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SHORT COMMUNICATION

Gonadosomatic index and fecundity of threatened reba carp, *Cirrhinus reba* (Hamilton), in the Ganges River (northwest Bangladesh)

Md. Abu Sayed Jewel, Md. Ayenuddin Haque, Mst. Shahanaj Ferdous, Mst. Samsad Khatun, Dil Afroza Khanom, Jakia Hasan

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Abstract. The gonadosomatic index (GSI) and fecundity of the threatened *Cirrhinus reba* (Hamilton) was studied over a period of one year from January to December 2015 in the Ganges River (northwest Bangladesh). The GSI index indicated that the *C. reba* breeding season in the Ganges was from June to September with the peak in August. Fish fecundity increased with increasing fish length and weight, and the highest fecundity (265,042.23) was recorded in a fish with a total length, a body weight, and an ovary weight of 23.80 cm, 136.00 g and 45.00 g, respectively. There was a linear relationship between fecundity and total length (r = 0.871), body weight (r = 0.872), and ovary weight (r = 0.879), with that between ovary weight and fecundity being the strongest.

Keywords: *Cirrhinus reba*, fecundity, GSI, Ganges River

M.A.S. Jewel [✉], M.A. Haque, M.S. Ferdous, M.S. Khatun, D.A. Khanom
Department of Fisheries, Faculty of Agriculture
University of Rajshahi, Rajshahi 6205, Bangladesh
e-mail: jewelru75@yahoo.com

J. Hasan
Bangladesh Fisheries Research Institute (BFRI),
Marine Fisheries & Technology Station, Cox's Bazar, Bangladesh

Introduction

Cirrhina reba (Hamilton) is one of the most popular food fishes, and it is widely distributed in India, Bangladesh, Pakistan, Nepal, Burma, and Thailand (Jayaram 1981, Davis and West 1993). *C. reba* has been declared as vulnerable in Bangladeshi waters by the IUCN (2000) as a consequence of increased fishing pressure and the degradation of its natural habitat. Therefore, implementing a sustainable management for this species is required. In recent years, there has been increasing interest in the commercial culture of *C. reba* in Bangladesh. The major constraint of the large-scale culture of this species is the unavailability of quality spawn from the wild and also the scarcity of mature brood fish. To utilize and manage this species judiciously in a culture system, it is essential to understand its reproductive biology and spawn production and to develop larval rearing techniques. It is of paramount importance to assess this species's fecundity in order to evaluate its reproductive potential. Fecundity studies are an important part of fishery science, because they have direct bearing on fish production and exploitation (Shafi et al. 2012). Thorough knowledge of fish fecundity is

essential for evaluating the commercial potential of fish culture and stock recruitment and also for studying the life histories of species, practical culture, and hands-on management of fisheries (Shafi 2012). Numerous studies on the biology of this species are available that address such issues as feeding (Naik et al. 2015, Lashari et al. 2010), life-history traits (Hossain et al. 2013), and induced spawning (Sarkar et al. 2004). Lashari et al. (2007) studied the gonadosomatic index and fecundity of *C. reba* in fishponds in the district of Jacobabad, Sindh, Pakistan, and Ramasamy and Rajangam (2017) studied the maturation and reproductive biology of the same species in the lower Anicut Reservoir, Tamil Nadu, India. However, information regarding the reproductive potential of this species in Bangladesh is still poor. Therefore, the present study aimed at providing a comprehensive account of the gonadosomatic index and fecundity of *C. reba* in the Ganges River (northwest Bangladesh).

Materials and methods

The present study was conducted in the lower parts of the Ganges River, northwest Bangladesh, which is also known as the Padma River. Five distinct stations from Godagari (24°27'34.79''N and 88°20'09.54''E) to Chargat (24°16'43.25''N and 88°45'06.75''E) Rajshahi were selected as collection sites of fish specimens during a period of one year (January to December 2015). The location of the five sampling stations is shown in Fig. 1. Fish specimens were collected from fishers at each station. The total number of specimens collected during the study period was 600, among which 317 were male and 283 were female. The samples were transported to the processing laboratory at the Department of Fisheries, University of Rajshahi for detailed studies. After recording the morphometric parameters (body length and body weight) and determining the sex of the fresh fish, fifty gravid females were selected from the 283 female specimens (10 each month from May to September) to calculate reproductive periodicity and fecundity. Visual observation and experience were used to identify the gravid females. Before dissection, the total length of each fish was measured to the nearest cm with a digital slide caliper (0.01 mm) and weight was recorded to the nearest 0.1 gram with an analytical balance (Mettler Toledo). After dissection, the ovaries were cleaned properly, and each lobe of each pair was weighed separately to the nearest mg. Then the ovaries were wiped with blotting paper to remove moisture and preserved in a 5% formalin solution for 24 hours so that the eggs would swell to facilitate calculations. The gonadosomatic index (GSI) was calculated according to the following formula:

$$GSI = 100 \times W_1 \times W_2^{-1}$$

where, W_1 = gonad wet weight, W_2 = total fish wet weight

In this study, the gravimetric method (Hunter et al. 1989) was used to determine fish fecundity. The preserved ovaries were weighed, and then samples

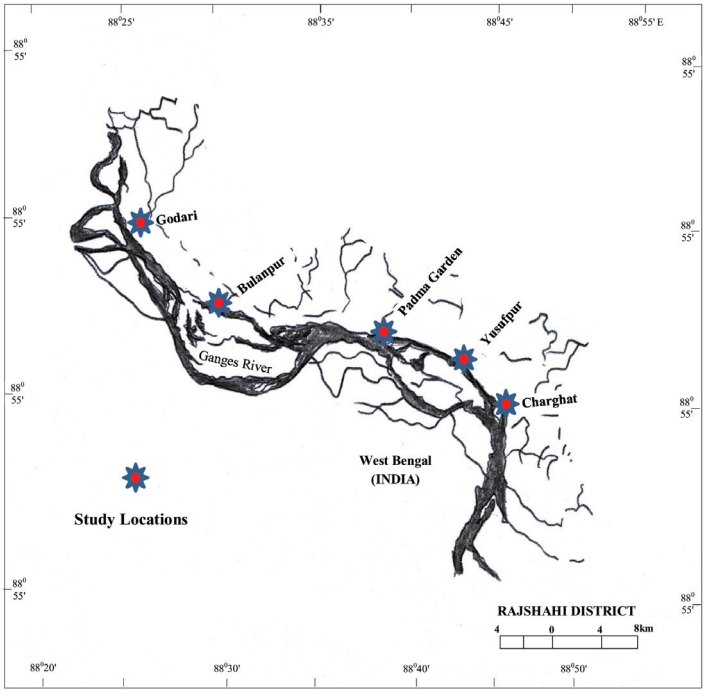

Figure 1. Location of sampling stations in the Ganges River (northwest Bangladesh).

from anterior, middle, and posterior regions of each lobe of each pair were weighed accurately. The eggs in each of the three sections were counted, and then the mean number of eggs was calculated. The total number of eggs for each individual was calculated from the sample mean and the total weight of the ovaries. The following equation was used to estimate fecundity:

$$Fecundity = \frac{Total\ \ weight\ of\ ovary \times No.\ of\ eggs\ in\ the\ fraction}{Weight\ of\ the\ fraction}$$

The trends of the relationship between fecundity and total length, fecundity and total weight, and fecundity and ovary weight were examined with the least squares method, i.e., Y = a + bX, where Y = Fecundity, X = body measurements (TL = total length, BW = body weight, Ow = ovary weight, a and b are constants). Finally, relevant statistical analyses were performed using Microsoft Excel (version 10.0).

Results and discussions

Monthly GSI value of female *C. reba*

The gonadosomatic index is a well-known relationship, and it is used frequently to determine the reproductive periodicity of fishes. Monthly variations are helpful when estimating reproductive periodicity. Monthly variation in GSI values were noted during the present study period (see in Fig. 2). The highest GSI values for female *C. reba* were recorded in August (20.48) while the lowest were in October (0.20). In the present study, mature females had mature, ripe ovaries that increased the specimens' GSI value in August, which is similar to the findings of Akhter and Akhter (2011), who also report the highest GSI values during the spawning season. The highest GSI value in August during the present study indicates that peak breeding period of *C. reba* occurred in August and extended from June to September in the Padma River. This could have been because of the higher levels of flowing flood waters in the river during these months. Similar results are also reported by Akhteruzzaman et al. (1998) and Hussain and Mazid (2001), who reported that the reba carp spawning season starts in April and ends in August with peak spawning occurring during the rainy months in flowing flood waters. On the other hand, achieving maturity during this season can also prompt spawning in this fish species (Gupta and Banerjee 2016). Sharp declines in GSI values occurred from October onward (0.84), which might have been the result of spawning (Fig. 2). Similar observations are reported by Nandikeswari and Anandan (2013) in *Terapon puta* Cuvier and by Mishra and Saksena (2012) in *Labeo calbasu* (Hamilton).

Fecundity

Fecundity has been defined as the number of ripening eggs prior to spawning, and it is one of the main factors governing population year class size. The estimated total length (TL), body weight (BW), and ovary weight (Ow) of *C. reba* ranged from 14.3 to 23.8 cm, 32.0 to 136.0 g, and 4.8 to 45.0 g, respectively, during the study period (Table 1). Maximum fecundity was noted in fish of a total length of 23.8 cm (136.0 g) and the minimum was noted at a total length of 14.3 cm (32.0 g). Therefore, the present study revealed that larger fish were more fecund than smaller fish.

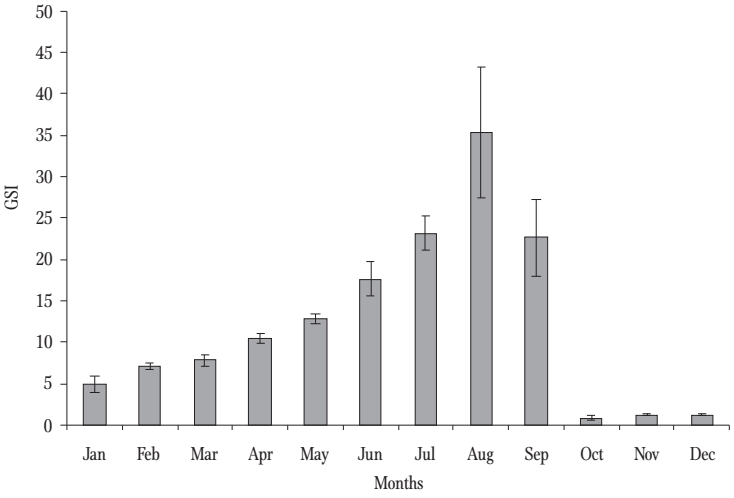

Figure 2. Monthly GSI of female *C. reba* collected from the Ganges River (northwest Bangladesh).

Table 1
Average of fecundity counts at various length ranges of *C. reba* collected from Ganges River (northwest Bangladesh)

Total length						Numbers of eggs per body weight	Numbers of eggs per ovary weight
range (cm)	mean (cm)	Body weight (g)	N	Ovary weight (g)	Fecundity		
14.30-16.30	15.15	38.11	8	9.07	19549.41	512.97	2155.39
16.31-18.31	17.03	46.40	15	11.66	29402.34	633.67	2521.64
18.32-20.32	19.16	90.63	17	17.66	70850.83	781.76	4011.94
20.33-22.33	21.25	113.43	9	23.37	126758.28	1117.50	5423.97
22.34-24.34	23.80	136.00	1	45.00	265042.23	1948.73	5889.73

Table 2
Relationship of fecundity to total length (TL), body weight (BW), and ovary weight (Ow) of *C. reba* collected from the Ganges River (northwest Bangladesh)

Parameters	Fecundity – size relationship	*a*	*b*	r	r^2
F vs. TL	ln (F) = 5.892 ln (TL) – 6.354	-6.354	5.892	0.871*	0.7617
F vs. BW	ln (F) = 1.492 ln (TW) + 4.495	4.495	1.492	0.872*	0.7604
F vs. Ow	ln (F) = 1.316 ln (Ow) + 7.282	7.282	1.316	0.897*	0.8043

* indicates significance at $P < 0.01$

Similar results were reported previously by Jan and Ahmed (2016) in *Schizothorax plagiostomus* Heckel and by Alam and Pathak (2010) in *Labeo rohita* (Hamilton). During the study period, the mean fecundity was 11,542.10 ± 53,602.28, which was within the fecundity range reported by Lashari et al. (2007) of 20,722 to 211,200 eggs in their earlier study of the same fish species in fishponds of Pakistan. Higher *C. reba* fecundity was reported by Khan (1986) as 22,356 to 437,400 eggs from the Baigul Reservoir (U.P.), India. The differences between the present findings with those of other researchers could stem from factors that affect fish fecundity such as size, age, and condition, and also fish habitat and the food they consume (Islam et al. 2012, Jan and Ahmed 2016).

The relationship of fecundity to total length, body weight, and ovary weight was calculated and is summarized in Table 2. During the present investigation, regression analysis revealed that fecundity increased with increased total length, body weight, and gonad weight in *C. reba.* Similar observations are reported by Lashari et al. (2007) for the same species and Hossain et al. (2017) for different fish species (*Pethia ticto* (Hamilton)). However, the relationship between fecundity and body weight was stronger (r = 0.872) than that between fecundity and total length (r = 0.871). The strongest correlation was noted between fecundity and ovary weight (r = 0.879). Similar observations are reported by many authors, i.e., Roy et al. (2014) for *Glossogobius giuris* (Hamilton), Ali et al. (2013) for *Mastacembelus armatus* (Lacepéde), and Oso et al. (2011) for *Hepsetus odoe* (Bloch).

Conclusion

The present work is an important baseline study on the reproductive biology, and, specifically, the gonadosomatic index (GSI) and fecundity indices of the *C. reba* in the Padma River in northwest Bangladesh. The results of the study are an effective tool for fishery biologists, managers, and conservationists who are initiating early management strategies and

regulations for the sustainable conservation of the remaining stocks of this species in the Padma River ecosystem.

Author contributions. A.S.J. supervised the research work; A.H. analyzed the data and wrote the manuscript; Mst. S.F. – data collection; S.K. – data collection; A.K., J.H. – manuscript preparation.

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