



Research Note

Reproductive Features of *Puntius sophore* (Hamilton 1822) from Rivers of Tripura, India

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Puntius sophore (common name: pool barb/spot fin swamp barb/stigma barb), a Cyprinid has wide geographical distribution in India, Bangladesh, Myanmar, Nepal, Pakistan, China (Talwar & Jhingran, 1991), Bhutan (Petr, 1999a) and Afghanistan (Petr, 1999b). This species matures in a year and breeds naturally in freshwater during monsoon (FAO, 1996). The species has high economic value due to its nutritive status, ornamental value and market demand both as fresh and processed products (Talwar & Jhingran, 1991; Samad et al., 2009). However, the stocks of *P. sophore* are declining rapidly due to heavy fishing pressure and in recent studies from the Indian waters, it is categorized as near threatened (Dua & Parkash, 2009; Sarkar et al., 2010). Culture of these small fish with major carps may contribute to the livelihood of the rural poor (Debnath et al., 2014). For proper management of the species, knowledge of length weight relationship, fecundity, gonado-somatic index (GSI) and observation of gonadal development are important.

In a fishery, length-weight relationship is often used to investigate environmental adaptability and to estimate growth of a given species (Pitcher & Hart, 1982). It helps to estimate the live weight of a fish when the length is known and vice-versa (Le Cren, 1951) and is an important input in fish biology which further provides information on stock condition (Bagenal & Tesch, 1978). Condition factor (K) serves as a useful index of the nutritional and biological cycle viz., gonadal development and spawning. In addition, fecundity data as a biological

parameter helps to assess abundance, reproductive potential and to evaluate commercial potential of a fish stock. GSI helps in understanding the maturity stage and exact time of spawning (Lagler, 1956). Gonadal maturation represents a series of cyclic morphological changes, where the gonads undergo gradual growth and ripeness.

Keeping in view the importance of the above biological parameters in determining the reproductive success and formulating management strategies, a study was undertaken to determine the length-weight relationship, fecundity, GSI, ovarian development and sex ratio of *P. sophore* as it has commercial value as a food fish as well as an ornamental fish.

The study was carried out during October 2011 to September 2012. Adult *P. sophore* ($n = 600$, 111 males, 164 females and 320 unidentified sexes) were collected from rivers of Tripura, India. Specimens were identified as per Talwar & Jhingran (1991). After collection, total lengths (L) were measured with digital caliper (Mitutoyo corporation, Japan); total body weight (W) of individual fish was measured to the nearest 0.001 g using an electronic balance (Meller Toledo, Switzerland). The degree of association between length and weight was computed using linear regression analysis. The length-weight relationship (LWR) was estimated using the equation given by Le Cren (1951): $W = a L^b$, where, a = proportionality constant, b = growth exponent, W = weight (g) and L = length (mm). A logarithmic transformation was used to make the relationship linear ($\log W = \log a + b \log L$). The values of the compiled growth exponent were used for the calculation of condition factor, K ($K = 100 W / L^b$). For each species, slopes of length-weight regressions were compared against isometric value of three

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using student's t-test (Sokal & Rohlf, 1987). The relative condition factor was calculated as: $K_n = W/\hat{W}$, Where, $\hat{W}$ = calculated weight derived from length-weight relationship (Le Cren, 1951). The relationship between length and weight was determined for male and female fishes separately by transforming the values of both variables to logarithmic values and fitting a straight line by the method of least squares.

For determining GSI, the gonads were weighed to nearest 0.001 g using an electronic balance. GSI was calculated as the ratio of total body weight to gonadal weight. For fecundity estimation, three sub-samples (each from anterior, middle and posterior part) were taken from each matured ovary. The number of eggs in each of the sub-samples were counted under a magnifying glass and mean value was computed. Relative fecundity, (F) was calculated as

$$F = n \times G/g$$

Where

'n' = average number of eggs

'G' = weight of the gonads in gram

'g' = weight of sub sample in gram

Egg diameter was measured using a 10X microscope (Carl Zeiss, Germany) provided with a numerical camera (ProgRes® CT3, USA). The condition for the characterization of the maturity stage of ovary was assessed based on colour, texture, size, shape and extent of occupancy of gonads in the body cavity as described by Qasim (1973).

Length-weight data of *P. sophore* was pooled into a single equation which was calculated as: $\log W = -2.182 + 3.322 \log L$ ($r^2 = 0.892$). The parabolic equation derived was $W = 0.0066L^{3.322}$.

The value of 'b' (regression coefficient) in length-weight relationship for this species is reported as 3.322 suggesting that the length-weight relationship followed the cubic law for isometric growth (Grover & Juliano, 1976). On plotting the observed weight of *P. sophore* against the observed length, a parabolic curve was obtained (Fig. 1). Similarly for male, female and unidentified sex groups, length weight relationships were determined and given in Table 1.

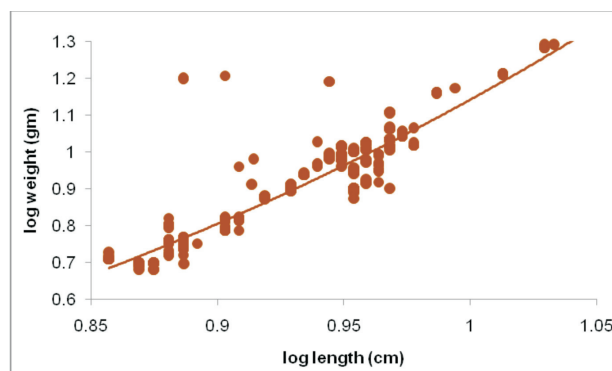


Fig. 1. Length-weight relationship of $\log_{10}$ values of *Puntius sophore*

The coefficient of correlation (r^2) values of different length groups are tabulated in Table 1. As K value is less than 1, except for male it indicates that the general well being of fish is poor (Choudhury et al., 2012). Here the K value for pooled data was 0.663; for male 1.308; for female 0.779 and fishes with unidentified sexes 0.588 respectively (Table 1). The fluctuations noticed in ' K_n ' values during the study period are represented in Fig. 2. ' K_n ' values showed two troughs (February and June) and the remaining months have almost constant value. Fluctuations in the condition of many fishes were observed in relation to their reproductive cycle, feeding rhythms (Manojkumar & Kurup, 2010) or physico-chemical factors of environment, age, physiological state of

Table 1. Length-weight regression equation of *Puntius sophore*

<i>Puntius sophore</i>	n	Logarithmic equation	Parabolic equation	K	K_n	r^2	t-value
Total	600	$\log W = -2.182 + 3.322 \log L$	$W = 0.0066L^{3.322}$	0.663	1.011 ± 0.108	0.892	3.24*
Male	112	$\log W = -1.885 + 2.984 \log L$	$W = 0.013L^{2.984}$	1.308	1.006 ± 0.068	0.945	3.21*
Female	164	$\log W = -2.11 + 3.24 \log L$	$W = 0.0078L^{3.24}$	0.779	0.999 ± 0.09	0.915	3.80*
Unidentified	324	$\log W = -2.236 + 3.388 \log L$	$W = 0.0058L^{3.388}$	0.588	1.013 ± 0.209	0.88	4.24*

*Indicate significance at $p < 0.01$

fish or some other unknown factors (Kalita & Jayabalan, 1997). In *P. sophore*, constant ' K_n ' values were recorded (except in the month of February and June) with a peak in January. This could be attributed to the increased spawning time in them, as opined by Menon (1950). Thus, it appears that reproductive cycle in *P. sophore* relates to the variations in the condition factor. Sex-wise analysis of ' K_n ' values in this study suggest that the male populations had better health and well being as compared to females (1.006 and 0.999 for male and female population, respectively) (Le Cren, 1951). The fish growth was found to be allometric ('t' test $p < 0.01$).

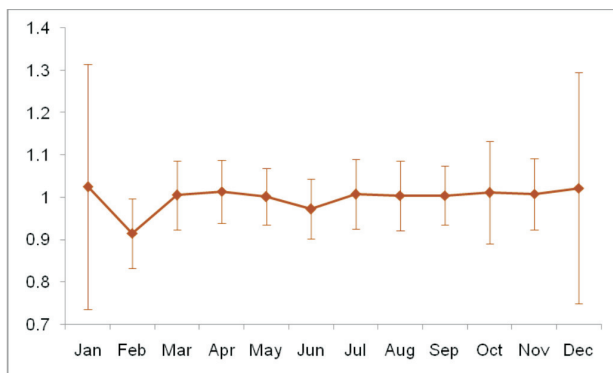


Fig. 2. Monthwise variation of relative condition factor (K_n) of *Puntius sophore*

The GSI indicates the state of gonadal development which reflects the maturity stages in fishes (Parween et al., 1993). The average GSI recorded in male and female populations was highest during July month (14.22 ± 3.9 and $20.88 \pm 4.55\%$ respectively). Increase in GSI corresponds to an increased gonadal development which is between March to July (Fig. 3). A gradual decrease in value after and with no gonads observed from November to February (winter

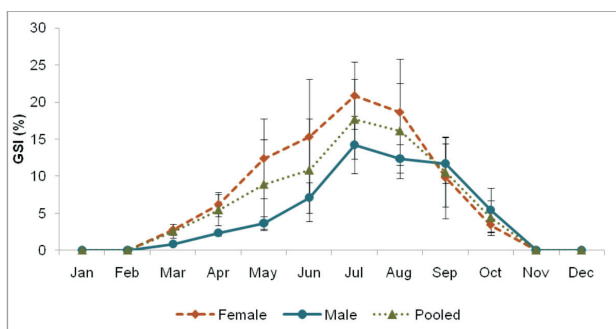


Fig. 3. Changes in GSI±SD value of male and female *Puntius sophore*

season) indicates that the peak spawning season for *P. sophore* is July (Fig. 3). Other species of genus *Puntius* have a prolonged spawning period (April to August) with peak during rainy season (Chandrasoma & de Silva, 1981).

In the present study, an increase in GSI corresponds to an increase in egg diameter and vice versa (Fig. 4), thus suggesting that the two parameters were proportional.

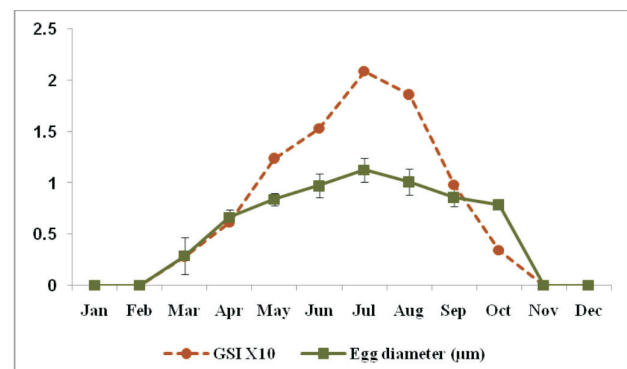


Fig. 4. Relationship between egg diameter and GSI (Female) of *Puntius sophore*

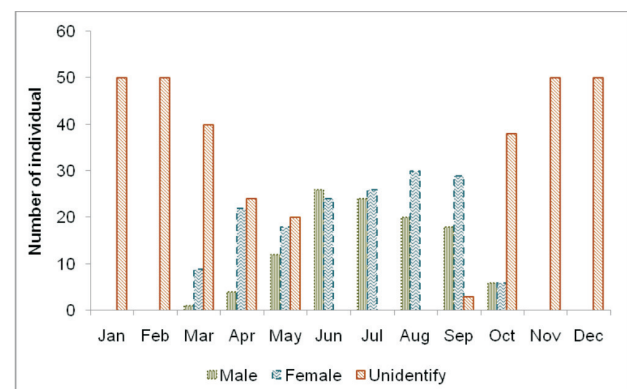


Fig. 5. Differences in the number of male, female and unidentified *Puntius sophore* in different months

Fecundity was estimated during the peak spawning season (July) and the relative fecundity observed was $4073 \pm 310 \text{ g}^{-1}$ body weight. According to Srivastava & Singh (2005), it varied from 439 to 24385 eggs in fishes having weight ranging from 2-26 g, whereas Bithy et al. (2012) estimated a range of 7951 to 23053 eggs for a corresponding body weight of 10.12 to 26.5 g. The sex ratio observed for the *P. sophore* in the current study was different from the expected ratio of 1:1 (female:male). The sex observed ($n = 600$) for one year period from October

2011 to September 2012 (50 fishes every month) was 111 males, 164 females and 320 unidentified sexes (Fig. 5).

Ovarian development and reproductive strategy have been described in many teleost fish species to understand the time course and energetic consequences of reproductive efforts. In the present study, breeding season of *P. sophore* was observed during July to August that corresponds with south-west monsoon which is observed in other *Puntius* spp. (Arunachalam & Sankaranarayanan, 1998) (Mannan et al., 2010). The increase in GSI with advanced ovarian developmental stages was observed in this study which supports earlier reports in *Puntius titteya* (Sundarabarathy et al., 2004) and *Puntius dukai* (Joshi & Joshi, 1989). During the annual ovarian cycle, *P. sophore* showed maximum GSI prior to spawning in July. Thus, it can be concluded that the fish would shed its eggs all at once within a very short spawning period as reported in three other *Barbus* species (De Silva et al., 1985).

Results of the present study provide useful information on the growth, reproductive biology and spawning season of *P. sophore* to assist biologists in conservation measures and to undertake captive breeding programmes.

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