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Research Article

Food, feeding habit and reproductive biology of freshwater garfish (*Xenentodon cancila*) from south-western Bangladesh: Implications to fishery management

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ABSTRACT

The food and feeding habit and some aspects of reproductive biology of *Xenentodon.cancila* were conducted in greater Jessore region, South-western Bangladesh. A total of 138 specimens were collected randomly from different fish markets from April 2015 to March 2016. Guts were categorized in different status on the basis of its fullness and it was showed that mostly empty (75%) followed by 14% full and 11% half full. Various food items were encountered in the gut of the fish, *viz;* zooplankton (32%), phytoplankton (20%), crustaceans (18%) and small fish (15%). As *X. cancila* largely depends on animal materials (65%), it is indicated as a carnivorous fish. The present investigation also revealed that males were significantly ($P>0.01$) dominant over female. The breeding season of the species is April to September and the female get maturity at the size of 178.58 mm of total length.

INTRODUCTION

Xenentodon cancila (freshwater garfish) is a needlefish found in freshwater and brackish habitats in South and Southeast Asia. As a reasonably popular fish, it has been traded under a variety of common names, including needlefish, silver needlefish, Asian freshwater needlefish, needle-nose halfbeak, freshwater gar, needle nose gar and other local dialects (Rahman, 1989; Al-Mamun, 2003). The fish is one of the costly indigenous fresh food in the country (Rahman, 2005) and the market price is around BDT 400/kg (US$ 5). It is also a potential aquarium fish in the country. It is rich with vitamin-A which plays an important role in preventing child blindness.The distribution of this fish is transboundary in the greater area of South Asia and thus contributes a global significance with its taste and nutrition (Talwar and Jhingran, 1991; Frose and Pauly, 2012). The major part of the catch is consumed locally. However, the small part of the harvested fish is exported to the Middle East, Europe and America as a human consumable food item (Dutta, 2015). Bangladesh is reportedly one of the largest producers of garfish for the global market and thus attention should be given to unveil ecological aspects of this fish for its further conservation.

Upstream of the rivers and the freshwater reservoirs are the main habitat of X. cancila; for instance, it is highly abundant in the Ganges-Brahmaputra system in the Indian subcontinent (Rahman, 1989; Talwar and Jhingran, 1991). The adult freshwater garfish prefers habitat that contains minimal floating vegetation (Pethiyagoda, 1991). It is reported from Sri Lanka that the fish mostly feeds on crustaceans, small fishes and insects (Pethiyagoda, 1991). However, this feeding habit depends on the context of their local habitat, for instance, food availability and types of prey in its ecological niche (Bhuiyan *et al.*, 2006).

Xenentodon cancila is declining from natural habitat compared to other small indigenous species due to habitat destruction and fishing pressure (Islam *et al*., 2016). Therefore, the management of the fishery is necessary for the target fish, such as this garfish. The knowledge of the food and feeding habits is one of the important biological information which is essential for the management of any fish (Begum *et al.*, 2008; Sarkar and Deepak, 2009).Also, understanding different aspects of reproduction biology such as maturity size, breeding season and fecundity are the prerequisites for both culture and fisheries management strategy (Islam *et al.*, 2016).

There are few studies on the different biological aspects of the species in Bangladesh and other regional habitats like the availability of the species (Ali *et al.*, 2004; Chandra *et* *al*., 2011; Kostori *et al.*, 2011; Samad *et al.*, 2013; Ahsan *et al.*, 2014), marketing status (Flowra *et al*., 2012; Jesmine, 2013), food and feeding habits (Gupta, 1971; Chaturvedi and Parihar, 2014; Parihar *et al.*, 2016; Rao, 2017), length-weight relationship (Chandrika and Balasubramonian, 1986; Hossain et al., 2013) and the reproductive biology (Subba and Meheta, 2012; Bano *et al*., 2012; Chakrabarti and Banerjee, 2015; Mian *et al*.,2017). However, there are no systematic studies in details on the food and feeding habits and reproductive aspects and their relations for the regional fishery management for the species reported in Bangladesh. The present study thus aims to study food and feeding habit, maturity size, breeding season and fecundity of garfish caught in the south-western region of Bangladesh which could contribute to understanding and conserving the freshwater fish species.

MATERIALS AND METHODS

The experimental species ,*Xenentodon cancila* were collected from different fish markets of greater Jessore area during April, 2015 to March, 2016 (Figure 1). Three local markets were selected from each of the district of the area such as Jessore (23° 10' 14.39" N; 89° 12' 44.70" E), Narail (23° 10' 00" N; 89° 30' 00" E), Jhinaidah (23°30' 0.00"N; 89°10' 0.12"E) and Magura (23° 29' 27.37" N and 89° 25' *16.08"* E). Fishes were preserved at 10% formalin solution to prevent further digestion of food materials (Bhuiyan *et al.*, 2006) and brought to the laboratory of Fisheries and Marine Bioscience department of Jessore University of Science and Technology for further investigation. In the laboratory, each individual fish was measured for the total length (TL) and body weight (BW) to the nearest millimeter and gram by using a slide calipers (Electronic digital caliper) and electronics balance (A&D company, Model: EK 1200i; Japan). The individuals were classified into different size classes according to its length intervals.

The gut of each of the sample was dissected out and weighted, and the gut contents were taken into a Petri dish and diluted using distilled water to investigate the contents. The food items were identified by using a photographic microscope (Model: Zeiss Primo Star). The indexes were developed on the basis of gut content by visual observation (Mamun *et al*., 2004). The observation of their guts gave three gut indexes such as empty, full and half full by visual estimation occurrence method (Mamun *et al*., 2004; Mitra *et al*., 2007; Suresh *et al*., 2007). The investigators' personal bias is likely to influence the results of this analysis method and hence taken large number of samples to minimize the personal biasness. The gut contents were analyzed on the basis of percent frequency occurrence (Hynes, 1950; Gupta and Banerjee, 2014). The food items also were analyzed on the basis of their sex, size-class and seasons.

Specimens were dissected and observed gonad to identify the sexes. The number of male and female in percentage was plotted against months and seasons. Chi-square test was made to find out the sex ratio for the difference, if any, from hypothetical ratio 1:1. Three analytical methods were used to estimate the size at maturity of the individuals. The potential cluster or modals were developed on the basis of scatter distribution or plotted of the total length against the total body weight of the females (Adopted from Islam and Kurokura, 2012). It was assumed that after development of gonad, the weight of the individuals gained rapidly compares to other and hence the rapid weight increment point considered as maturity size. In the second method, the size at maturity of *X. cancila* was determined by break point analysis by plotting body weight against total length. Separate regression lines were fitted to the plots for immature and mature fishes. The body weight at which the regression lines for mature and immature fishes intersected was taken as the mean size at which *X. cancila* attain sexual maturity. The third method was the probit analysis. It was used to determine the size at which 50% of fishes reaches sexual maturity (Robertson and Kruger, 1994). The data from sample fishes were allocated to 25 mm distance size classes. The proportion (*p)* of mature female in each size class was calculated according to Mikhaylyuk (1985) that was converted to logit(p)=ln(p/1-p)). The logistic data were then converted to probit (P) =p+5. Finally, the probit data were plotted against size classes, and a regression line was fitted to the data points. The size class value equivalent to probit 5 was extrapolated as the median size at sexual maturity. The mean value of the three analytical methods was finally considered the maturity size of the population. Breeding season was determined by the maturity percentage of female *X. cancila* from the sampled fish. The gravimetric method as described by Lagler *et al.* (1967) was applied according to the following formula for the estimation of fecundity.

$$\text{Fecundity} = \frac{\text{Total gonadweight} \times \text{No. ofeggs}}{\text{Weight of small portion of total gonad}}$$

RESULTS AND DISCUSSION

The information on food and feeding habit of the species is very scanty (Gupta and Banerjee, 2017) and particularly no such information in Bangladesh context is available as per best of the authors' knowledge. In the present study, a total of 138 guts of *Xenentodon cancila* were observed during the study period and most of the guts in both sexes (>75%) were empty whereas only 13% guts were full (Fig. 2) and three indexes of the guts of *Xenentodon cancila* in both sexes showed maximum percentage of guts empty (77% and 75%) and half full percentage was relatively higher in males (12%) than females (10%).. The gut indexes in respect of different seasons, the fish showed highest feeding intensity in rainy season (July to October), compare to other two seasons when their guts were much full (23%). However, the highest percentage of the guts (93%) was empty during summer (March-June). It was showed that empty guts decreased slightly with the increase of size. The full guts were moderately present in the middle-class size group (121-200 mm) and was absent in young (<120 mm) (Fig. 3). It is noticed that middle-sized fishes were more active than the younger fishes as the maximum numbers of empty percentage found in the small fishes. Fishes also showed very low feeding intensity during summer.It may be due to their breeding activities as noticed summer is the peak breeding season. The similar activities were reported by Chaturvedi and Parihar (2014) and they mentioned most empty guts during May to June and this is for the bigger size of the gonads which occupied larger space in the body cavity and allowed a little space for the food. As most of the times its guts were empty, it could say that *X. cancila* is mainly a carnivorous fish.

The stomach analysis of 138 specimens of *X. cancila* revealed that the food consisted of zooplankton, phytoplankton, crustaceans and small fishes which were also found by Chaturvedi and Parihar (2014) and Parihar *et al.* (2016). In the present study the dominant group of diet of *X. cancila* was zooplankton (32%) followed by phytoplankton (20%) which differed from other such studies. The both sexes showed almost similar feeding pattern. Chaturvedi and Parihar (2014) recorded major group as phytoplankton (56.43%) and zooplankton consisted the 2nd largest contributor (26.44%) from Chambal River, India. Parihar *et al.* (2016) also reported that the dominant item was phytoplankton (58.05%) followed by zooplankton (23.39%) from Tighra reservoir, India. However, on the basis of biomass and consideration of other food items like insects, fish, crustaceans along with zooplankton, both of the reporters denoted the fish is carnivorous. In the present study zooplankton, fish and crustaceans represented 65% of the food item occurrence of the fish and hence it could confirm that the *X. cancila* is a carnivorous fish. In addition, Gupta (1971), Bhuiyan (1964) and Word-Cambell *et al.* (2005) documented that the fish feed mostly other fishes. The choice of food items was almost similar in both sexes. However, female choose higher zooplankton than male (Fig. 4). In winter only phytoplankton and zooplankton were noticed while in rainy season, they had different items of food (Fig. 5). The food items of *X. cancila* also were analyzed on the basis of different size classes which are presented in Fig. 6. The larger animals showed higher tendency of being fed on zooplankton and crustaceans. In case of season, zooplankton was found to be maximum in summer season and crustaceans were found maximum in rainy season along with zooplankton. The little seasonal variation in feeding habit might be due to the fluctuation in the availability of different food items in different season (Chaturvedi *et al.*, 2014).

During the study period, among the total collected specimens, the sex ratio recorded 1: 0.77 which represented significant (*P>0.01*) dominant of male over female (Table 1). Though males were of higher percentage in the most of the sampling months but comparatively higher dominancy showed in February (87.5%) and exceptionally the females were higher (62.5%) in the month of July. In contrast, Hossain *et al.* (2013) reported a higher percentage of female (52%) that was not significantly different than that for male in the Ganges River, Northwestern Bangladesh. The sex differences may be due to different location or could be the biasness in harvesting by farmers.

In the present study, it is found that the fishes showed sudden increase in weight at 183 mm total length (Fig. 7) and hence it was considered the maturity size of the species. The fitted regression lines between total body weight and total length for mature and immature female are shown in Fig. 8. The fulcrum represents the point at which two regression lines meet (i.e. breakpoint). The breakpoint occurred female individuals at 180 mm total length. The probit analysis indicates that 50% of the female populations mature at the size of 172.75 mm (Fig. 9). Thus, on an average of three estimating system, it showed the maturity size of female *X. cancila* is 178.58 mm total length. It was not possible to confirm the maturity size as we did not find such published reports on the maturity size of the species.

In the present study, the plotted of mature ovary of *X. cancila* in different months showed that they may breed in summer and rainy season but not in winter season (Fig. 10). However, their peak breeding season may be during summer (April-May) as higher percentage of mature female reported during that time. The breeding season of *X. cancila* was April to September which is supported by other workers (Subba and Meheta, 2012; Bano *et al.*, 2012 and Mian *et al.*, 2017). Bano *et al*. (2012) reported spawning season May to August from Bhopal, India while Mian *et al*. (2017) mentioned that spawning season of the fish in wild ranged from April-August while peak in June from North-East Bangladesh. The short spawning period (June to July) was noticed by the Subba and Meheta (2012) from Nepal. The reproductive periodicity in fishes is guided by several environmental factors together with the endocrine activities. Bano *et al.* (2012) mentioned that both light and temperature are important factors controlling the maturation of gonad in fishes.

Twelve months' observation revealed that the fecundity of *X. cancila*varied from 779 to 2099 with an average 1409 ± 268. This finding was more or less similar to other earlier works. Mian *et al*. (2017) reported fecundity 1328-2234 from North-East Bangladesh and Bhuiyan and Islam (1990) observed that the average fecundity of *X.cancila* was 1432 with the range of 750-2852.

Table 1: The sex ratio (male: female=1:1) of *X. cancila*in different sampling months in greater Jessorearea, south-western Bangladesh.

Months	Obs	% M	% F	M: F	χ2	Significance
April	9	66.67	33.33	1:0.50	1	Ns
May	10	50	50	1:1	0.00	Ns
June	14	50	50	1:1	0.00	Ns
July	16	37.5	62.5	1:0.75	1.00	Ns
August	22	54.55	45.45	1:0.83	0.18	Ns
September	17	64.71	35.29	1:0.55	1.48	Ns
October	11	54.55	45.45	1:0.50	0.09	Ns
November	9	55.56	44.44	1:0.80	0.12	Ns
December	8	62.5	37.5	1:0.60	0.50	Ns

January	6	66.67	33.33	1:0.50	0.66	Ns
February	8	87.5	12.5	1:0.14	4.50	S
March	8	50	50	1:1	0.00	Ns
Total	**138**	**56.52**	**43.48**	**1:0.77**	**9.54**	**S**

Obs=Number of observation; M=Male; F=Female; NS= Non- significance; S=significance

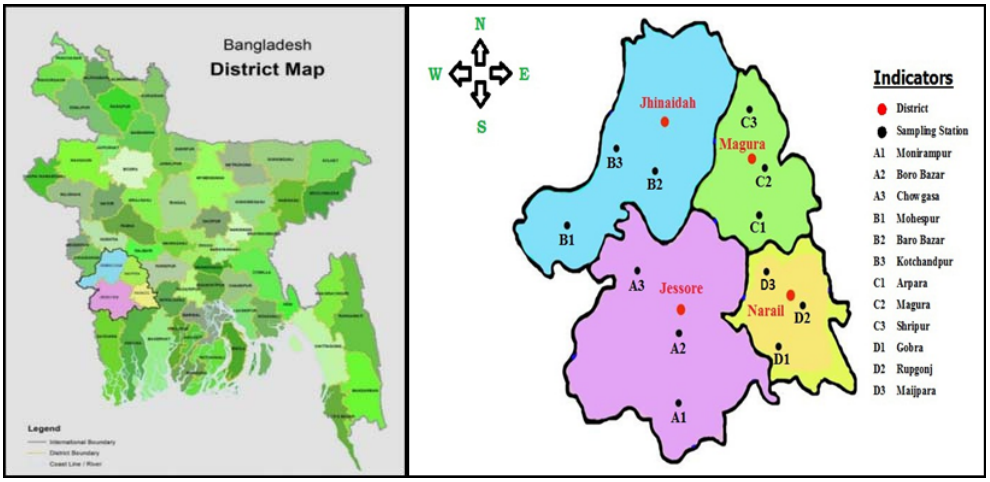

Fig. 1. Map showing Bangladesh (right) and the greater Jessore area (left) along with all districts and sampling stations distinguished as A1, A2…D3

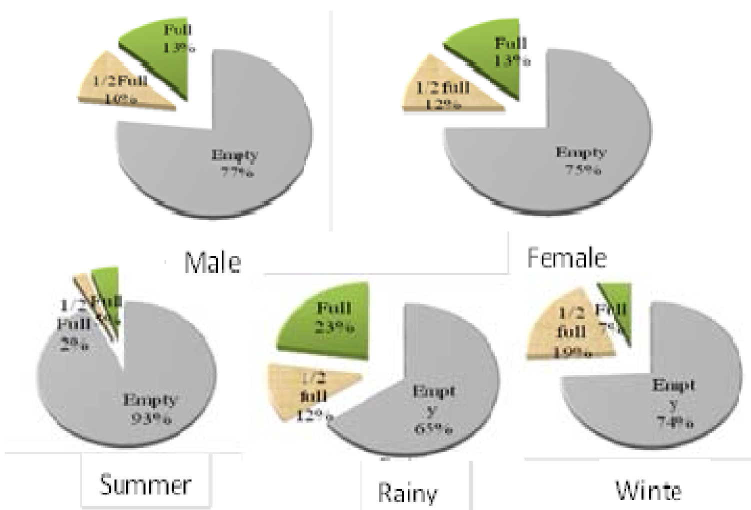

Fig. 2. Gut index of *Xenentodon cancila* in different sexes and season in greater Jessore area, Southwestern Bangladesh.

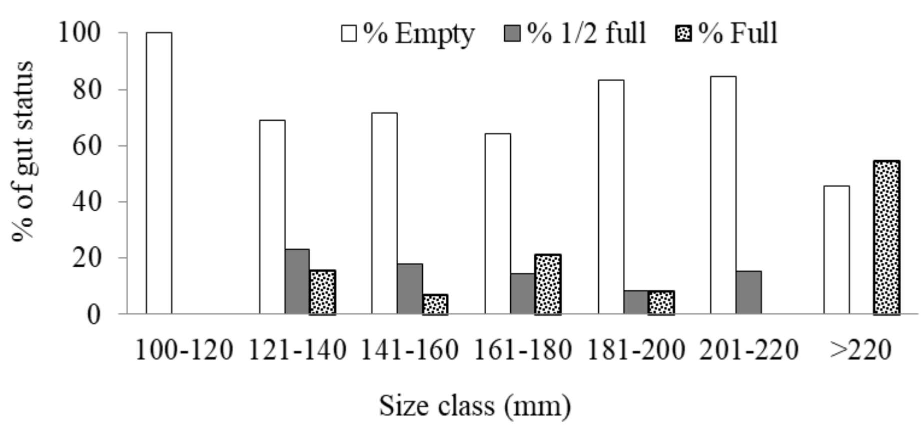

Fig. 3. Gut index of *Xenentodon cancila* on the basis of size class in greater Jessore area, Southwestern Bangladesh.

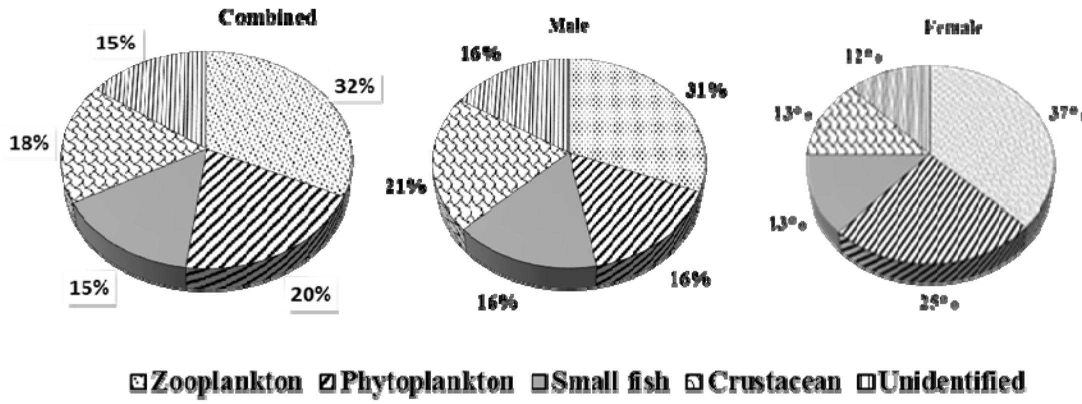

Fig. 4. The major food items of *Xenentodon cancila* in combined and in different sexes.

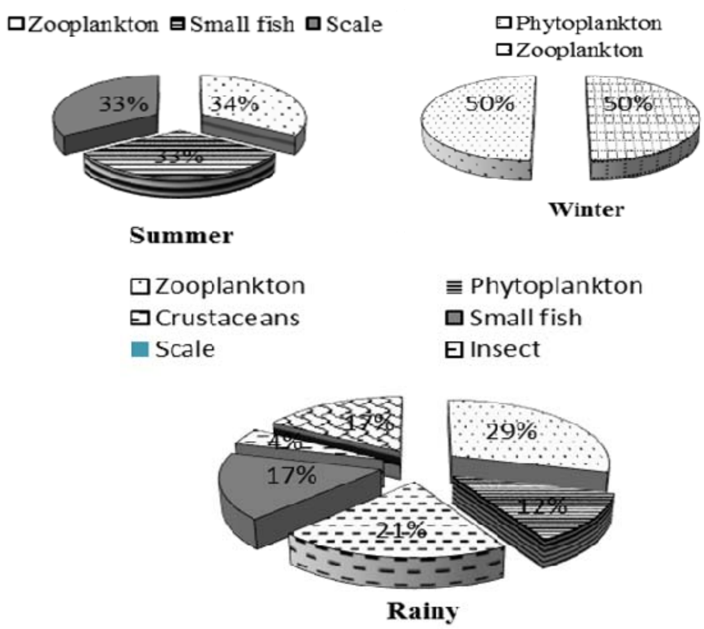

Fig. 5. The major food items of *Xenentodon cancila* in different seasons.

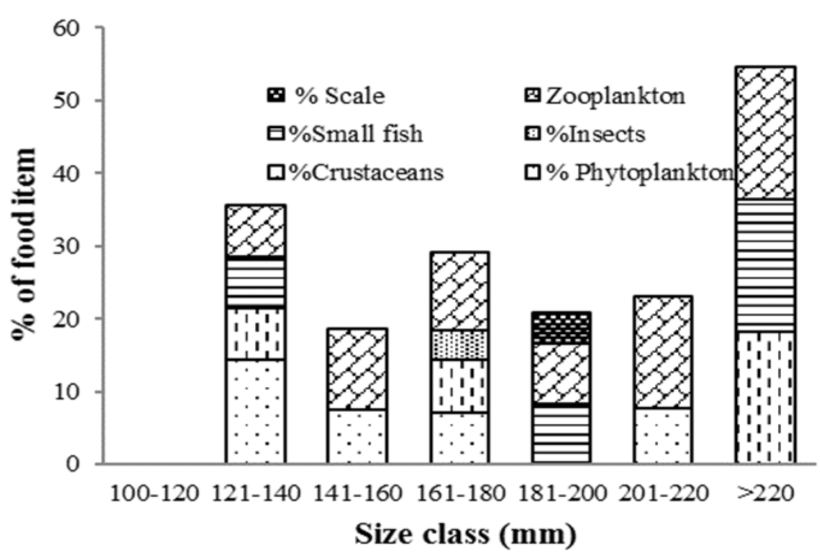

Fig. 6. Food items of *Xenentodon cancila* in different size class recorded from south-western Bangladesh.

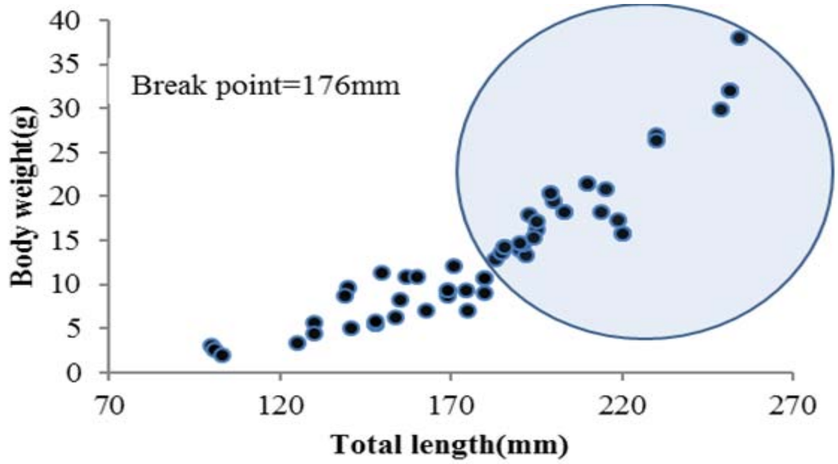

Fig. 7. Modal analysis of female *Xenentodon cancila* which indicated that > 183 mm total length fishes could represent different cluster and hence indicated its maturity size.

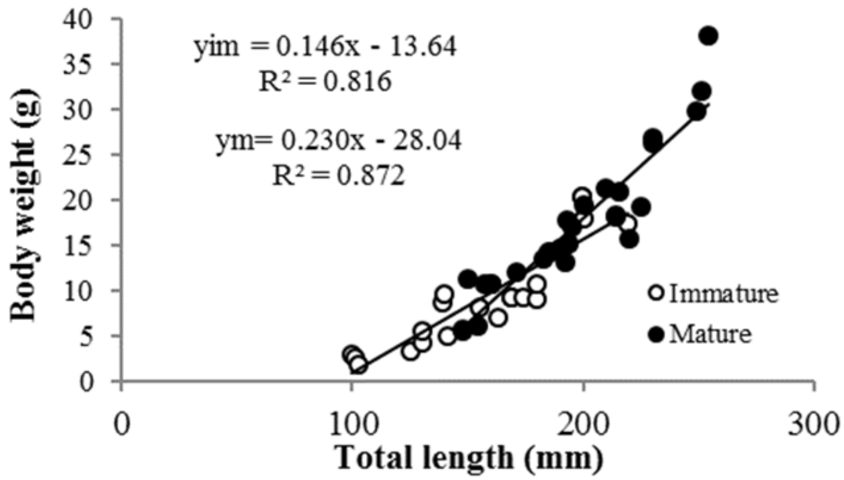

Fig.8. Break point analysis of mature and immature female *Xenentodon cancila*. The fulcrum represents the pint at which two regression line meet and it noticed at the size of 180 mm total length.

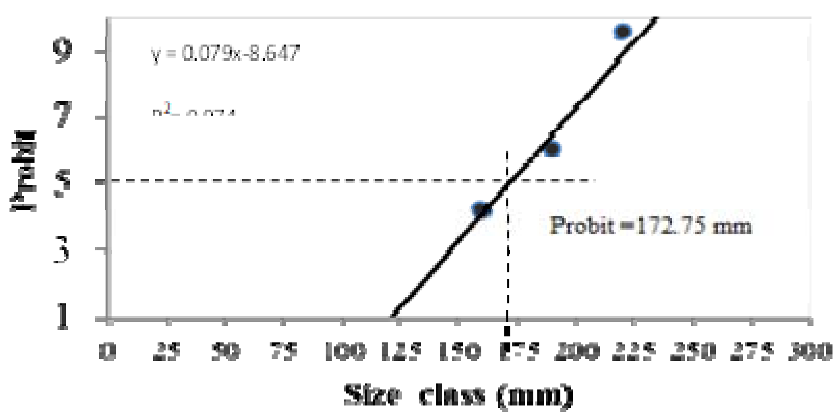

Fig. 9. Probit analysis of female *Xenentodoncancila* which showed 50% female mature at172.75 mm total length from Jessore region, southwestern Bangladesh.

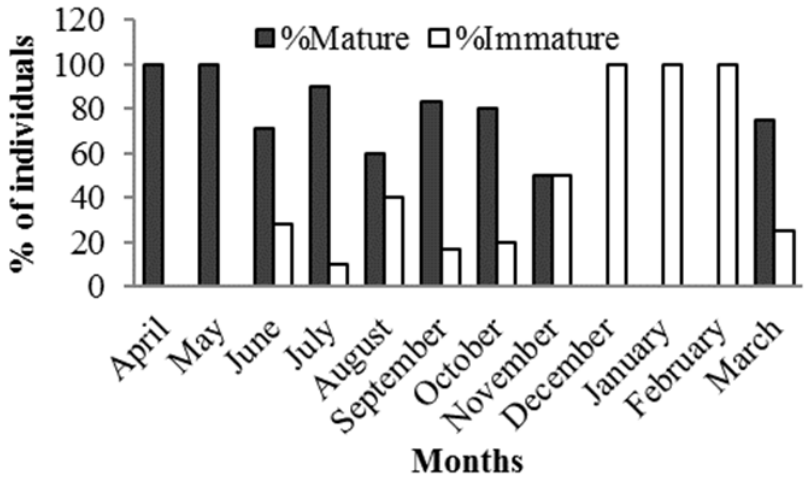

Fig. 10. Breeding season of *Xenentodon cancila* on the basis of maturity percentage of female in greater Jessore region.

CONCLUSION

The gut contents in the present study determined that the species *X. cancila* is a carnivorous fish. The males were significantly (P>0.01) higher in composition (1:0.) than the female. The breeding season of the species is April to September and females get maturity at the size of 178.58 mm of total length. These findings may help fish biologists to manage *X. cancila* fishery in the country of present study (Bangladesh) as well as in nearby territories.

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