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Some aspects of reproductive biology of *Botia dario* (Hamilton-buchanan) from Sivasagar District, India

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A B S T R A C T

Certain aspects of reproductive biology of *Botia dario* from Sivasagar district, Assam were carried out. The sex ratio (M:F) of *B. dario* was 1 : 1.36. The ova diameter ranged from 0.5 to 0.77 mm with a mean of 0.6 ± 0.1. The species is high fecund and the ranged from 8000 to 49600 in fishes ranging from 7 to 13.9cm (mean 10.51 ± 2.01) and in body weight from 4.8 to 32.1gm (mean 15.82 ± 8.62). The relationship between fecundity (F) and total length (TL), total body weight (BW) and total gonadal weight (GW) were found to be linear with the 'r' values 0.94, 0.96 and 0.95 respectively. The gonadosomatic ratio (GSR) ranged between 2.05 and 12.58 with mean of 7.37 ± 3.5 in case of female and in case of male ranged between 0.5 and 2.5 with mean of 0.94 ± 0.5. The GSR showed highest peak in the monsoon and lowest in the pre-monsoon season. The relationship between GSR and TL, BW and GW were also found to be linear with the 'r' values 0.7, 0.75 and 0.71 in case of male and 0.67, 0.66 and 0.84 respectively in case of female.

Introduction

Reproductive ecology of any fish is essential for assessing commercial potentialities of its stock, life history, culture practice and actual management of its fishery (Lagler, 1956). In order to make success in fish culture, it is important to assess the yearly breeding cycle of potential cultivable species. Knowledge of gonadal development and the spawning season of a species allow subsequent studies on spawning frequency of its population, which is important for its management. During a particular phase of reproductive period spawning of a fish occurs, sometimes annually and sometimes at regular interval throughout the year. A thorough understanding of the early development of a fish species is also considered an important step for the fish culturists.

Several works on reproductive biology of different species have been reported in recent years. Notable among them were- Mohammad and Pathak (2010); Akther and Akther (2011); Saha and Saha (2011); Phukon and Biswas (2012); Saikia *et al.*, (2013); and Gupta and Banerjee (2012). *B.*

dario is a small sized, popular ornamental loach found in rivers, lakes, ponds, streams and wetlands of Assam. It is esteemed as food on account of invigorating qualities of its flesh. In spite of the above, basic information about the biological aspects of the fish is rather scanty. An attempt has been made here to study certain aspects of the reproductive biology of the species from the wetlands of upper Assam.

Materials and Methods

A total of 840 samples of *Botia Dario* (Hamilton-Buchanan) were used for the study. Fish samples were differentiated into separate sexes using both the naked eye and microscope. Among the total specimens collected, 356 were males and 484 females. After collection the specimens were preserved in 10% formalin solution. Gonads were dissected out and preserved in 5% formalin solution in separate vials and plastic containers. During preservation the gonads were properly labeled for subsequent studies. Excess amount of moisture were removed by blotting the surface of the fish as well as the gonads with blotting paper before taking weights. Measurements of total length were taken to nearest cm and weights of body and gonads were taken to nearest g using electronic balance. Clumps of eggs were gently teased with dissecting needle. The number of eggs in each sub-sample was counted. The fecundity (F) of each fish was estimated following Bagenal (1978).

The relationship between fecundity with independent variables (X) total length (TL), body weight (BW) and gonadal weight (GW) were expressed according to Le Cren (1951) using the equation $F = aX^b$, where, a, is a constant and b, the regression coefficient. The relationships between gonadal weights with independent variables (X) and also between gonadosomatic ratio and the independent variables were calculated. Fertility coefficient (FC) was also estimated according to Riedel (1965) - $FC = E/TL^3$, where E is the number of eggs produced and TL, the total length of female fish.

Result and Discussion

A total of 840 samples of *Botia Dario* with observable gonads were used to study. Males were 356 (42%) and females were 484 (57%) (Table 1). This gives a male-female ratio of 1:1.36 in favour of females (χ^2 =19.5, $p \leq 0.01$). Except in May, males were outnumbered by the females throughout the year (Table 1).

The ova diameter ranged from 0.5 to 0.77 mm with the mean diameter 0.6 ± 0.1. Monthly progression of ova-diameter showed that immature ova present in the ovaries during Dec–Feb (Fig. 1). The maturing ova (0.5–0.58 mm) with mean 0.54 $\pm$ 0.05 and the ripe ova (0.6–0.77 mm) with mean value 0.7 $\pm$ 0.08 were present during March-July. The mature ova began to build up from March onwards and reached its peak during July–August and disappeared from September again reappeared from March.

The gonadosomatic ratio (GSR) of *B. dario* ranged between 2.05 and 12.58 (mean 7.37 $\pm$ 3.5) in case of female and 0.5 to 2.5 (0.94 $\pm$ 0.5) in case of male with a peak in the monsoon and lowest in pre-monsoon seasons (Fig. 2) (Table 2). The relationship between GSR and other independent variables like total length, body weight and gonadal weight showed positive correlation. The models obtained for relations of GSR with total length (TL), body weight (BW) and gonadal weight (GW) were as follows –

Male- Log GSR = Log (-5.36) + 0.21 log TL; r = 0.7
Log GSR = Log (-3.95) + 0.22 log BW; r = 0.75
Log GSR = Log0.48 + 7 log GW; r = 0.71
Female- Log GSR = Log (-0.73) + 0.77 log TL; r = 0.67
Log GSR = Log 3.9 + 0.44 log BW; r = 0.66
Log GSR = Log 4.62 + 5.5 log GW; r = 0.84

The number of eggs per clutch of *B. dario* ranged from 8000 (7cm and 4.8g size) to 49600 (13.9cm and 32.1g size) with mean of 24717.16 + 14237.86 eggs/clutch. The number of eggs produced varied greatly even within the same size group. The regression relation of fecundity (F) with total length (TL), total body weight (BW) and gonadal weight (GW) showed a highly positive correlation (Fig. 3). The models obtained for relations of fecundity (F) with total length (TL), total body weight (BW) and gonad weight (GW) were-

Log F = Log (-45552) + 6685.9 log TL; (r = 0.94);
Log F = Log (-480.3) + 1592.5 log BW; (r = 0.96);
Log F = Log (8707.6) + 9766.4 log BW; (r = 0.96).

The fertility coefficient for the fish under study was 18.9 $\pm$ 4.6.

Study of monthly sex ratio depicted the female dominance over male in this population and the deviation of sex ratio from the expected ratio of 1:1. Hussain *et al.* (2007) earlier reported male dominance in *B. dario*. This difference may be due to the availability of species at the different habitat, places etc. The deviation of sex ratio from the expected value and female dominance over male in population have been reported by Gupta and Banerjee (2013) in Amblypharyngodon mola and also a number of workers (Akhter and Akhter, 2011; Azadi and Rahman, 2008; Hoque and Rahman, 2008; Mondal and Kaviraj, 2010; Olurin and Savage, 2011 and Parvin *et al.*, 2011).

The monthly values of gonadosomatic ratio (GSR) and the presence of ripe ovaries of B.dario throughout the duration of this study indicate a monocyclic breeding habit with peak period of breeding occurring in between March and August. GSR tends to increase with maturation of gonad (initiation of breeding season), becomes maximal during the period of peak maturity and declines abruptly thereafter, when the fish becomes spent after gamete extrusion and/or reabsorption (Nikolsky, 1963; Le Cren, 1951; Olurin and Savage, 2011). So, during the monthly study of GSR value in any fish species; the month(s) at which GSR value(s) reach at peak(s) depict the spawning period for that particular fish species and the months with high GSR values represent the breeding periodicity of that particular fish species. In respect to male, GSR has shown highly positive relationship with total body length, total body weight and total gonadal weight; but comparison of correlation coefficients of GSR-total body length (r=0.7), GSR-total body weight (r=0.75) and GSR-total gonadal weight (r=0.71) have indicated that variation in GSR can be explained better in terms of total body weight than in terms of total body length and total gonadal weight. In case of female, GSR has shown the same type of relationship and correlation coefficients of GSR-total body length (r=0.67), GSR-total body weight (r=0.66) and GSR-total gonadal weight (r=0.84) have indicated that variation in GSR in female can be better explained in terms of total gonadal weight than in terms of other body parameters.

Table.1 Monthly proportion (%) of male and female in *B. dario*

Month	Males		Females		M:F	χ^2
	(n)	%	(n)	%		
March	24	40	36	60	1 : 1.5	2.4^{*}
April	22	36	38	63	1 : 1.73	4.3^{*}
May	39	52	36	48	1 : 0.92	0.12^{ns}
June	26	40	39	60	1 : 1.5	2.6^{*}
July	30	46	35	54	1 : 1.7	0.4^{ns}
August	25	41	35	58	1 : 1.4	1.6^{ns}
September	26	42	36	58	1 : 1.4	1.6^{ns}
October	38	45	46	54	1 : 1.2	0.76^{ns}
November	38	45	46	54	1 : 1.2	0.76^{ns}
December	20	30	45	69	1 : 2.3	9.6^{*}
January	30	41	43	59	1 : 1.4	2.3^{*}
February	38	43	49	56	1 : 1.3	1.4^{ns}

*Significant; ns- not significant

Table.2 Seasonal variation in Gonadal weight and GSR of male and female *Botia Dario*

Seasons	Male		Female	
	Gonad wt.(g)	GSR	Gonad Wt.(g)	GSR
Premonsoon	0.06 ± 0.009	0.85 ± 0.05	0.77 ± 0.07	8.7 ± 0.39
Monsoon	0.16 ± 0.07	1.5 ± 0.55	2.6 ± 1.1	11.6 ± 1.6
Post-Monsoon	0.01 ± 0.004	0.53 ± 0.08	0.17 ± 0.1	3.06 ± 1.3
Winter	0.02 ± 0.003	0.67 ± 0.07	0.45 ± 0.1	5.9 ± 0.6

Fig.1 Monthly variation of mean intra-ovarian ova diameter of *Botia Dario*

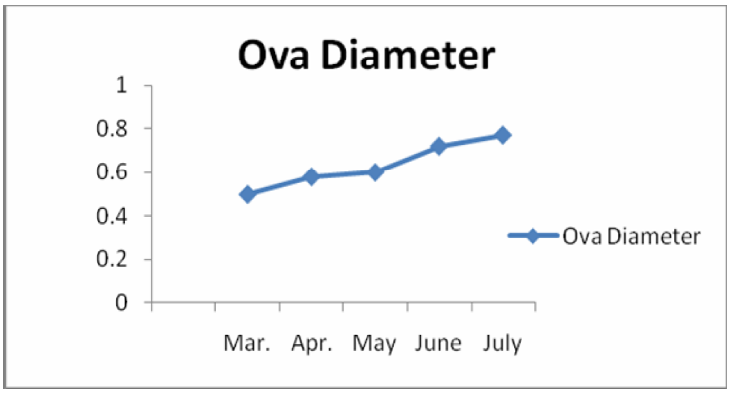


Fig.2 Seasonal variation of Gonado-somatic ratio of male and female *Botia Dario*

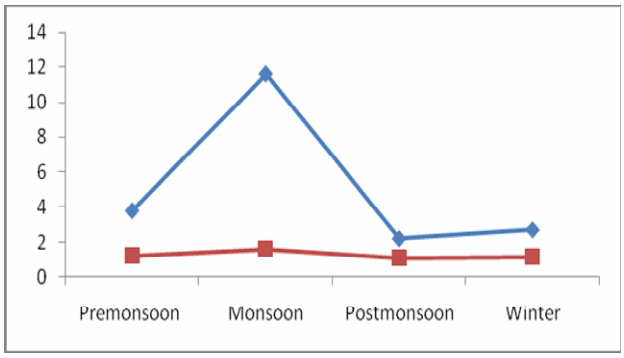
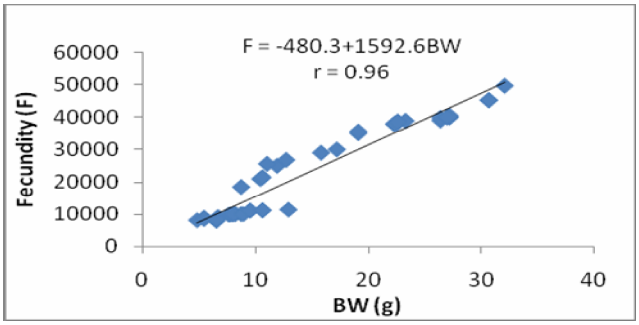
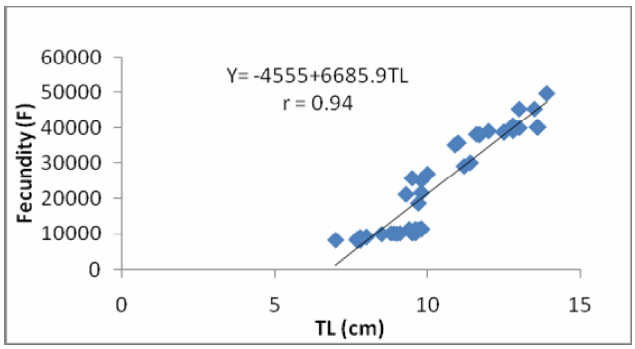
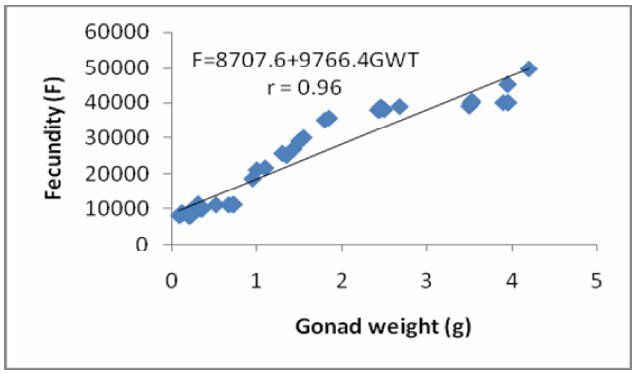


Fig.3 (A-C): Log-log relationship between fecundity and body parameters







The fecundity is affected by many factors, such as the size and age of the female (Thorpe *et al.,* 1984), the life-history strategy (Morita and Takashima, 1998), food supply and temperature (Fleming and Gross, 1990). The fecundity of *B. dario* ranged from 8000 to 49600, which is closer to the observations made by Hussain *et al.* (2007) for the same species.

Masoud *et al.,* (2011) reported that the number of eggs increased linearly with the increase in fish size in case of *Garra rufa*. According to Jonsson and Jonsson (1999), fecundity increases with body size because the amount of energy available for egg production and the body cavity accommodating the eggs increases with fish size. The correlation coefficient for the relationship between fecundity and total body weight and total gonad weight indicate high positivity in comparison to the total length of the body. Variation in ova diameter is probably one of the important pieces of evidences used in determination of fish reproductive strategy (Tomasini *et al.,* 1996). The maximum ova diameter was observed in *Botia Dario* from March to July showing the spawning season of this fish.

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