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Research Article
Food and Feeding Habit of Reba Carp *Cirrhinus reba* in the Padma River, Northwestern Bangladesh

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Abstract

Background and Objective: Study of food and feeding habit of reba carp *Cirrhinus reba* in river ecosystem is necessary to plan conservation of the fish and propagate it's culture potentiality. The objective of the present study was to give some basic and logical interpretation of feeding nature of *Cirrhinus reba*. **Materials and Methods:** Accordingly, 600 specimens of the fish were collected and analyzed at five different sampling stations of Padma river, Northwestern Bangladesh during January and December, 2016. **Results:** Gut content analyses revealed that the food of *C. reba* consisted principally of Debris, Cyanophyceae, Chlorophyceae, Bacillariophyceae, Euglenophyceae, higher plants, Rotifera, Cladocera, Copepoda, Ostracoda and other unidentified food items. The *C. reba* should thus be classified as omnivorous. However, the index of pre-ponderance and relative gut length indicated plant materials and detritus as the most preferred food item of this fish species. Seasonal effect on diet was also observed. **Conclusion:** It is concluded from this study that *C. reba* can be included in freshwater aquaculture along with other species of fishes.

Key words: Index of preponderance, relative gut length, gastro-somatic index, *Cirrhinus reba*

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Studies on food and feeding habit of fish are essential pre-requisites to plan conservation and investigate aquaculture potential of carp species. Among minor carps, *Cirrhinus reba* is one of the popular food fish and is widely distributed in India, Bangladesh, Pakistan, Nepal, Burma and Thailand[1,2]. It is locally known as "Aikhor or Raikhor" (western part of Bangladesh), "Bangna" (Eastern part of Bangladesh), "Bhangan" (North Western Part of Bangladesh). Currently, *C. reba* has been included under IUCN category "Vulnerable (VU)" due to a decline in its abundance, extent of occurrence, area of occupancy and habitat[3]. However, with its initial quick growth and local market acceptance *C. reba* appears to be a potential species for rearing in pond along with Indian major carps. Therefore, it is necessary to know all the biological aspects, in which knowledge of food and feeding habits constitute a valuable portion[4]. Feeding is the dominant activity of the entire life cycle of a fish[5] and food is the main source of energy which plays an important role in determining the population levels, rate of growth and condition of fishes[6]. The food and feeding habits of fish vary with the time of the day, season, size of fish, various ecological factors and different food substances present in the water body[7]. To the best of author's knowledge, no detailed research work on food and feeding habits in natural waters has been performed on *C. reba* in Bangladesh. Therefore, the present study was designed to deal with the food and feeding habits of *C. reba* and gain knowledge that help to select such species of fish for culture and produce an optimum yield by utilizing all the available potential food of the water bodies without any competition.

MATERIALS AND METHODS

Sampling site and study duration: During the study period, samples of *C. reba* were collected from the commercial catch of fishermen at five different locations of Padma river from Godagati to Chargat, Rajshahi, Bangladesh for a period of one year (from January-December 2016). Name of the sampling station with GPS point were shown in Fig. 1.

Collection, preservation and analysis of gut content: In each sampling station, 10 fishes were collected every month, thereby making a collection of total 50 fishes from all sampling stations per month and overall 600 individuals of *C. reba* during the whole study period. Alimentary canals were dissected out and preserved in 10% alcohol for further study. In the laboratory, the weight of gut of each fish was recorded by electronic balance with 0.01 g accuracy. Total length of the alimentary canal was also measured in centimeter. Gut contents were squeezed out in Petri dish and the food items were identified by naked eye (for macro organisms) and by microscope (for micro or small organisms). The food items were identified according to the guidelines of Ward and Whipple[8] and Prescott[9] and the unidentified materials were grouped under the miscellaneous group. Food in relation to size of the fish was also studied by tabulating percentage composition of varying food items against the size groups. The fishes were categorized into 5 size groups and the intervals of each size groups were kept at minimum level in order to precise observation of food items at each size group.

Index of pre-ponderance: For quantifying the relative importance of all food items, the index of pre-ponderance[10] was calculated according to the following formula:

$$I = \frac{V_I O_I}{\sum V_I O_I} \times 100$$

I = Index of preponderance
V_I = Volume % of a particular food item
O_I = Occurrence % of a particular food item

The frequency of occurrence and volumetric methods were used for the determination of relative importance of the different food items[11]. The percentage frequency of occurrence was estimated as:

$$\text{Frequency of occurrence}(\%) = \frac{\text{Number of fishes with particular food group}}{\text{Total number of fishs with food}} \times 100$$

Estimation of the volume of food by food-group was done by assigning points to each group and percentage points were estimated as:

$$\frac{\text{Point of particular food group}}{\text{Total points of all food group}} \times 100$$

For percentage point method, food categories were assessed on a rank score ranging from 0-100 according to percentage of gut content of each individual as 100 points were allotted to the gut with 95-100% food content, 75 points to more than 65% and less than 95%, 50 points to less than 65% and more than 35% and 25 points to the gut with less than 35 and more than 5% food content, respectively. After that, the number of

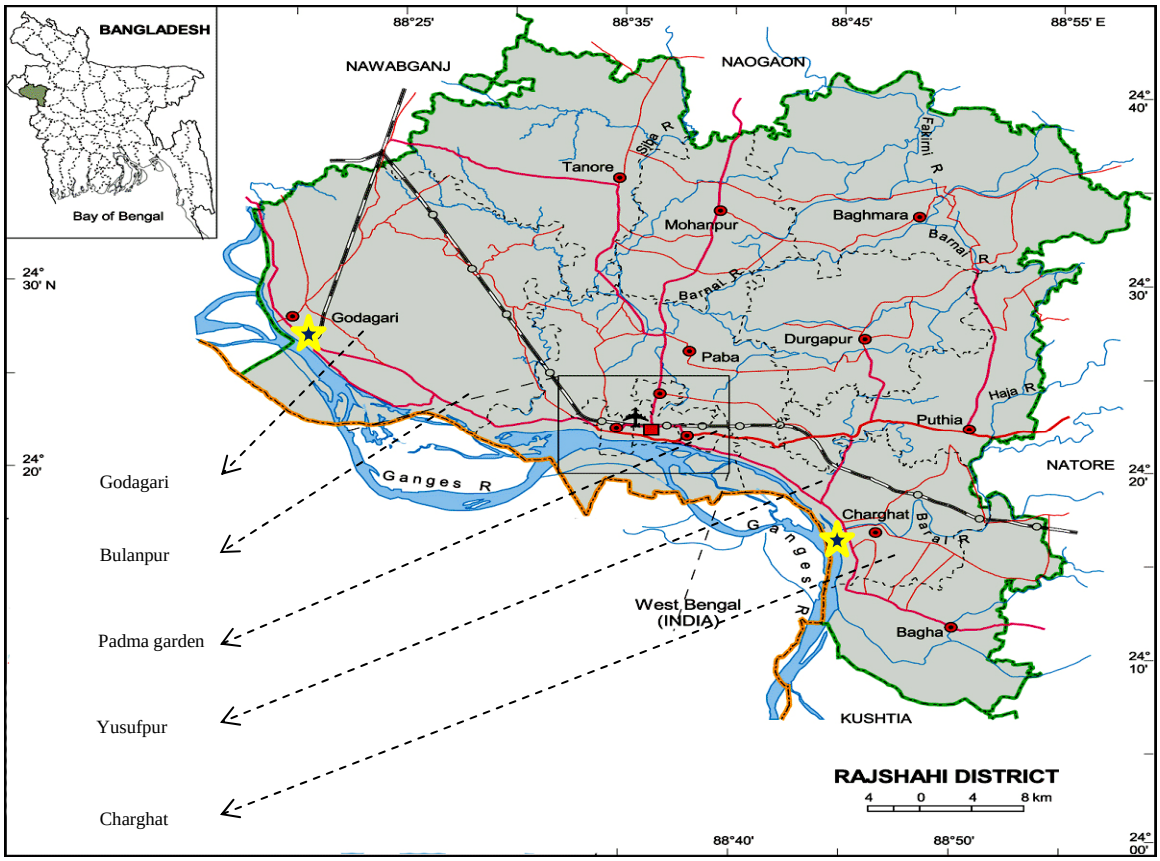

Fig. 1: Location of sampling stations (indicated by yellow stars)
Source: Google map

points that each category received was weighted by multiplying the allotted points to the actual degree of fullness of the gut. The volume of microscopic food items was done by drop count method as followed by Manorama and Ramanujam[12]. In this method, gut content of each sample was diluted with tap water to a known volume from where 10 drops were examined under microscope on a Sedgewick-Rafter counting chamber (S-R cell). The numbers of different food items were counted from 10 fields at different parts of the S-R cell. The relative volume of each food item in each sample was computed by multiplying the proportion of each food item in 10 drops by the total volume of the stomach content.

Relative gut length (RGL): Relative gut length was determined using the method of Hynes[7] using the formula:

$$RGL = \frac{\text{Length of gut (cm)}}{\text{Total length of fish (cm)}} \times 100$$

Gastro-somatic index (GaSI): Gastro-somatic index was evaluated using the computational formula given by Biswas[13]:

$$GaSI\ (\%) = \frac{\text{Total weight of gut (g)}}{\text{Total weight of fish (g)}} \times 100$$

Statistical analysis: A one way ANOVA was employed to test the monthly and size wise differences of fish and gut morphometric, whereas a chi-square (χ^2) test was used to compare the variations of fish and gut morphometric between male and female individuals. All the statistical analyses were performed using SPSS (Statistical Package for Social Science) version 20.0 (IBM Corporation, Armonk, NY, USA) at the significance level of $p<0.05$.

Approval statement: The present study was approved by Institutional Animal Care and Use Committee, Institute of Environmental Science, University of Rajshahi, Bangladesh.

RESULTS

Food items in the gut of *C. reba*: The percentage composition of various food items recorded from the stomach content of *C. reba* during the study period were presented in Table 1. The major food items by percentage were debris, which constitute 45.14% by volume and 100% by occurrence of the total food items. However, other unidentified matters were also found in large quantities. Among the phytoplankton group, Chlorophyceae constitute major portion and among zooplankton, percentage composition of rotifer was the highest. Among other food items, higher plants got the highest position with percentage composition of 16.13% by volume and 77.13% by occurrence (Table 1). The index of pre-ponderance showed detritus as the most preferred food item followed by higher plants, Rotifera, Cladocera, Chlorophyceae, Copepoda, Cyanophyceae, Bacillariophyceae, Ostracoda and Euglenophyceae (Table 1).

Relative gut length (RGL) and gastro-somatic index (GaSI): Monthly variations in morphometric characters of the intestine and gastro-somatic index (GaSI) value together with total length and total weight of *C. reba* obtained during the study period were shown in Table 2. Significant difference ($p<0.05$) was observed in total length (TL), total weight (TW), gut length (GL), gut weight (GW), relative gut length (RGL) and GaSI among different months. During the study period, the average value of GL was highest in the month of August and the lowest in December with a mean value of 36.89±19.08 cm. The mean value of GW was 0.64±0.50 g, whereas the highest value was observed in May and the lowest in November. During the study period, RGL of the studied fish ranged between 3.37±0.66 (June) to 1.83±0.52 (December) with a mean value of 2.73±0.82. During the study period, the mean value of GaSI of *C. reba* was found 2.95±1.47, whereas the highest value was observed in February and in lowest in August.

Length wise variations of total length, total weight, gut length, gut weight, relative gut length and gastro somatic index of *C. reba* was shown in Table 3. Significant difference ($p<0.05$) was observed among the different size group of fishes in their TL, TW, GL, GW, RGL and GaSI. GL and RGL were found to increase from smaller to larger size groups of fishes where GW and GaSI showed uneven distribution among

Table 1: Percentage of composition by volume, occurrence and index of pre-ponderance of food items of *Cirrhinus reba* in the Padma river, Bangladesh

Feed items	Volume (V_i)	Occurrence (O_i)	V_iO_i	Index of pre-ponderance 'I'$= V_iO_i \times 100/\Sigma V_iO_i$	Grading
Debris	45.14	100.00	4514.00	51.46	I
Cyanophyceae	1.67	68.08	113.69	1.30	VIII
Chlorophyceae	4.99	71.99	359.23	4.10	VI
Bacillariophyceae	1.59	65.17	103.62	1.18	IX
Euglenophyceae	0.49	36.19	17.73	0.20	XI
Higher plants	16.13	77.13	1244.11	14.18	II
Rotifera	8.03	77.30	620.72	7.08	IV
Cladocera	5.33	69.77	371.87	4.24	V
Copepoda	4.35	64.24	279.44	3.19	VII
Ostracoda	0.56	42.00	23.52	0.27	X
Others	11.73	95.75	1123.15	12.81	III
			$\Sigma V_iO_i = 8771.09$		

Table 2: Monthly variations (mean±SD) of total length (TL), total weight (TW), gut length (GL), gut weight (GW), relative gut length (RGL) and gastro somatic index (GaSI) of *Cirrhinus reba* in padma river, Bangladesh

Months	TL (cm)	TW (g)	GL (cm)	GW (g)	RGL	GaSI
January	11.62±1.59^{d}	13.31±3.71^{ef}	29.70±12.46^{d}	0.42±0.28^{e}	2.47±0.71^{d}	2.90±1.23^{b}
February	12.73±1.86^{c}	21.07±8.95^{cd}	36.66±12.61^{c}	0.89±0.56^{bc}	2.81±0.51^{c}	3.94±0.91^{a}
March	12.73±1.05^{c}	21.98±4.97^{cd}	36.86±7.88^{c}	0.94±0.34^{ab}	2.87±0.39^{ab}	4.17±0.74^{a}
April	12.62±1.37^{c}	18.50±6.65^{de}	36.12±10.78^{c}	0.74±0.48^{cd}	2.81±0.57^{c}	3.71±1.07^{a}
May	14.26±1.46^{b}	27.35±7.80^{bc}	45.58±13.50^{b}	1.11±0.43^{a}	3.14±0.63^{bc}	3.96±0.71^{a}
Jun	14.75±1.63^{ab}	32.07±11.99^{b}	50.70±14.57^{b}	0.94±0.38^{ab}	3.37±0.66^{a}	2.91±0.64^{b}
July	13.27±1.60^{c}	24.26±8.88^{cd}	38.03±12.27^{c}	0.51±0.43^{e}	2.81±0.61^{c}	2.19±1.87^{cd}
August	15.60±2.80^{a}	45.52±33.36^{a}	54.07±20.01^{a}	0.51±0.42^{e}	3.35±0.69^{a}	1.49±1.60^{e}
September	15.13±4.51^{ab}	50.46±42.95^{a}	52.23±30.24^{a}	0.59±0.44^{de}	3.13±1.13^{ab}	1.91±1.48^{de}
October	10.12±2.96^{e}	13.21±12.16^{f}	24.05±14.56d^{e}	0.57±0.61^{de}	2.20±0.65^{e}	3.76±1.54^{a}
November	9.39±2.12^{e}	8.06±4.66^{f}	19.49±11.19^{e}	0.20±0.24^{f}	1.96±0.55^{ef}	2.09±0.85^{cd}
December	10.09±1.79^{e}	9.16±4.86^{f}	19.15±9.76^{e}	0.21±0.09^{f}	1.83±0.52^{f}	2.42±0.55^{c}
Mean	12.69±2.98	23.75±21.45	36.89±19.08	0.64±0.50	2.73±0.82	2.95±1.47

Values in the same row having different superscript letters are significantly different ($p<0.05$)

Table 3: Length wise variations of total length (TL), total weight (TW), gut length (GL), gut weight (GW), relative gut length (RGL) and gastro somatic index (GaSI) of *Cirrhinus reba* in Padma river, Bangladesh

Size groups	TL (cm)	TW (g)	GL (cm)	GW (g)	RGL	GaSI
6-9	8.18±0.54^{f}	5.40±0.54^{f}	13.96±1.58^{f}	0.13±0.04^{c}	1.71±0.13^{e}	2.42±0.79^{b}
>9-12	11.11±0.72^{e}	13.11±3.19^{e}	23.69±5.30^{e}	0.35±0.19^{c}	2.12±0.38^{d}	2.55±0.99^{b}
>12-15	13.63±0.84^{d}	23.87±5.51^{d}	42.03±7.33^{d}	0.88±0.40a^{b}	3.07±0.39^{c}	3.74±1.51^{a}
>15-18	16.21±0.74^{c}	40.97±10.59^{c}	61.08±6.41^{c}	1.11±0.63^{a}	3.76±0.27^{b}	2.86±1.59^{b}
>18-21	19.83±0.67^{b}	98.86±22.25^{b}	85.22±4.48^{b}	0.80±0.60^{b}	4.30±0.14^{a}	0.95±1.09^{c}
>21-24	22.30±1.12^{a}	125.40±7.09^{a}	97.36±11.90^{a}	0.71±0.12^{b}	4.36±0.34^{a}	0.57±0.07^{c}
Mean	12.69±2.98	23.75±21.45	36.89±19.08	0.64±0.50	2.73±0.82	2.95±1.47

Values in the same row having different superscript letters are significantly different ($p<0.05$)

Table 4: Chi-square test results (mean±SD) of TL, TW, GL, GW, RGL and GaSI between male and female of *Cirrhinus reba* in Padma river, Bangladesh

Variables	Male	Female	Chi-square value*
TL	12.02±2.72	13.45±3.08	0.206
TW	19.09±13.63	28.96±26.79	0.333
GL	33.57±16.87	40.60±20.69	0.495
GW	0.72±0.52	0.54±0.45	0.005
RGL	2.63±0.79	2.84±0.84	0.182
GaSI	3.53±1.26	2.30±1.41	0.023

*Asymp. Sig. (2-sided)

different length groups. The RGL was highest in the size groups of >21-24 cm and GaSI was highest in >12-15 cm size group of fishes. Comparison of gut morphometric characters through Chi-square test showed significant differences ($p<0.05$) in GW and GaSI, while differences of GL and RGL between the sexes are insignificant (Table 4).

DISCUSSION

Cirrhinus reba is an herbivorous fish that actually feeds on plant materials in aquatic environment. In the present study, the gut content of *C. reba* exhibited 11 food groups, among which debris constituted the major portion followed by higher aquatic plants. Similar finding was also reported by Lashari *et al*.[14], who found debris to be the most dominant food items followed by higher plants in the gut content of *C. reba*. Higher percentages of debris in the gut content indicated bottom feeding nature of this fish species. Other investigators[14-16] also reported *C. reba* as bottom feeding fish.

But the percentages of debris were decreased with increase in size groups and subsequently replaced by plant materials especially higher plants. Animal food items occupied a small portion of total gut content of adult *C. reba*. The turning point from pre-ponderance of animal food items to plant food items in *C. reba* was found at >9-12 cm total length. This result is in agreement with Yada[17], who found that the ingestion ratio of zooplankton decreased with increasing of fish total length.

During the study period, the GaSI was found lowest during August which indicated the period of low feeding activity and it seemed to be closely related with maturation of gonads. During this period, fully developed gonads were seen in most of the female individuals, which limited the space in the gut for intake of food. Similar scenario was also observed in case of size variations of fishes where larger size groups exhibited lower values of GaSI and smaller individuals possessed higher values of that index. Variation in GaSI was also more pronounced in females as compared to males and they showed significant variation through Chi-square test. As because the ovaries occupy more space compared to testes such type of variation is obvious. Besides the impact of maturation, lower value of GaSI during the months of June, July, August and September compared to other months was due to high water level and low food abundance in water. Therefore, the GaSI was directly related to the feeding activity and maturation of *C. reba*. Similar observations were also reported by Kumar *et al*.[18] in *Gibelion catla* and Kurup[19] in *Labeodus sumieri* where they showed that the GaSI was fluctuated with feeding intensity and spawning season of these fish species. Dadzie *et al*.[20] also observed low GaSI during spawning period (May to September) of *Pampus argenteus*.

During the study period, RGL with the value greater than 3 were observed during the month of May, June, August and September and the total length of fishes during these months were comparatively higher than other months. Classification of fishes according to size groups also showed that fishes above the size group of >9-12 cm possessed the RGL greater than 3. Therefore, according to the classification of Ward-Campbell *et al*.[21] for cyprinids fish family (RGL 1 indicates carnivorous diet, 1 RGL 3 indicates omnivorous and values of RGL 3 indicate diet based on plant material or detritus) fishes during these months and size groups showed herbivorous feeding nature. This was also proved by the analysis of gut content of fishes where it was observed that larger fishes were intended to feed upon larger amount of plant materials compared to other food items. Similar observation was also reported by Gupta[22], who showed that RGL values increased with increase of vegetable matter in

food and decreased with the increase of animal matter. However, mean value of RGL is 2.73±0.82 which indicated omnivorous feeding nature according to the classification of Ward-Campbell *et al.*[21].

The present study deals with 600 individuals of *Cirrhinus reba*. To get sound knowledge on food and feeding habits of this species, more individuals needs to be exained. Therefore, the present study suggested increase the sampling individuals and wide range of area to get better understanding of the feeding habit of this species.

CONCLUSION

The above findings indicate that *C. reba* in river Padma is an herbivorous fish with highest feeding intensity in summer season followed by winter and lowest in monsoon season. Monsoon is also breeding season of this fish species which influence the feeding habits. The finger lings of *C. reba* prefer zooplankton up to a certain length group and intended to consume plant materials in their adult stage.

SIGNIFICANCE STATEMENT

The present study discovered that based on the feeding nature of *C. reba* in Padma River, this fish can be domesticated in pond aquaculture system. Thus, it would help the farmers in future to increase fish production in freshwater aquaculture system in Bangladesh.

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