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Feeding biology of near threatened small indigenous species dhela, *Osteobrama cotio* (Hamilton 1822)

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Abstract. To get success in culture of any fish species, detail information on food and feeding habit of that particular fishspecies is really crucial. So the present study has been performed toget the information on the food and feeding habit of *Osteobrama cotio*. A total of 30 Genera of food organisms were identified and recorded from the gut content of *O. cotio*, where 29 Genera belong to phytoplankton and one belongs to zooplankton. The percentage of food composition recorded from the gut of the fish were: Bacillariophyceae (12.90%), Chlorophyceae (63.82%), Cyanophyceae (11.32%), Euglenophyceae (8.13%), Rhodophyceae(1.57%), Rotifera (1.43%) and Benthos (0.83%). Chlorophyceae was the most preferred food item and benthos was the least preferred food item of the fish. Gut fullness of the fish was the highest during May and June and the lowest in December. The study results suggest, *Osteobrama cotio* is an omnivorous column feeder with much higher preference for phytoplankton over both zooplankton and benthos. As it is expected that the outcomes of the present study would be useful in the conservation and management of Dhela in the open water and in the domestication in future to pave the way of the aquaculture in captivity of this nutritionally rich threatened small fish of Bangladesh.
Keywords: *Osteobramacotio*, Food habit, Gut content

Introduction

Osteobrama cotio is locally known as Dhela, Mou, Moa, Keti (Bangladesh); Cotio (English) a species of ray-finned fish (Actinopterygii) in the Genus *Osteobrama*. The species has been found in freshwater rivers, ponds and lakes in lower foothill areas throughout Bangladesh (Rahman 1989), Pakistan; Assam, West Bengal, Bihar, Madhya Pradesh, Uttar Pradesh and Punjab in India (Talwar and Jhingran 1991). *O. cotio* is one of the most favorite and tasty fish which was once abundant in Bangladesh.This species is red listed as a near threatened (NT) species by IUCN (2015) due to significant declination of population and if it continues and the threats are not removed the species will face the risk of extinction (IUCN 2015).Dhela is particularly important for its high content of vitamins and minerals. Therefore, scientific information about *O. cotio*is crucial for the conservation of the species.

Food is the main source of energy that determines the population levels, rate of growth and condition of fishes (Begum *et al.* 2008). Feeding is the dominant activity of the entire life cycle of fish (Royce 1972). Fish use a great diversity of organisms as food and these differ in size and taxonomic group. Study of food and feeding habits of fishes have manifold importance in fishery biology and in fisheries management program (Khan and Fatima 1994, Sarkar and Deepak

2009). A quantitative and qualitative analysis of the gut content to determine food and feeding habits of fishes provide necessary information on the food chain, availability of different food sources and feeding rate. It is also useful to evaluate the competition between species and seasonal, geographical or daily variation in food composition and indicates related migration pattern or feeding adaptations in response to the availability of different food sources as well (Lakshmi 2010).This is needed for ecological study and aquaculture systemfor the utilization of all the available potential food of the water bodies without any competition with one another. Dhela, though an important food fish and near threatened (NT), the earlier studies failed to properly include the feeding and breeding biology of this species. There has been dearth of information on the biological aspects of Dhela, which is prerequisite for the efficient management of its stocks. However, to date the feeding biology of Dhela has not been properly studied except Chandra and Haq (1986) and Ali *et al.* (1984). Therefore the present study has been designed to study the feeding biology of this important but threatened fish species with the expectation that the outcome of the study would contribute to the efficient management of wild stocks of *O. cotio* and would pave the ways of its domestication.

Materials and Methods

Fish sample of *O. cotio* were collected from part of the Dhanuriver of Mohanganjupazilla of Netrokona district once in a month from December 2017 to October 2018except January 2018 due to unavailability of fish. Fishes are collected randomly with the help of fine meshed seine net in order to ensure all size group of *O. cotio* population available in the catch.Immediately after collection, the fishes were preserved in 10% formalin in a plastic bottle prevent digestion of food materials and to stop the enzymatic activity of the gut content. Seventeen to twenty one fishes were chosen randomly to study the gut content at each month. The fishes were washed with tape water and soaked with tissue paper. Total Length (TL) and Body Weight (BW) of each fishwere measured to the centimeter for length and gram for body weight.The body cavity of the fishes were carefully openedand the alimentary canal was dissected outand preserved in 10% formalin in a labeled small plastic bottle to analyze gut content. Each gut contents were analyzed separately.

Food contents of the guts were taken out and were diluted in 5 ml distilled water using the method adopted by Miah and Siddique (1992) and Dewan *et al.* (1985). One ml sub sample from 5 ml were transferred by a pipette to a Sedgwick Rafter cell. Ten fields out of 1000 fields of the counting cell were chosen randomly and the total number of plankton found in the 10 fields were counted and multiplied by 500 to get the total number of plankton in the gut. By using a binocular microscope (Olympus BH-2 with phase contrast facilities) all organisms were counted and identified up to genus level.

Four methods namely Numerical method, Frequency of occurrence method, Index of fullness method and Points methods were applied for the determination of food items taken by the fish.All the gut contents were analyzed and total number of individuals in each food categories was recorded and wasexpressed as a proportionof total individual of all food categories (Ikusemiju and Olanian 1977, Crisp *et al.* 1978).Stomach contents were examined and the individual food organisms were sorted and identified to calculate the number of stomach containing one or more individuals of each category. The number of stomachs is then expressed as a percentage of all stomach (Hyslop 1980). An index of fullness of the stomach was recorded

irrespective of size of gut of fishto observe the intensity of feeding. The gut was classified as full, three fourth full, half full, one fourth full and empty gut as suggested by Pillay (1952) and 4, 3, 2, 1, and 0 points were allotted to each gut respectively.The food items wereallotted points on the basis of quantity and all the points assigned to different food items were summed up and scaled down to express them in percentage composition of gut content of all the fishes examined (Hynes 1950).

Results

Food items in the gut contents of *O. cotio:* The result of the gut content analysis of *O.cotio* showed that the fish feed on variety of food items which were broadly categorized as Phytoplankton, Zooplankton and Benthos. A total of 30genera of food organisms were identified and recorded from the gut content of *O. cotio*, where 29 genera belonged to phytoplankton, one belonged to zooplankton and the benthic organisms were unidentified. Among the plankton population five groups were phytoplankton which were Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenophyceae and Rhodophyceae and one group of zooplankton that was Rotiferafound the gut content of *O.cotio*. The food organisms recorded from the gut content of *O.cotio* were presented on Table I.

Table I. Food items found in the gut content of *O. cotio*

Sl. No	Major food groups	Generic status under each group
1	Bacillariophyceae	*Actinella, Cyclotalla, Fragillaria, Navicula, Nitzschia, Surirella* and *Tabellaria*
2	Chlorophyceae	*Actinestrum, Ankistrodesmus, Chlorella, Cosmarium, Closterium, Gonatozygon, Pediestrum, Pleurococcus, Scenedesmus, Sticococcus, Tetradon, Ulothrix* and *Volvox*
3	Cyanophyceae	*Anabaena, Aphanizomenon, Aphanotheca, Mycrocystis, Oscilatoria* and *Spirulina*
4	Euglenophyceae	*Euglena* and *Phacus*
5	Rhodophyceae	*Hildenbrandia*
6	Rotifera	*Notholca*
7	Benthos	Unidentified

Monthly feeding patterns of *O. cotio:* The food items in the gut contents of *O. cotio* have been categorized into seven classes namely Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenophyceae, Rhodophyceae, Rotifera, and unidentified benthos. Results of monthly analysis of gut content following numerical method and points method have been presented in Tables2, and3, respectively. Monthly variation of these food items was observed during the study period of the gut content of *O. cotio* have been presented in Fig. 1.

Occurrence of Bacillariophyceae was observed regularly in the gut of fishes. Their occurrence was maximum (17.82%) in December 2017 and minimum (8.41%) in July 2018.Average percentage of occurrence of Bacillariophyceae was 12.95%. On the basis of points method the occurrence of Bacillariophycea was 19.50% where maximum (21.81%) was in December 2017 and minimum (17.49%) was in July2018.Chlorophyceae was the dominant group represented by thirteen genera and was found throughout the study period in the diet of *O. cotio*. Chlorophyceae made up of average 63.60% of the total gut contents. The maximum

occurrence was 68.33% recorded in June 2018 and minimum was 56.37% in December 2017. On the basis of points method the average contribution to total points was 49.40% where maximum (52.87%) in June 2018 and minimum (44.63%) in December 2017. Cyanophyceae was the third dominant major group of food item during the study period and represented by six genera. Maximum(14.71%) occurrence was observed in December 2017 and minimum (9.82%) in August 2018. The six genera of Cyanophyce contributed average11.35% of total food content of *O. cotio*. On the other hand contribution to total points was 16.93% where maximum (19.31%) contribution observed from October 2018 and minimum (15.74%) was in August 2018. Euglenophyceae contributed8.24% of total diet. Maximum (11.36%) contribution from Euglenophyceae was recorded from October 2018 and minimum (5.43%) from April 2018. On the basis of point method maximum (8.23%) in July 2018 and minimum (5.73%) in June 2018 were found and contributed 6.90% to total points.

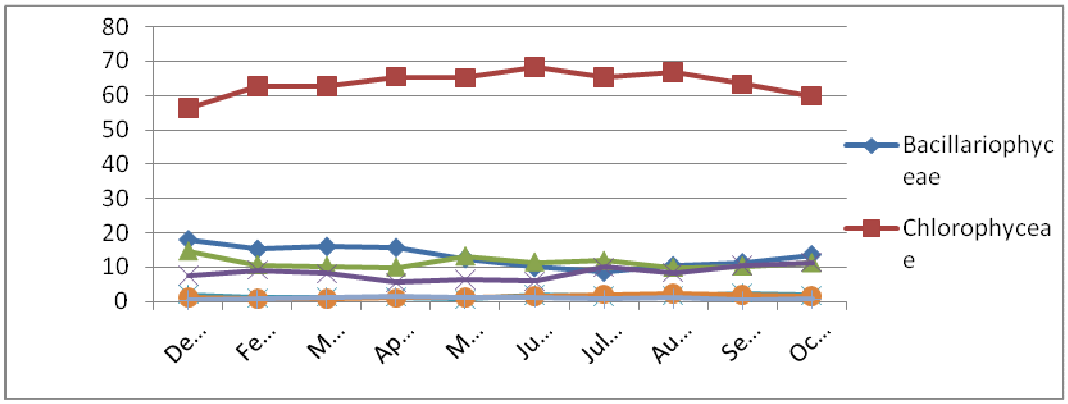

Fig. 1. Monthly variations in the percentage of food items in the gut content of *O. cotio*. The number of fish examined varied between 17 and 21.

Occurrence of Rhodophyceae was maximum (2.42%) in September 2018 and minimum (0.71%) in May 2018. Average contribution of Rhodophyceae to total diets was1.61%. Observation of Rhodophyceae on the basis of points method showed that average contribution tototal points was2.51% where maximum (3.36%) was in December 2017 and minimum (1.84%) in May 2018.

The only representative genus of Zooplankton was Rotifera. Occurrence of Rotifera was highest (2.09%) in July 2018 and lowest (0.84%) in February and March 2018 while 1.44% was the average contribution to total diets.On the basis of points method the average contribution to total points was 2.51% where highest (3.19%) and lowest (2.17%) contribution was in December 2017 and April 2018 respectively.

The least contribution to the total diets of the fish was from unidentified benthic organisms. Benthic organisms contributed an average of 0.81% of total gut content. The maximum amount (1.17%) was recorded in June 2018 and minimum (0.39%) in September 2017. Points method observation showed that contribution of benthic organism to total points was 2.25% and maximum 2.76% and minimum 1.31% observed from May 2018 and September 2018 respectively.

Table 2. Monthly variations in the percent (%) composition of various groups of food items found in the gut of *O. cotio* during the study period

Month	No of fish Examined	Items collected from the gut of *Osteobramacotio*						
		Phytoplankton					Zoopla-nkton	Benthos
		Bacillario-phyceae	Chloro-phyceae	Cyano-phyceae	Eugleno-phyceae	Rhodo-phyceae	Rotifera	Benthos
December	21	17.82	56.37	14.71	7.41	2.18	1.05	0.46
February	19	15.03	62.64	10.63	9.09	1.10	0.78	0.73
March	17	15.85	62.65	10.32	8.11	1.33	0.84	0.90
April	17	15.50	65.47	9.95	5.43	1.32	0.97	1.36
May	17	12.33	65.17	13.23	6.30	0.71	1.23	1.03
June	18	9.74	68.33	11.48	5.80	1.89	1.59	1.17
July	18	8.41	65.36	11.91	10.03	1.61	2.09	0.59
August	18	10.24	66.79	9.82	8.31	1.66	2.28	0.90
September	18	11.17	63.29	10.27	10.54	2.42	1.92	0.39
October	18	13.43	59.9	11.24	11.36	1.83	1.66	0.58
Average		12.95	63.60	11.35	8.24	1.61	1.44	0.81

Table 3. Monthly variations in the percentage (%) of total points of different food categories of *Osteobramacotio* on the basis of points method

Month	No of examined fish	Items collected from gut of *Osteobramacotio*						
		Phytoplankton					Zoopla-nkton	Benthos
		Bacillari-ophyceae	Chloro-phyceae	Cyano-phyceae	Eugleno-phyceae	Rhodo-phyceae	Rotifera	Benthos
December	21	21.81	44.63	18.82	6.71	3.36	3.19	1.68
February	19	19.75	49.74	16.23	7.23	2.47	2.47	2.11
March	17	21.04	48.60	16.03	7.26	2.42	2.23	2.42
April	17	19.89	51.90	15.91	5.42	2.35	2.17	2.35
May	17	19.33	51.57	16.21	6.08	1.84	2.21	2.76
June	18	16.82	52.87	17.01	5.73	2.59	2.39	2.59
July	18	17.49	49.38	17.28	8.23	2.47	2.88	2.26
August	18	19.38	50.48	15.74	6.91	2.30	2.50	2.69
September	18	19.66	49.25	16.85	7.69	2.81	2.43	1.31
October	18	19.88	45.56	19.31	7.72	2.51	2.70	2.32
Average		19.50	49.40	16.93	6.90	2.51	2.51	2.25

Food categories based on percentage of occurrence: On the basis of percentage of occurrence, Chlorophyceae was the dominant group and only group to found in 100% gut of the fishes. Occurrence of Bacillariophyceae, Cyanophyceae and Euglenophyceae were nearly same which were 96.13%, 96.69% and 91.71% respectively in the gut of examined fishes. Rhodophyceae and Rotifera were found to occur 76.24% and 75.14% guts of fishes. The least common type of food group was Benthos which found to occur 66.85% gut of the fishes (Table 4).

Table 4. Composition of the gut contents of *Osteobrama cotio* based on percentage of occurrence

No. of fish examined	Food group	No. of fish in which occurred	Percentage of occurrence
181	Bacillariophyceae	174	96.13
	Chlorophyceae	181	100
	Cyanophyceae	175	96.69
	Euglenophyceae	166	91.71
	Rhodophyceae	138	76.24
	Rotifera	136	75.14
	Benthos	121	66.85

Monthly variation in average index of fullness of *O. cotio:* The values of average index of fullness varied monthly. Highest index of fullness value (4.0) was recorded from May 2018 and June2018 and lowest value (1.19) from December 2017 (Fig. 2). No fishes were found with empty gut during the study period.

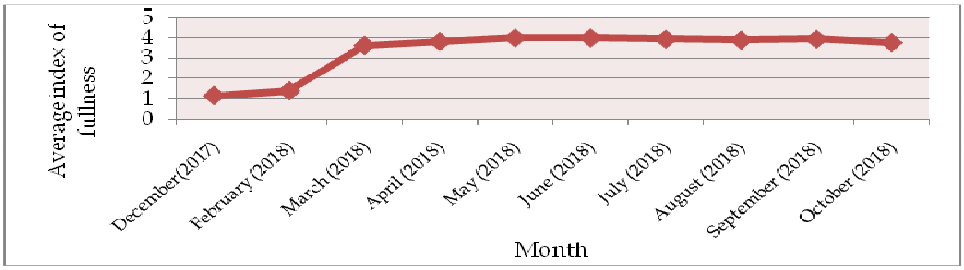

Fig. 2. Monthly variations of average index of fullness.

Seasonal variation of feeding intensity of *O. cotio:* A seasonal variation in feeding intensity of *O. cotio* was observed during the study period. The examined months were classified into four seasons as Winter- November to January, Spring- February to April, Summer- May to July and Autumn- August to September. Feeding intensity was found highest in summer and lowest in winter. *O. cotio* started to feed more from spring and reached peak in summer and then gradually decreased the intensity of feeding (Fig. 3).

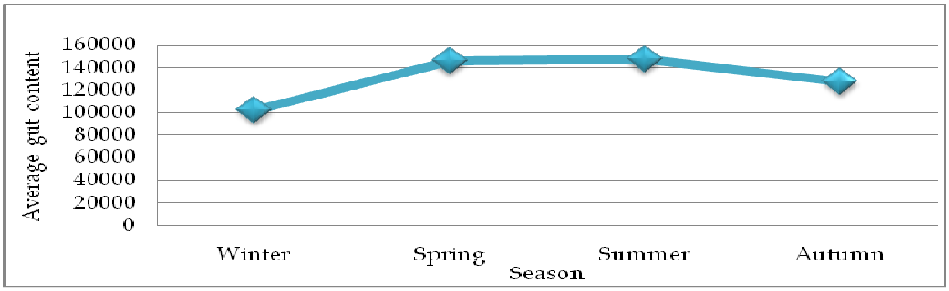

Fig. 3. Seasonal variations in stomach content of the fishes.

Discussion

Present research is conducted to observe the food and feeding habits of small fish *O. cotio*. The present study shows that *O. cotio* feed on diverse food organismswhere phytoplankton (97.75%) was the most dominant group of food itemfollowed by zooplankton(1.44%) and benthic organisms(0.81%).Chandra and Haq (1986) studied the food and feeding habit of *O. cotio* and found that the fish preferred algae, zooplankton and organic debris.While Ali *et al*. (1984) stated that debris was by far the most dominant food groups found in the stomach of *Rohteecotio* both by percentage of occurrence (100%) and percentage of total points (32.87%). Besides debris out of the different food groups Cladocera (100%, 15.53%) and Copepod (92.53%, 13.27%) were the most important food items by both percentage of occurrence and percentage of total points respectively.The results of the present study is not in agreement with Ali *et al*. (1984) but more or less similar with the findings of Chandra and Haq (1986). Gupta and Banerjee (2013) studied food and feeding habits of *Amblypharyngodon mola* and observed Chlorophyceaeasas the most dominant food group (67.15%) followed by Bacillariophyceae (21.99%) and Cyanophyceae (5.62%). They stated *Amblypharyngodon mola* as a herbivorous fish. In a similar study, Mahmud *et al*. (2004) studied in food and feeding habits of Chapila *Gudusia chapra* and reported that Chapilais a plankton feeder and the fish showed highest preference for Cyanophyceae while Bacillariophyceae was negatively selected.

Analysis of gut content of *O. cotio* showed that the food content comprised of Chlorophyceae (63.82%), Bacillariophyceae (12.90%), Cyanophyceae (11.32%), Euglenophyceae (8.13%), Rhodophyceae (1.57%), Rotifera (1.43%) and Benthos (0.83%). Gut ofall the fishes observed in the month of May and June were found to be full,¾ full gut was observed in all months except May and June,½ full gut was observed from December to April and October and ¼ full gut was observed in December and February.Gupta and Banerjee (2013) observed full gut of *Amblypharyngodon mola* from January to July with highest percentages beingobserved from February to April. Fishes with ¾ full gut was observed from January to September with highest percentagesfrom February to April. Fishes with ½full gut was observed all through the season with highestpercentages from May to July and again in Decemberand January. Fishes with ¼ full gut was observedall the season expect in the month of April. Feeding intensity of *O. cotio* varied with the change of seasons.The fishes started feeding more from the Spring to the Summer and gradually decreased from the Autumn to the Winter.From the analysis of gut content of *O. cotio* it might be said that it is a column feeder fish with greater preference for plant origin food (97.74%), which agreed uponthe report of Das and Moitra (1986), Dewan (1973), Shafi and Quddus (1982), Ameen and Rashiduzzaman (1986) and Ahmed *et al*.(1993). From the findings of gut content analysis of the present study, it can be concluded that *O. cotio* is an omnivorous but predominantly herbivorous column feeder fish. The present study provides information on feeding biology of the small indigenous fish species *O. cotio,* which is imperative for the sustainable utilization of this species in the habitats. The study uses basic methods of analysis for food and feeding habits, and calibration of data on feeding intensities can be used as a tool to evaluate variations in feeding intensity in the other impacted habitats as well as in the lotic environment.The outcomes of the present study would be immensely useful in both conservation and management of Dhela in the inland open water and in the domestication to pave the way of the aquaculture of this nutritionally rich important but threatened small food fish of Bangladesh.

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