Gulf of Carpentaria, Australia. J Exp. Mar. Biol. Ecol. 1983; 69:37-59.
6. Dall W, Hill BJ, Rothlisberg PC, Staples DJ. The biology

- of the Penaeidae. In: Blaxter, J. H. S., Southward, A. J. (Eds.). Adv. in Marine Biol. Academic press, London, 1990, 27.
7. Erisman B, Aburto-Oropeza O, Gonzalez-Abraham C, Mascareñas -Osorio I, Moreno-Báez M, Hastings Spatio-temporal PA. dynamics of a fish spawning aggregation and its fishery in the Gulf of California. *Scientific Reports*. 2012; 2, Article number: 284.
 8. Garcia S. Reproduction, stock assessment models and population parameters in exploited penaeid shrimp populations. In: Rothlisberg, P. C., Hill, B. J., Staples, D. J. (Eds.). Second Australian Natl. prawn Seminar, NPS2, Cleveland, Australia. 1985, 139-158.
 9. Niamaimandi N, Arshad A, Daud SK, Saed CR, Bahram K. Reproductive biology of the green tiger prawn (*Penaeus semisulcatus*) in coastal waters of Bushehr, Persian Gulf. ICES J Mar. Sci. Adv. Access. 2008, 1-7.
 10. Peixoto S, Soares R, Wasielesky W, Cavalli RO, Jensen L. Morphometric relationship of weight and length of cultured *Farfantepenaeus paulensis* during nursery, grow out, and brood stock production phases. *Aquacul*. 2004; 241: 291-299.
 11. Peixoto, S., R.O. Cavalli, F.D. Incao, A.M. Milach, and W. Wasielesky. A comparative study of the ovarian histology of eyestalk ablation and unablated *Farfantepenaeus paulensis* after spawning. *Boletim do Instituto de Sao Paulo*. 2003; 28:71-76.
 12. Quintero MES, Garcia A. Stages of gonadal development in the spotted pink shrimp *Penaeus brasiliensis*. *J. Crust. Biol*. 1998; 18:680-685.
 13. Qureshi NA, Amanat Z. Reproductive biology and size at sexual maturity of *Penaeus merguensis* (de man, 1887) from the Sonmiani Bay Lagoon, Balochistan, Pakistan, *J of animal and plant sci*. 2014; 24(2):503-511.
 14. Ramamurthy S, Kurup NS, Annigeri GG. Studies on the fishery of the penaeid prawn *Metapenaeus affinis* (Milne Edwards) along the Mangalore Coast. *Indian J Fish*. 1975; 22:243-254.
 15. Rao PV. Maturation and spawning of the penaeid prawns of the southwest coast of India. *FAO Fish. Rep*. 1968; 57:285-302.
 16. Saher NU, Qureshi NA. Relative growth and morphological sexual maturity of *Ilyoplax frater* (Brachyura: Ocypodoidea: Dotillidae) from mangrove area of Korangi creek. *Pakistan J Zool*. 2011; 43:133-140.
 17. Subrahmanyam CB. Notes on the bionomics of the penaeid prawn *Metapenaeus affinis* (Milne Edwards) of the Malabar Coast. *Indian J Fish*. 1967; 10:11-22.
 18. Sultana R. A comparative study of reproductive organ of selected penaeid prawns of Pakistan. M-Phil thesis. University of Karachi, 1985.
 19. Tuma DJ. A description of the development of primary and secondary sexual characters in the banana prawns. *Penaeus merguensis* De Man (Crustacea: Decapoda: Penaeinae). *Aust. J Mar. Fresh. Res*. 1967; 18:73-88.
 20. Van Zalinge NP, Khaliluddin M, Khan W. Description of the shrimp fishery including a stratified sampling scheme for shrimps landings and effort at Karachi Fish Harbour. *FAO*. 1987; FI: DP/PAK/77/033 Field Documen.