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## Size at Sexual Maturity of the Female Pool Barb, *Puntius sophore* (Cyprinidae) in the Old Brahmaputra River, North Eastern Bangladesh

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### ABSTRACT

The size at sexual maturity of the female *Puntius sophore* was estimated in the Old Brahmaputra river, North eastern Bangladesh, using direct observation of sexual characters (e.g., gonadosomatic index) and by the indirect way using relative growth. Monthly samples were collected using a combination of fine-meshed cast nets and seine nets. All specimens were sexed and Standard Length (SL), Fork Length (FL), Body Weight (BW) and Gonadal Weight (GW) of all female individuals was measured. The gonadosomatic index (GSI) was calculated as  $GSI = (GW/BW \times 100)$ . The size at sexual maturity was estimated by the relationships of SL-GSI and SL-FL. The estimated size at sexual maturity of female *P. sophore* was 4.2 cm standard length based on the relationship between standard length and gonadosomatic index. On the other hand, relative growth of fork length to standard length showed a transition point at sizes 4 cm standard length, indicating size at sexual maturity of female *P. sophore*. This study presents information on the size at sexual maturity of female *P. sophore*, which will be useful for the management and conservation of this important fishery in Bangladesh and neighboring countries.

**Key words:** Standard length, gonadosomatic index, *Puntius sophore*, sexual maturity, management

### INTRODUCTION

The pool barb, *Puntius sophore* (Hamilton 1822) is a freshwater to brackish water cyprinid small indigenous fish in Bangladesh. This fish is widely distributed inland water of the Indian sub-continent including Bangladesh, Pakistan, India, Nepal and Bhutan (Talwar and Jhingran, 1991; Menon, 1999; Petr, 1999; Mirza, 2003). The species is also reported from China (Talwar and Jhingran, 1991), Afghanistan (Petr, 1999) and Myanmar (Oo, 2002). *Puntius sophore* is benthopelagic (demersal) and inhabits rivers, streams, ponds, beels, oodplains, baors, haors in plains and sub-montane regions predominantly (Menon, 1999; Craig *et al.*, 2004). It is an important target species for small-scale shers in Bangladesh (Shafi and Quddus, 1982; Rahman, 2005). Several studies (Thilsted *et al.*, 1997; Roos *et al.*, 2002; Thilsted, 2003) reported this fish as both an important food resource and a crucial source of micronutrients essential in preventing

malnutrition and vitamin and mineral deficiencies in rural communities, particularly of vulnerable groups such as poor women and children in Bangladesh. In addition, it can also be used as an aquarium fish (Froese and Pauly, 2011).

A number of studies from various water bodies have been conducted on *P. sophore*, including length-weight relationship and relative condition factor in Indian water (Talwar and Jhingran, 1991; Reddy and Rao, 1992; Menon, 1999) growth in the Jamuna river, Bangladesh (De Graaf, 2003), length-weight and length-length relationships in the Mathabhanga river, North western Bangladesh (Hossain *et al.*, 2006), biodiversity in the Pravara Sangam district of Ahmednagar, India (Shinde *et al.*, 2009) breeding-ground suitability profile in the Damodar river system, India (Sarkar and Banerjee, 2010) growth in the Old Brahmaputra river, Bangladesh (Ahamed *et al.*, 2012), different biological aspects in Bangladeshi water (Hossain *et al.*, 2012a) and population structure in the Chalan beel, Bangladesh (Rahman *et al.*, 2012). However, the present study describes the size at sexual maturity of the female *P. sophore* based on direct observation of sexual characters (e.g., gonadosomatic index) and by the indirect way using relative growth in the Old Brahmaputra river, Bangladesh.

## **MATERIALS AND METHODS**

The present study was conducted in the Old Brahmaputra river of Bangladesh (straddling 23°58' and 25°25'N and 89°38' and 91°15'E). Monthly samples were collected from the river section passing through Bangladesh Agricultural University campus at 24°42'N and 90°28'E during January-December 2009. Sampling was conducted from a traditional fishing boat, using a combination of fine-meshed cast nets and seine nets of <2 mm mesh, in order to catch all size groups within the population. All specimens were preserved in ice and transferred to the laboratory and fixed in 10% formalin prior to analysis. The Standard Length (SL) and Fork Length (FL) of all individuals were measured to the nearest 0.01 cm using a digital slide caliper (Mitutoyo, CD-15PS, Tokyo, Japan), while Body Weight (BW) was recorded using a digital balance (Shimadzu, EB-430DW, Tokyo, Japan) to 0.01 g accuracy. All collected specimens were sexed by incision of the abdomen and visual inspection of the gonad. All fat, connective tissue and blood vessels were carefully removed from the gonads and Gonadal Weight (GW) was measured to the nearest 0.001 g. Only female individuals were used in the present study.

The Gonadosomatic index (GSI) was calculated as:

$$GSI = \frac{GW}{BW} \times 100$$

The size at sexual maturity was estimated by the relationships of SL-GSI and SL-FL. The relationship between SL and FL was obtained by the equation of Huxley (1932):

$$Y = a+bX$$

using untransformed data. SL-FL data were divided into two subsets, using a specific SL value as a transition point. A separate linear regression was calculated for each subset of the data. Such calculations were repeated iteratively with sequential relocation of the breakpoint at 0.1 cm intervals over the whole size range of females. The lowest combined Residual Sum of Square (RSS) in the resultant two subsets data indicated the transition point (Lovett and Felder, 1989;

Ohtomi *et al.*, 2005; Ahamed and Ohtomi, 2014). To define the growth type, a further regression was conducted using log-transformed data. Significant deviation of the b value from the theoretical isometric value ( $b = 1$ ) indicates either positive ( $b > 1$ ) or negative ( $b < 1$ ) allometric growth in term of length-length relationship (Hartnoll, 1982), which was verified with Student's t-tests (Sokal and Rohlf, 1987). Analysis of covariance (ANCOVA) was used to test for significant differences in slopes and intercepts between two subsets data (Zar, 1984).

**RESULTS**

The relationship between SL and GSI of female *P. sophore* is shown in Fig. 1. The lowest and highest GSI recorded during this study was 0.05 and 23.62, respectively. The GSI rose sharply at around 4.2 cm SL. Therefore, the size at sexual maturity of *P. sophore* was considered to be 4.2 cm SL. Spearman's rank correlation test showed a significant correlation between SL and GSI ( $r_s = 0.489$ ,  $p < 0.001$ ), indicating that GSI was dependent on the body size.

As shown in Table 1, the relative growth of FL to SL of *P. sophore* was divided into two phases, using a specific SL value as breakpoint based on the minimum value of the total RSS in the

Table 1: Estimated slope and intercept of linear equation representing the relationship between standard length and fork length of female *Puntius sophore* in the Old Brahmaputra river, Bangladesh and RSS in different sets of two phases

Relationship	Breakpoint (SL, cm)	Early phase				Late phase				Total RSS
		Slope	Intercept	n	RSS	Slope	Intercept	n	RSS	
SL vs. FL	3.8	1.222	-0.247	23	0.323	1.100	0.144	289	8.741	9.064
	3.9	1.207	-0.202	28	0.516	1.101	0.136	284	8.542	9.058
	4.0	1.193	-0.159	33	0.592	1.103	0.129	279	8.466	9.057
	4.1	1.163	-0.066	36	0.664	1.101	0.138	276	8.438	9.102
	4.2	1.148	-0.019	51	0.967	1.104	0.123	261	8.130	9.097
	4.3	1.139	0.009	53	1.012	1.103	0.128	259	8.101	9.112
	4.4	1.129	0.043	56	1.038	1.102	0.134	256	8.087	9.125
	4.5	1.118	0.078	59	1.065	1.101	0.140	253	8.070	9.135
	4.6	1.094	0.163	69	1.154	1.097	0.165	243	7.980	9.134
	4.7	1.11	0.094	85	1.405	1.101	0.137	227	7.980	9.385

n: Number of individuals, SL: Standard length, RSS: Residual sum of square, FL: Fork length

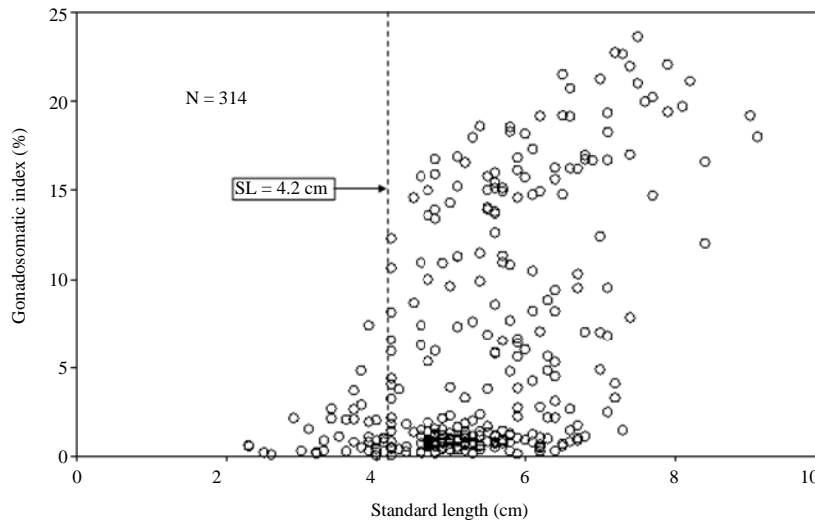


Fig. 1: Relationship between gonadosomatic index and standard length for female *Puntius sophore* in the old Brahmaputra river, Bangladesh

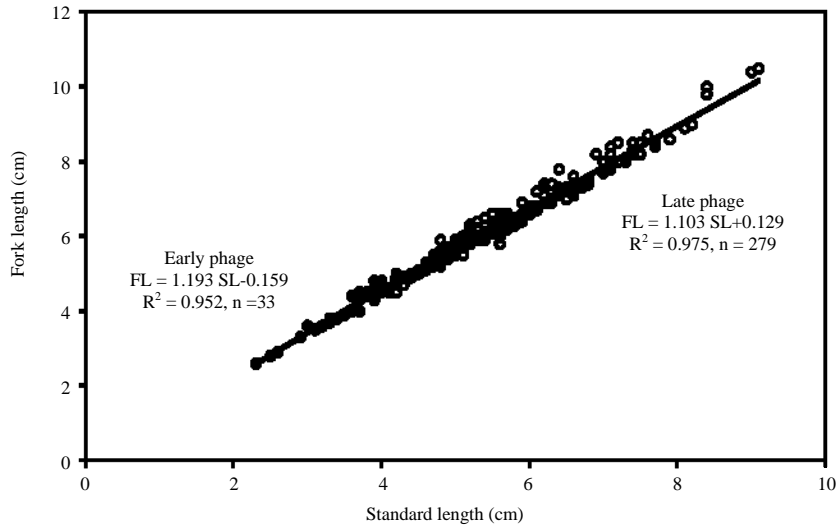


Fig. 2: Relationship between standard length and fork length for female *Puntius sophore* in the old Brahmaputra river, Bangladesh

Table 2: Allometric coefficients measured as slope for linear regressions (by least square estimate, with log-transformed data) between SL and FL of *Puntius sophore*

Relationship	Sex	n	Allom. coef	95% CI	r <sup>2</sup>
SL vs. FL	Early phase	33	1.043**	±0.036	0.965
	Late phase	279	0.974**	±0.010	0.973

\*\*Allometric coefficient significantly ( $p < 0.001$ ) different from 1.0, SL: Standard length, FL: Fork length, n: Sample size, Allom. coef: Allometric coefficient, 95% CI: Confidence interval of slope, r<sup>2</sup>: Coefficient of determination

regression analysis. The relative growth rate of FL changed abruptly at sizes 4 cm SL (Fig. 2); below this size, FL increased more rapidly than SL, yielding positive allometric growth (Table 2) However, after this size FL showed negative allometric growth with SL. There was a highly significant difference in both slopes and intercepts between above and below transition point for the regression examined (ANCOVA,  $p < 0.001$ ).

## DISCUSSION

The size at sexual maturity is of special interest in fisheries management, which is widely used as an indicator for minimum permissible capture size (Lucifora *et al.*, 1999). Available information on size at sexual maturity of fishes can be obtained from the plots of percentage occurrence of mature females against length class using logistic equation (King, 2007), though few studies (Gab-Alla *et al.*, 1990; Hossain *et al.*, 2012a) have reported low accuracy of estimating size at sexual maturity using logistic equation.

However, in the present study, the size of sexual maturity of female *P. sophore* was estimated using two different approaches. The first one is using the relationship between SL and GSI as a functional maturity as reported by several authors (Hossain and Ohtomi, 2008; Hossain *et al.*, 2010, 2012a, b; Ahamed *et al.*, 2014). The second one is using the relative growth of FL to SL as an indirect approach to estimate sexual maturity, where an abrupt increment/decline in size and proportion was observed, that could be used to explain the sexual maturation of *P. sophore* as reported by several studies (Lovett and Felder, 1989; Mantel and Dudgeon, 2005; Mantelatto and Barbosa, 2005; Biagi and Mantelatto, 2006; Botello and Alvarez, 2006; Miranda and Mantelatto, 2010; Ahamed and Ohtomi, 2014).

In this study, the size at first sexual maturity of *P. sophore* was estimated as 4.2 cm SL on the basis of the relationship between SL and GSI. On the other hand, the relative growth rate of the FL changed abruptly at 4.0 cm SL, which may simply reflect an association with sexual maturity. Several studies (Felder and Lovett, 1989; Lovett and Felder, 1989; Gonzalez-Gurriaran and Freire, 1994; Manjon-Cabeza and Garcia-Raso, 1999; Muino *et al.*, 1999; Nates and Felder, 1999; Tuck *et al.*, 2000; Lizarraga-Cubedo *et al.*, 2003; Ahamed and Ohtomi, 2014) on the relative growth of different body dimensions reported this transition or inflexion point as an indicator of sexual maturity. It is notable that the estimated size at sexual maturity (4 cm SL) based on relative growth is much closer to the estimated functional maturity (4.2 cm SL). Therefore, the size at sexual maturity of female *P. sophore* could be around 4.0 to/or 4.2 cm SL in the Old Brahmaputra river, Bangladesh.

There were no published reports dealing with the size at maturity of *P. sophore* from the Old Brahmaputra river, although a number of studies were reported from other waters. For example, Halls *et al.* (1999) reported that the size at sexual maturity of female *P. sophore* in the Pabna Irrigation and Rural Development Project (PIRDP), Talimnagar Sluiceway, Pabna, Bangladesh was 6.1 cm TL. However, in a later study, Halls (2005) reported the size at sexual maturity of female *P. sophore* in the Lohajang river, Tangail, Bangladesh was 4.5 cm TL. A recent study by Hossain *et al.* (2012b) reported the size at sexual maturity of female *P. sophore* in the Padma river, Bangladesh was 5 cm TL. The result of the present study could not be compared with the previous studies due to the variation in body length measurements (SL/TL) though all previous studies showed different results on the size at sexual maturity of female *P. sophore*. These variations in the size at sexual maturity may be influenced by the abundance and seasonal availability of food, temperature, photoperiod and other environmental factors in different zoogeographical regions (King, 2007).

## CONCLUSION

This study is a basic description of the size at sexual maturity of *P. sophore* obtained by direct observation of sexual characters (GSI) and compared with body lengths corresponding with the breakpoints identified by segmented models in the Old Brahmaputra river, Bangladesh. The results of the present study will be useful for the management and conservation of this important fishery. Studies on the size at sexual maturity of male *P. sophore* will be interesting and deserve to be explored in future research.

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