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Reproductive biology of Indian Silurid catfish *Ompok pabda* in river Gomti

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Abstract

Reproductive biology of an Indian Silurid catfish, *Ompok pabda* were determined in a moderately impacted tropical River Gomti in India. Samples of fish were collected monthly between May 2008 to April 2009 in two zones; upstream site at Mishrikh, Sitapur and midstream site at Lucknow. Length at first maturity calculated through maturity curve was 12.9 cm (males) and 13.9 cm (females) in total length. The gonado-somatic index indicated that spawning generally occurred between June - September and sex ratio showed a predominance of females, representing 54.3% of the total sample. The fecundity was found to vary from 2460 to 5986 nos, with mean of 4330 ± 799 for the fish with total length of 11.5-20.0 cm. The relationship of fecundity with total length and total body weight of the fish was Log F = 0.374 Log L+ 0.37, r^2 = 0.999 and Log F = 0.337 Log W – 0.40, r^2 = 0.966. The well defined traits of *O. pabda* from the Ganges basin provide basic information which can be further used for species conservation planning.

Key words

Fecundity, Gomti River, *Ompok pabda*, Sexual maturity, Silurid fish

Introduction

Catfish of the genus *Ompok* Lacepede (1803) are medium sized members of family Siluridae and usually found in lakes and large rivers throughout South and South East Asia. In India, *O. pabda* (Hamilton 1822) locally known as pabda is an indigenous, highly priced delicious, and nutritious catfish and well preferred because of relatively few bones. It is distributed in Afghanistan, Pakistan, Bangladesh, Myanmar and India (Jayaram, 2006). In India, it is widely distributed in the plains and sub mountain regions and commonly found in natural water bodies i.e. rivers, lakes and floodplains (Sarkar *et al.,* 2005). The species has recently been prioritized as a new candidate species for conservation and aquaculture (Sarkar and Lakra, 2010; Lakra *et al.,* 2010). However, the natural population of *O. pabda* has been greatly reduced in the Indian water with a very low percentage catch (Relative abundance=0.27–0.77) and a very restricted distribution in the tributaries of river Ganga basin (Sarkar *et al.,* 2010). Due to reduced abundance it has been listed as a threatened species as per IUCN criterion (Lakra and Sarkar, 2007; Lakra *et al.,* 2010). Managing fisheries resources requires a thorough knowledge of biological aspects like size at first maturity, gonadal maturation, fecundity etc. (de Carvalho *et al.,* 2009; Fontoura *et al.,* 2009). The biological indices related to reproduction of any fish is essential for evaluating the commercial potentialities of its stock, life history and also indicate the way in which fish use environmental and energetic resources (Chakraborthy *et al.,* 2010). The gonadosomatic index is a good indicator of reproductive activity, being used to determine the stages of gonadal maturation (Hojo *et al.,* 2004).

In India, although literature were available on different aspects of *Ompok pabda* like captive breeding (Sarkar *et al.,* 2005; Purkayastha *et al.,* 2012), captive breeding and seed production (Chakrabarti *et al.,* 2009), stock densities (Kohinoor *et al.,* 2009), reproductive cycle (Chakraborty *et al.,* 2010), length-weight relationship and condition factor (Gupta *et al.,* 2011; Banik *et al.,* 2012; Froese and Pauly, 2012) but no studies have been

available on the pattern of reproductive biology from the wild population of *O. pabda* from Gomti River or any other rivers and tributaries in Northern India. Therefore, this study aimed to determine the reproductive potential, size-at-maturity, fecundity, sex ratio, spawning season and generate first baseline information of *O. pabda* in the wild population of river Gomti.

Materials and Methods

The study was conducted along 250 km stretch of Gomti River from the upstream site at Mishrikh, Sitapur and midstream site at Lucknow during May 2008 to April 2009 on monthly basis using cast and gill nets. A total of 396 samples ranging from 8.0 to 20.0 cm in total length comprising of 181 males and 215 females. All fresh specimens were weighed to the nearest 0.1 g and total length (TL) to the nearest centimeters. The ovaries were removed from the fresh specimens and preserved in 5 % formalin for further studies. The sex ratio was determined by the proportion of females to males expressed as percent of total sample for each month. Length at 50% maturity (L_{50}) was estimated as the length at which a randomly chosen specimen had a 50% chance of being mature following Walker (2004). Differences between the size compositions by sex were tested using Mann-Whitney tests (Sokal and Rohlf, 1998). The spawning season was determined following the monthly changes in percentage frequency of maturity stages and the mean monthly values of the gonado-somatic index (GSI), calculated as per standard methods (De Vlaming *et al.,* 1982; Anderson and Gutreuter, 1983).

The maturity development stages were assigned as: immature; resting; ripe; ripe and running; and spent (Holden and Raitt, 1975). Size at first maturity was calculated from the rate of maturity females and males at each size. The timing of reproduction was established by plotting the maturity stages and the monthly values of GSI against the sampling period. The sex and stage of maturity of each specimen were ascertained macroscopically and the weight of the gonads (GW) was taken to the nearest 0.01 g. Significance testing was performed with a threshold of 95% ($p < 0.05$). Parameter estimations were performed using the Non Linear Regression routine of SPSS 16.0. The fecundity of the fishes was determined by direct counting method. In this method, the 0.1 g of subsample was taken from three sides of each mature ovary (anterior, posterior and middle side) and numbers of eggs contained in subsamples were counted. An average fecundity was calculated for each individual fish by multiplying number of mature ova in subsamples by weight of subsamples. The relationship between absolute fecundity and total length and absolute fecundity and total body weight were calculated using the least square method (Snedecor and Cochran, 1968).

Results and Discussion

The sex ratio was based on the 396 specimens in the size range of 8.0 to 20.0 cm. The maximum recorded size for males was 19.2 cm and that for females was 20.0 cm. Monthly variations in sex ratio of the fish showed highly significant (Chi-square, $p > 0.01$) from the expected male: female ratio of 1: 1. In this study, the ratio ranged from 1: 1.13 to 1: 2.3. The overall sex ratio for the pooled observations also varied significantly from the expected ratio (Chi-square, $p > 0.01$), with 1.19 females for every male and sex ratio greatly fluctuated during the study period indicating a predominance of females (54.3%) in the area (Fig. 1). Similar results were reported for *Silurus aristotelis* from Lake Pamvotis (Leonardos *et al.,* 2009). The proportion between different sexes in a population can vary due to several environmental and

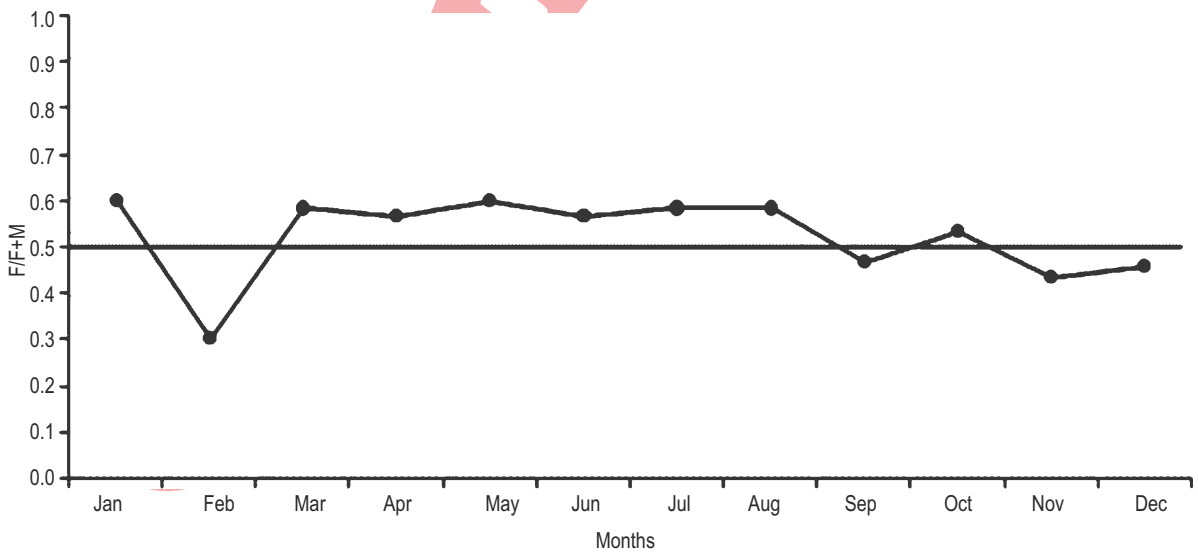

Fig. 1 : Sex ratio for *O. pabda* collected in Gomti river during 2008-09

physiologic factors that affect the sexes differently (Vazzoler, 1996).

In the present study, males and females with ripe gonads were recorded from May to September, but they were mostly abundant in July and August. Ripe and running males and females were observed in July and especially in August. Spent males and females were mainly recorded from October to November (Fig 2 a, b). The fish started maturing in March and most of the fishes were in maturing stages during April to May. Ripening of the ova commenced in the month of May-June. The similar results were recorded in case of *Chrysichthys nigrodigitatus* (Offem *et al.,* 2008), *Mystus cavasius* by Hussain and Hossain (1999). The partly and fully spent ovaries were encountered in September and October. The females with ovaries having ova diameter larger than 0.18 were considered to be in maturing stages. The number of fish caught was maximum during April-May, while the immature specimens were maximum in November to February. Chakraborty *et al.* (2010) also observed same results in case of *O. pabda* from Bangladesh. The status of the ovary of the fishes caught during October - January revealed that most of the ovaries were spent. These results indicated that the most productive fishing period for the species is October – February.

Age at maturity reflects an evolutionary compromise between the costs and benefits to fitness of reproducing comparatively early or late in life (Hutchings, 2002). Minimum

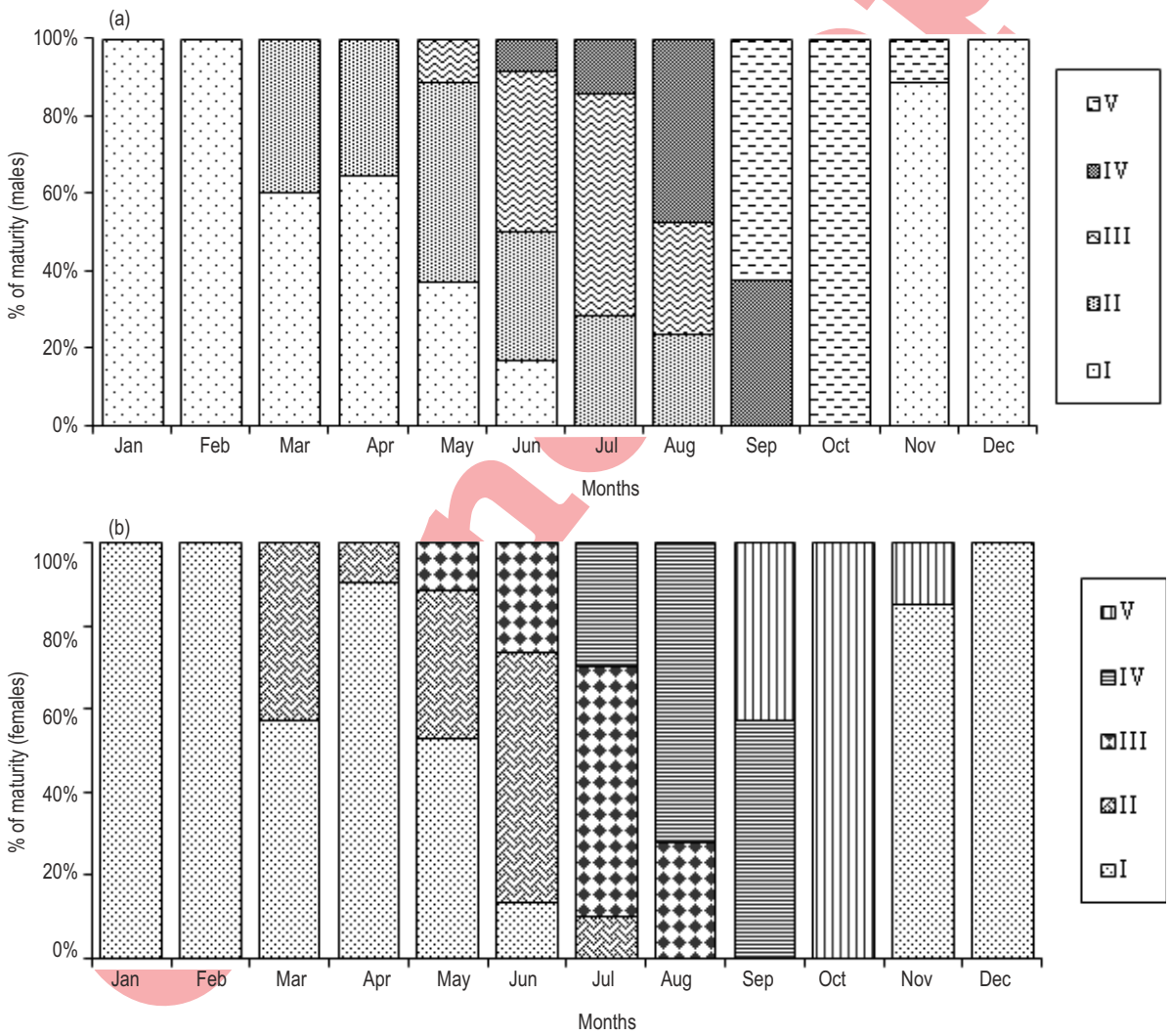

Fig. 2 : Monthly changes (%frequency) of the maturity stages of *O. pabda* (I, Immature stage II, resting; III, ripe; IV, running ripe; V, spent) (a) Male, (b) Female

length at which at least 50% of the individuals are mature during spawning is here considered as the minimum size at first maturity. A total of 396 samples of *O. pabda* (181 males and 215 females) were examined, in which size of males and females ranged from 8.2-19.2 cm and 8.4-20.0 cm in length, respectively. The females were significantly different ($p < 0.05$) from males. Maturity curve (Fig 3 a, b) plotted for the fish by direct observation of ovaries and testis and changes in the proportion of mature fish in the population with increasing fish length showed that 50% of the males matured at 12.9 cm (size at first maturity for male) total length and females at length 13.9 cm (size at first maturity for female). Thus, in this population, males matured at a smaller size than females. Offem *et al.* (2008) reported similar size difference in male and female individuals of another silurid catfish, *Chrysichthys nigrodigitatus* from Nigeria. The smallest mature female and male were 12.5 and 11.5 cm in total length, respectively. L_{50} varied in relation to gender, being higher for females. Sarkar *et al.* (2008) also recorded that the size at maturity and mean maturity percentage varied in male and female *Chitala chitala* (a featherback) across different river basins studied.

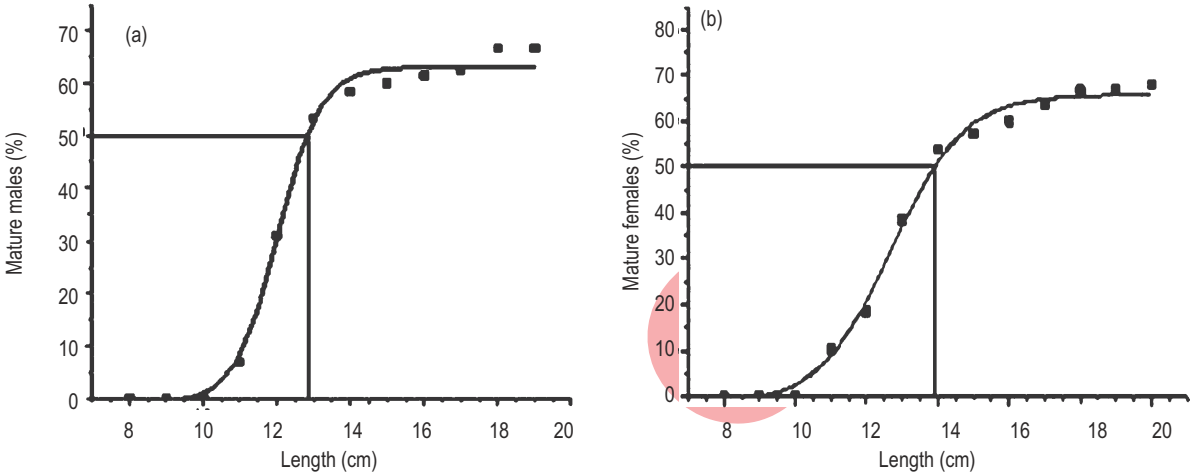

Fig. 3 : Proportion of mature *O. pabda* in every 2.0-cm-TL size class for. Size of 50% maturity was estimated as 12.9 cm TL in male (n = 181) and 13.9 cm TL in female (n = 215) (a) Male, (b) Female

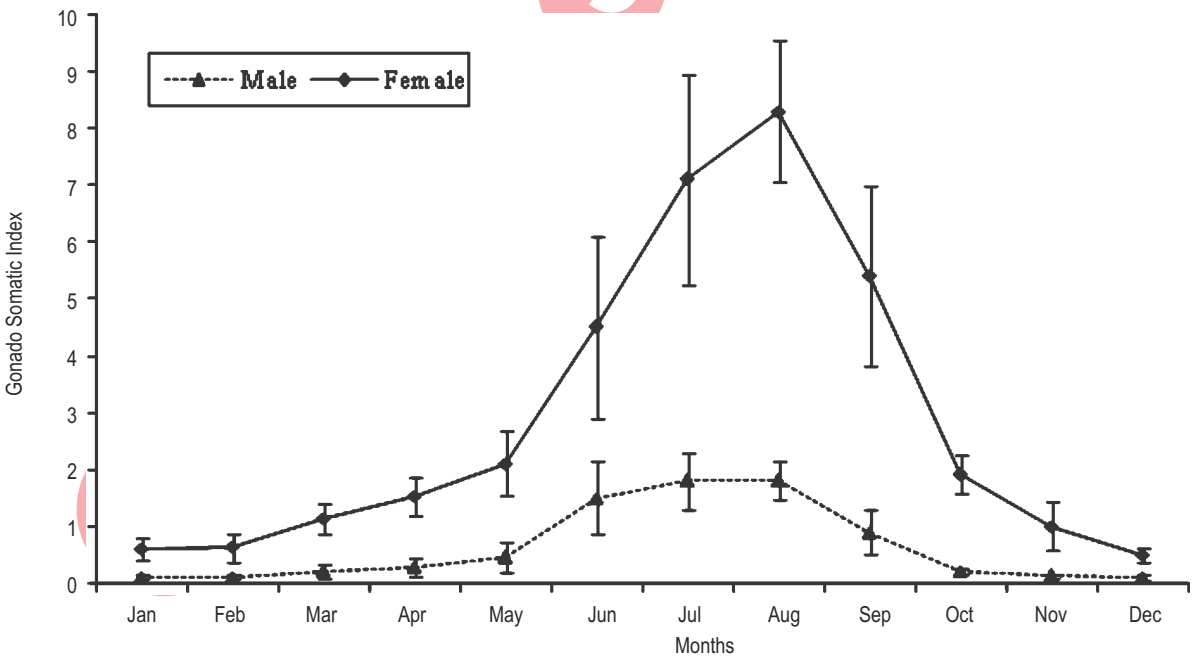

Fig. 4 : Monthly variations in mean values of GSI of male and female of *O. pabda*

The monthly variations in gonado-somatic index (GSI) of the male and female fish are shown in Fig 4. The values of GSI varied from 0.5 to 8.3 for female and 0.1 to 1.8 for male. The mean GSI of the fish tend to increase as the fish reached maturity and after spawning, it declined and the minimum GSI was recorded during resting phase. The higher value of GSI in males and females were observed in ripe and running ripe stages. Both the values were low during October - February. As expected, the values began to rise from March onwards until July - August and started to fall onwards. This also indicated that the spawning was over by October. The higher values of GSI for both males and females during June to September indicated that the fish breed during this period. The average monthly GSI values indicated that the female gonads developed slowly from March to May and rapidly from July to August. GSI for females was always higher than that for males probably due to heavier ripe female gonads. The values of gonado-somatic index (GSI) were low from January to April (0.5 – 1.24), suggesting the ovaries to be in resting and maturing stages. The values increased in June (males: 1.5 and females: 4.5) and reached peak in August (males : 1.8 and females: 8.3) indicating the gonads to be in mature and ripe stages. The low values from October to December suggested the spent condition. These observations were similar with *Chrysichthys nigrodigitatus* (Offem *et al.,* 2008) and different from other catfish *Silurus aristiletis* (Leonardos *et al.,* 2009).

Absolute fecundity was estimated by counting the mature ova in a Stage IV ovary. A total of 48 samples of mature fish were examined and it was found that the absolute fecundity of fish varied from 2460 to 5986 eggs with mean value of mean 4330 ± 799 for the fish with 11.5-20.0 cm in total length and 18.0-38.0 g in weight. The fecundity per 100 g body weight ranged from 10128 – 30838 with mean value of 20228±5053 eggs. This fecundity was slightly more than those recorded in case of *O. bimaculatus* by

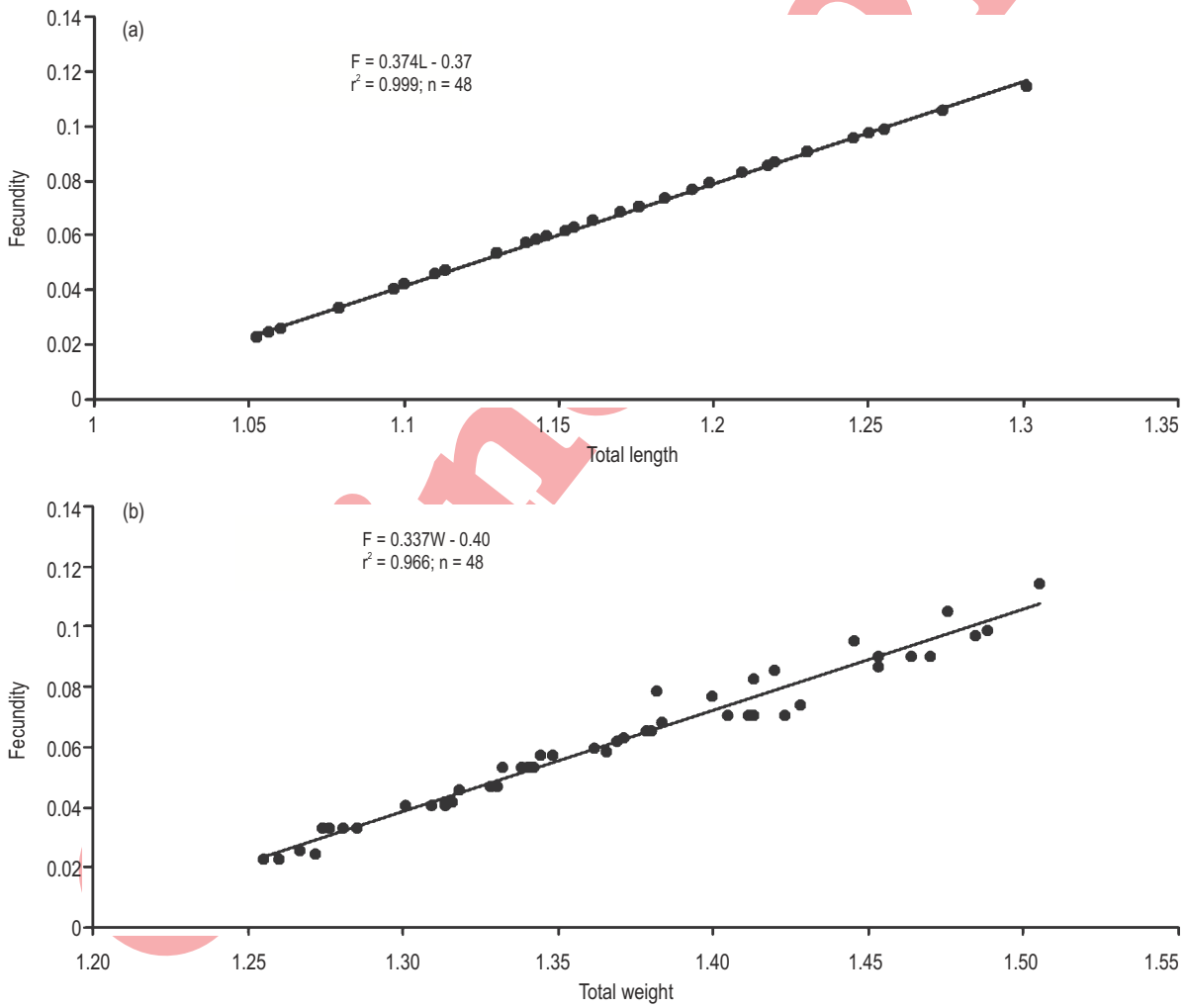

Fig. 5 : Linear regression between (a) total length and fecundity and (b) total body weight and fecundity of *O. pabda*

induced breeding (Sridhar *et al.,* 1998). A linear relationship was observed between absolute fecundity and total body length and weight of fishes (Fig 5 a, b). The study revealed that the fecundity, increased linearly with the increase of total length and total weight. The regression model of the relation of fecundity with total length and weight of the fish was Log F = 0.374 Log L+ 0.37, r^2 = 0.999 and Log F = 0.337 Log W – 0.40, r^2 = 0.966 (P > 0.01). Fecundity increased with increase in length and weight of the fish. Coefficient of correlation was positive, as the value of 'r^2' was 0.99. All the relationships showed that the values of co-efficient of correlations (r^2) were significant. The largest specimen (total length 20.0 cm and body weight 32.0 g) was found to carry 5143 eggs and the smallest sized fish (total length 11.5 cm and body weight 18.0 g) was found to carry 2460 eggs. But variation was found in the fecundity of fish of equal length. It is possible that the variation in fecundity of the *O. pabda* may be due to environmental conditions of the river. Similarly, linear relationships between fecundity and weight have been reported in different fish species like *Mystus bleekeri* (Musa and Bhuiyan, 2007), *Hilsa ilisha* (Akter *et al.,* 2007) and *Setipinna phasa* (Alam *et al.,* 1997).

Average diameter of ova in the present study was found to vary from 0.42 to 0.96 mm with mean value 0.87 mm, during April to September. A single stock of mature ova having diameter 0.75 – 0.97 mm were recorded from June to September. This observed ova diameter was smaller than that reported by Hussain (2006) for *O. pabda*, captive reared population and also *O. bimaculatus* (Sridhar *et al.,* 1998). The diameter of ova was significantly higher in the month of July and August where the diameter of ova decreased in the month of October compared to those of different months, which indicates that the diameter of ova attained its peak during spawning season. Similar observations were reported for this species in captive reared population of *O. pabda* (Chakrabarty *et al.,* 2009).

In conclusion, it is summarized that *O. pabda* is a low fecund fish and spawns once annually between June to September in river Gomti. The results of this study on reproductive traits like sex ratio, size at first sexual maturity, GSI, fecundity and spawning season may be beneficial for species conservation and management strategies in river Gomti as well as other similar rivers and tributaries. It is also recommended that there should be mesh size regulation and ban on the fishing in river during spawning period for protection and sustainable utilization of natural population of this species.

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