AMERICAN JOURNAL OF AGRICULTURAL SCIENCE, ENGINEERING AND TECHNOLOGY (AJASET)

ISSN: 2158-8104 (ONLINE), 2164-0920 (PRINT)

VOL: 5 ISSUE: 2 (2021)

PUBLISHED BY: E-PALLI, FLORIDA, USA

The American Journal of Agricultural Science, Engineering and Technology (AJASET) is blind peer reviewed international journal publishing articles that emphasize research, development and application within the fields of agricultural science, engineering and technology. The AJASET covers all areas of Agricultural Science, Engineering and Technology, publishing original research articles. The AJASET reviews article within approximately two weeks of submission and publishes accepted articles online immediately upon receiving the final versions.

Published Media: ISSN: 2158-8104 (Online), 2164-0920 (Print).

Frequency: 2 issues per year (January, July)

Area of publication: Agricultural Science, Any Engineering and Technology related original and innovative works.

EDITORIAL BOARD

American Journal of Agricultural Science, Engineering and Technology

GUT CONTENT ANALYSIS OF *Labeo calbasu* AT DIFFERENT SEASONS IN DEKHAR *HAOR*, SUNAMGONJ, BANGLADESH

F J Munny[1*], M S Uddin[1], M S Islam[2], M T Alam[1], I N Suravi[2], M A Kawsar[1] and N C Roy[3]

DOI: https://doi.org/10.54536/ajaset.v5i2.108

ABSTRACT

This research was conducted to find out the seasonal (monsoon and post monsoon) variation in gut contents of *Labeo calbasu* from June to November, 2016 in Dekhar *haor* of Sunamgonj district, Bangladesh. Three orders of phytoplankton were identified from the gut content *viz.* Bacillariophyceae (11 genera), Chlorophyceae (9 genera), and Cyanophyceae (4 genera). Bacillariophyceae ($6.98\pm1.61\times10^3$cell/L) were identified as the most dominant phytoplankton group. Two types of zooplankton *viz.* crustacean (5 genera) and rotifer (5 genera) were identified. Crustaceans ($0.88\pm0.4\times10^3$cell/L) were identified as the dominant group among zooplankton. Feeding intensity (average index of fullness, Gastrosomatic index) was higher in the post monsoon season compared with the monsoon season. The findings concluded that *L. calbasu* prefers phytoplankton over zooplankton, and the plankton consumption was slightly higher in the post-monsoon season than in the monsoon season. This research is expected to be crucial in the management and conservation of endangered *L. calbasu* in open waters, as well as provide baseline work for future research and open the path for captive aquaculture.

Keywords: Gut content, phytoplankton, zooplankton, haor, *Labeo calbasu*

[1]Department of Aquaculture, Sylhet Agricultural University, Bangladesh

[2]Department of Coastal and Marine Fisheries, Sylhet Agricultural University, Bangladesh

[3]Department of Fish Biology and Genetics, Sylhet Agricultural University, Bangladesh

*Corresponding author: F J Munny**,** Department of Aquaculture, Sylhet Agricultural University, Bangladesh, email: fatema.aq@sau.ac.bd

INTRODUCTION

The freshwater fish, *Labeo calbasu* is a member of the Cyprinidae family of the Cypriniformes order. It is a key component of the commercial fish catch of the Sylhet basin. This fish is an important food fish and is referred to as the "Black Rohu" in several regions (Rana and Jain, 2018). The study of gut content analysis of fishes is crucial for proper culture and management practice of fisheries resources, conservation and ecological studies. Most fish species' nutritional requirements vary as they get older. Changes in the content of dietary living creatures occur at different periods of the year, resulting in a variance in fish stomach content. These alterations might have a significant impact on ecological relationships, notably competition and predation among species, as well as changing the composition of food organisms. As a result, they may have an impact on fish feeding patterns throughout the year.

In the early 1980s, Kalibaus, along with three other IMCs, Rohu (*Labeo rohita*), Catla (*Catla catla), and* Mrigal (*Cirrhinus mrigala)* were extremely significant commercially, but because of a scarcity of seeds from natural or artificial sources, fish farmers lost interest. Over exploitation, habitat destruction, water contamination, dam construction, and a number of other anthropogenic issues have all had a severe influence on the natural populations of this fish species, affecting feeding migration and reproduction (Hasan et al., 2013; Hossain et al., 2010; Das and Barat, 1990; CAMP, 1998). Presently, *L. calbasu* is assessed as least concern (IUCN-Bangladesh 2015) despite the fact that it was formerly deemed endangered in Bangladesh (IUCN-Bangladesh 2000). Considering the issue, immediate measures are essential to protect and conserve this species.

Thus, it is high time to save this species by more study, particularly artificial reproduction. However, in order to achieve these goals, this fish must first be domesticated, which requires knowledge of its gut content as well as feeding biology. Apart from this limited data on the fish's population and nutrition, no published data on the gut content of *L. calbasu* has been found in Bangladesh, especially from the Sylhet basin. In consideration of this predicament, research was conducted to learn more about this species' gut content in the hopes that the results may aid in the effective management of *L. calbasu* wild populations, pave the road for domestication, and provide a baseline for future research.

MATERIALS AND METHODS

The research work was done with the fishes of the Dekhar *haor*, which is located at Dakshin Sunamgonj upazilla in the Sunamgonj district of Bangladesh. Approximately 10 to 12 fishes

were collected randomly from different fishermen of Purbo Pagla Bazaar, which were harvested from Dekhar *haor* in each month (June to November, 2016) for microscopic and macroscopic observation of gut contents. In the laboratory, the fish were thoroughly cleaned with running tap water and soaked in tissue paper. Each fish's body weight (BW) was measured in grams using an electric balance (Ohaus corp., USA). The sample was dissected from the ventral side of the fish and stretched interiorly along the belly of the fish to the head area. The gut weight of fish was measured in grams using an electric balance after it was dissected. Each gut's macroscopic condition was examined with naked eyes. The guts were then stored in a tiny plastic vial with 10% formaldehyde for microscopic examination of the stomach contents.

Index of fullness method

This method was used to track the feeding intensity. The gut of the fish was categorized as full, three-quarter full, half full, and one-fourth full and empty using this approach, as proposed by Pillay (1952).

Gastrosomatic index

The gastrosomatic index (GaSI) was used to track feeding intensity on a monthly basis.

$$\text{GaSI} = \frac{\text{weight of gut}}{\text{weight of fish}} \times 100$$

Microscopic observation of the gut

The contents of a gut were collected and diluted in 10 ml of distilled water using the procedures of Miah and Siddique (1992) and Dewan et al. (1985). From a 10 ml sample, a pipette was used to transfer a one ml sub-sample to a Sedgewick-Rafter cell. Of a total of 1000 fields in the counting cell, ten fields were selected at random, and the total number of planktons detected in those ten fields was counted and multiplied by 1000. All species have been identified to genus level using a binocular microscope (Olympus, model-CX41RF) using keys from Prescott (1962), Belcher and Swale (1976), and Bellinger (1976).

The formula for calculating plankton in a concentrated sample is as follows:

$$\text{N} = \frac{\text{A} \times 100 \times \text{C}}{\text{V} \times \text{F} \times \text{L}}$$

Where,

N= Number of plankton cell

A= Total number of planktons counted

C= Volume of final concentrated sample in ml

V= Volume of a field in cubic mm

F= Number of fields counted

L= Volume of original water in litter

Volumetric measurement

Volume is a good way to analyze herbivorous and mud-feeding fishes, as Hynes (1950) pointed out, because numerical techniques "become meaningless as well as incorrect." The following methods were used to determine the number of food items found in the gut contents of *L. calbasu*:

1) **Eye estimation method:** This is arguably the simplest method of calculating the volume of food components. The results of this type of analysis are subjective, and they can be swayed significantly by the researcher's personal convictions. Expertise gained via the analysis of large samples and frequent evaluation of estimated values in the same sample can reduce this complication. This estimating approach is an alternative to the numerical method for analyzing diets with food components that cannot be enumerated, such as plant material and detritus.

2) **Points (Volumetric) method:** Rather than assessing proportion by appearance, as in the previous technique, every foodstuff in the gut is given a numerical value depending on its volume. The following formula was used to compute the percentage volume within each sub sample:

$$\alpha = \frac{\text{Number of points allocated to component } \alpha}{\text{total points alloted to subsamples}} \times 100$$

Where, α is the percentage volume of the prey component α.

RESULTS AND DISCUSSION

Different parameters of wild *Labeo calbasu*

The average weight of fishes ranged from 125.6±43.52 to 192±19.81g where the average gut weight ranged between 7.24±2.25 and 12.48±1.45 which are presented in Table 1.

Table 1. Observation of different parameters of *Labeo calbasu* at different seasons at Dekhar *haor* in Sunamgonj

Months	Weight of fish(g)	Weight of gut(g)	GaSI*
Monsoon			
Jun	172.1±26.02	8.21±1.82	4.55±0.50
Jul	176.91±31.44	8.32±1.62	4.70±0.41
Aug	125.6±43.52	7.24±2.25	4.97±0.22
Sep	164.54±25.38	8.21±1.19	5.0±.0.22
Post Monsoon			
Oct	186.54±19.66	12.08±1.42	6.47±0.38
Nov	192±19.81	12.48±1.45	6.49±0.16

*GaSI: Gastro somatic index

Gastrosomatic index

The Gastrosomatic index (GaSI) was measured on a monthly basis, which was compiled in Table 1. It ranged from 4.55±0.50 (June) to 6.49 ±0.16 (Nov) (Table 1). The average GaSI in the monsoon was 4.8 and in the post monsoon it was 6.48 (Table 3**)**. Prakash (2015) noticed quantitative variance in food contends during the investigation, which was confirmed by an examination of the GaSI. It was found that the gastrosomatic index was lowest (3.425±0.152) during the monsoons and highest (5.874±0.145) during the post-monsoon season, with an annual average of 4.257±0.141. The findings showed that the fish consume voraciously during the monsoon season, i.e. the spawning season, and quickly rise after spawning, i.e. post monsoon season, to compensate for energy loss during the breeding season (monsoon season).As a result, decreased gastrosomatic index values during the research period may be attributed to gonadal maturation. Similar findings were reported by Rao et al. (1998) on Channa, Hatikakoty and Biswas (2003) on Tilapia, and Lalit et al. (2015) on Catla. Sarkar and Deepak (2009) assessed the gastrosomatic index of *Chitala chitala* and found that it was highest during the pre-monsoon and lowest during the monsoon season.

Table 2. Percentage of empty gut and averages index of fullness at different seasons at Dekhar *haor* in Sunamgonj

Months	No. of fish Examined	Feeding intensity (%)					Average index of fullness
		Full	1/2Full	1/4 Full	3/4 Full	Empty	
Monsoon							
Jun	10	10	10	40	10	30	1.34
Jul	11	9.09	18.18	36.36	9.09	27.27	1.27
Aug	10	20	30	20	10	20	2
Sep	11	18.18	27.27	18.18	18.18	18.18	2
Post Monsoon							
Oct	11	36.36	36.36	18.18	9.09	0	3
Nov	12	50	8.33	8.33	33.33	0	3.25

Table 3. Gut content of *L. calbasu* at different seasons at Dekhar *haor* in Sunamgonj

Season	GaSI	Average index of fullness	Percentage of full gut	Percentage of empty gut
Monsoon	4.8	1.65	14.32%	0%
Post Monsoon	6.48	3.13	43.18%	23.86%

Guts in different degrees of fullness

The percentage of an empty gut was absent in the post-monsoon months. The proportion of full gut was noticed to be higher (36.36%) in October and 50% in November (Table 2**)** and the average percentage of full gut was 43.18% in the post monsoon months (Table 3**).** It indicates the high intensity of feeding in the post-monsoon months. These results strongly concur with the research findings of Kumar and Siddique (1989). A minimum intensity of feeding was noticed during the monsoon months (June to September) and most of the gut either contained little food or was empty. The feeding activity rose in October and active feeding was recorded up to February. From March, the feeding intensity started declining and has fallen to its lowest value in the monsoon months.

Average index of fullness

November had the highest index value (3.25) while June had the lowest (1.27) and the average value in the monsoon was (1.65) and post monsoon was (3.13) (Table 3). The averages in the fullness index varied, indicating seasonal variations. According to Rahman (2013), the greatest index value (4.00) was recorded in September and October, while the lowest (3.20 percent) was reported in January. It might be related to the growth of the gonad, which takes up the majority of the abdominal cavity. The prevalence of mature fish feeding decreases during the breeding season compared to non-season, as reported by Ujjania (2003).

Food items found in the gut of *L. calbasu* at different seasons in Dekhar *haor*

Phytoplankton: During the research period, the stomach contents of the investigated fishes resulted in a total of 25 phytoplankton genera belonging to three planktonic groups. Bacillariophyceae, Chlorophyceae, and Cyanophyceae are the three primary planktonic groupings discovered. According to Vinci and Sugunan (1981) and Gupta (2001), the most common phytoplankton group was Bacillariophyceae.

Bacillariophyceae: Eleven genera of Bacillariophyceae were identified in the gut content of the fish**.** Among the phytoplankton groups, Bacillariophyceae was found to hold the first position in terms of numbers in the gut. Bacillarioceae were found to occur regularly in the guts of examined fishes (*Cyclotella sp., Amphora sp., Fragilaria sp., Cymbella sp., Gyrosigma sp., Gomphonema sp., Melosira sp., Navicula sp., Tabellaria sp., Nitzschia sp., Synedra sp*.). Their maximum amount (55%) was found in October and the minimum (41%) was found in July and the group in a total formed (48%) of the gut contents among phytoplankton. Ahmed et al. (1993) identified four genera of *Bacillariophyceae*. Shafiqul (2000) investigated the food and feeding habits of Dhela (*Osteobrama cotio*) and found that Bacillariophyceae accounted for 17.57 percent of the primary food items. The occurrence of Bacillariophyceae gradually increased from monsoon to post monsoon and the maximum occurrence ($9\pm1.61\times10^3$cell/L) was found in the month of October and the lowest ($4.8\pm1.61\times10^3$cell/L) was found in July (Table 4).

Chlorophyceae: The Chlorophyceae family includes the genera (*Cosmarium sp., Ankistro desmus, Scenedesmus sp., Coelastrum sp., Pediastrum sp., Oedogonium sp., Spirogyra sp., Ulothrix sp., Zygnema sp.*) The present study revealed that phytoplankton belonging to Chlorophyceae was the second dominant group in the gut of fish (Table 4). There were nine genera and formed the second most abundant group and made up (41%) of the gut contents among the phytoplankton. Ahmed et al. (1993) identified 15 different genera. In the current

investigation, (7.1±0.66×10^{3}cell/L) was identified in November and (5.3±0.66×10^{3}cell/L) was discovered in August. The largest percentage of Chlorophyceae (49%) was discovered in July, while the lowest amount (37%) was discovered in October (Table 4).

Table 4. Plankton number (×10^{3}cell/L) found in the gut of *L. calbasu* at different seasons at Dekhar *haor* in Sunamgonj

Group	Jun	Jul	Aug	Sep	Oct	Nov	Mean± SD
	Monsoon				Post Monsoon		
Chlorophyceae	5.6 (38)	5.8 (49)	5.3 (31)	5.4 (40)	6.1 (37)	7.1 (41)	5.88 ± 0.66
Bacillariophyceae	7.2 (49)	4.8 (41)	6.2 (45)	6.1 (37)	9 (55)	8.6 (50)	6.98 ± 1.61
Cyanophyceae	1.8 (12)	1.2 (10)	2.2 (16)	1.9 (14)	1.2 (7)	1.5 (9)	1.63 ± 0.40
Total phytoplankton	**14.6 (95)**	**11.8 (88)**	**13.7 (8)**	**13.4 (92)**	**16.3 (92)**	**17.2 (91)**	**14.5 ± 1.98**
Crustacea	0.3 (43)	0.7 (44)	0.8 (44)	0.7 (58)	0 (0)	0.6 (37)	0.51 ± 0.31
Rotifera	0.4 (57)	0.9 (56)	1 (56)	0.5 (42)	1.5 (100)	1 (62)	0.88 ± 0.4
Total zooplankton	**0.7 (5)**	**1.6 (12)**	**1.8 (12)**	**1.2 (8)**	**1.5 (8)**	**1.6 (9)**	**1.4 ± 0.39**
Total content	**15.3**	**13.4**	**15.5**	**14.6**	**17.8**	**18.8**	**15.9 ± 2.02**

Cyanophyceae: The Cyanophyceae family includes the genera *Anabena sp., Oscillatoria sp., Microcystis sp., Phormidium sp., and Anabena sp*. Four genera represented this group and were found to occur throughout the study period. Among the phytoplankton, Cyanophyceae was found to be the lowest group and made up 11.24% of the gut contents. The number of planktons in this group ranged from 1.5±0.40×10^3 to 2.2±0.40×10^3 cell/L. Chowdhury et al. (2007) found the abundance of cyanophyceae was highest in September and lowest in December-January. In this study, the highest percentage (16.06%) of Cyanophyceae among phytoplankton were found in August and the lowest percentage (7.36%) were found in the month of October (Table 4).

Zooplankton recorded in the gut of *L. calbasu*: Two planktonic groups of zooplankton were identified in the gut content of *L. calbasu, viz.,* crustaceans and rotiferans. Alam et al. (2002) found seven species of zooplankton. Laghari et al. (2015) discovered that zooplankton (Protozoan larvae, Dipteran larvae, Rotifers, Cladocerans, and Crustaceans appendages) and fish eggs made up 0.67 percent of the overall food content. Throughout the year, it was present in small quantities.

Crustaceans: About 5 genera of crustaceans were identified in the diets of fish. Dewan et al. (1991) identified five genera of Crustacea. In the present study, the abundance of crustaceans was higher (0.8 ±0.31×10^3cell/L) in August and was absent in October. This group made up 37% of gut content among zooplankton. Chowdhury et al. (2007) found the Crustacean was the most prevalent zooplankton category, accounting for 71% of the overall zooplankton population.

Rotifers: Five genera, namely *Brachionus, Trichocerca, Asplanchna, Notholca,* and *Keratella,* belong to this group and were identified in the diets of fish throughout the year. Chowdhury et al. (2007) identified five genera of Rotifera. In the current study, the highest number of Rotifers (1.5±0.4× 10^3cell/L) was identified in the month of October and the lowest (0.4±0.4×10^3cell/L) in June. This group made up 63% of gut content among zooplankton. The abundance of rotifers was high in the post-monsoon season and low in the monsoon season.

Percentage volume of different food items

In the current study, the average percentage of gut content was 70.88% detritus, 11.81% mud, 8.3% Bacillariophyceae, 6.75% Chlorophyceae, 1.73% Cyanophyceae, 0.45% Rotifera, 0.24% Crustaceans, and 0.08% miscellaneous. There is a lot of similarity between the current observations and those of the pioneers. Organic detritus matter was discovered to be the most preferred diet at 80.72 percent, followed by Bacillariophyceae 8.89 percent, dirt 7.08 percent, Chlorophyceae 7.08 percent, and Cyanophyceae 2.98 percent. The diet and feeding behaviors of carp (*L. calbasu*) were examined by Laghari et al. (2015). According to his observations, *L. calbasu* feeds predominantly on organic debris (71.98%), followed by sand and mud particles (8.56%), blue-green algae, diatoms, and zooplankton.

Table 5. Percentage volume of different food items found in gut of *Labeo calbasu* at different seasons at Dekhar *haor* in Sunamgonj

Months	Detritus	Mud	Bacillario-phyceae	Chloro-phyceae	Cyano-phyceae	Rotifera	Crustacean	Miscellaneous
				Monsoon				
Jun	64.74	16.18	8.84	7.49	2.02	0.25	0.21	0.27
Jul	78.15	8.38	4.48	5.17	3.31	0.29	0.22	-
Aug	71.68	13.44	6.36	4.74	2.86	0.37	0.31	0.23
Sep	71.59	13.42	7.6	5.45	1.43	0.25	0.26	-
Average	**71.54**	**12.85**	**6.82**	**5.71**	**2.40**	**0.29**	**0.25**	**0.25**

				Post Monsoon				
Oct	71.18	9.12	11.57	6.56	0.27	1.16	-	-
Nov	68.35	10.5	11.02	8.96	0.51	0.37	0.29	-
Average	**69.76**	**9.81**	**11.29**	**7.76**	**0.39**	**0.76**	**0.29**	**-**

Detritus: It was made up of unidentifiable plants and animal debris that was found frequently in the intestines throughout the year and served as the major food source in the gut contents (70.88% by volume). In June, a minimum of 64.74 percent was observed (Table 5). According to Singh and Singh (2000), *L. calbasu* feeds mostly on organic debris, which was found in the stomach contents of more than 80% of the animals examined and the stomach content was noticed to be changed on a monthly basis.

Mud mixed with sand: This item occurred throughout the gut contents, ranging between 8.38% in July to 16.18% in June by volume (Table 5). The average percentage was 11.81% by volume. Kumar and Siddique (1989) explained that sand and mud particles formed 12.24%, 11.76%, 11.32%, and 5.40% of the total gut contents of the river Ganga, Yamuna, Kali, and reservoir fishes, respectively. In the current investigation, a lot of sand and mud was detected in the guts of the fish in June, August, and September. The rest of the three months have seen a considerable amount of sand and mud. The mud in the gut came from the decaying organic waste that had been deposited on the bottom's sand and mud.

CONCLUSION

This study establishes a crucial baseline for the feeding biology of *L. calbasu*. The current research on *L. calbasu* gut content analysis revealed that the fish is a bottom feeder that feeds on decaying organic materials. The percentage of empty guts and the index of fullness showed seasonal fluctuation, with the number of empty guts being absent in post monsoon months and greater in monsoon months, and the index of fullness being higher in the post monsoon season than in the monsoon season. The study's findings would be a useful tool for conservation biologists, and managers to develop early management methods for the long-term protection of this species' populations. This aids in the selection of appropriate species for cultivation with the least amount of interspecies competition for natural food. It also gives crucial information for designing additional feed for this species.

ACKNOWLEDGMENT

The authors would like to thank the fishermen of Dekhar *haor* for their assistance in obtaining the specimens.

CONFLICT OF INTEREST

There are no conflicts of interest declared by the authors.

REFERENCES

Ahmed, A.T.A., Rahman, M.M., Mustafa, G. and Sanaullah, M., 1993. A comparative study of food and feeding habits of three species of fish from "Beel Mamud", Faridpur. *Bangladesh J. Zool*, *21*(1), pp.11-21.

Alam, M. T., S. M. Rahmatullah, M. S. Alam, and M. F. Rahman., 2002. Food and feeding habit of *Gudusiachapra* (Hamilton). *University Journal of Zoology, Rajshahi University*, *21*, 41-44.

Belcher, H. and Swale, S., 1976. A beginner's guide to freshwater algae. Institute of terrestrial ecology. Natural Environment Research Council.

Bellinger, E.G., 1992. *A key to common algae: Freshwater, estuarine and some coastal species*. London: institution of water and environmental management.

CAMP. 1998. Conservation assessment and management plan for freshwater fishes of India. In: Workshop Report. Molur, S. and Walker, S. (eds.). Zoo Outreach Organization, Coimbatore/CBGS and NBFGR, Lucknow, India, 158 p.

Chowdhury, M.M.R., Mondol, M.R.K. and Sarker, C., 2007. Seasonal variation of plankton population of Borobila beel in Rangpur district. *University journal of zoology, Rajshahi University*, *26*, pp.49-54.

Das, P. and Barat, A., 1990. Fish habitat degradation necessitating conservation. *Environmental series*, *4*, pp.85-89.

Dewan, S., Miah, M.J.U. and Uddin, M.N., 1985. Studies on the food and feeding habits of *Cyprinus carpio II*. diel and seasonal patterns of feeding of the fish. *Bangladesh Journal of Aquaculture (Bangladesh)*.

Dewan, D., Wahab, M.A., Beveridge, M.C.M., Rahman, M.H. and Sarkar, B.K., 1991. Food selection, electivity and dietary overlap among planktivorous Chinese and Indian major carp fry and fingerlings grown in extensively managed, rain-fed ponds in Bangladesh. *Aquaculture Research*, *22*(3), pp.277-294.

Gupta, M.D., 2001. Morphological adaptation of the alimentary canal of four *Labeo* species in relation to their food and feeding habits. *Indian Journal of Fisheries*, *48*(3), pp.255-257.

Hasan, M., Nahiduzzaman, M., Hossain, M.A.R. and Alam, M., 2013. Population genetic structure of an endangered kalibaus, *Labeo calbasu* (Hamilton, 1822) revealed by microsatellite DNA markers. *Croatian Journal of Fisheries: Ribarstvo*, *71*(2), pp.65-73.

Hatikakoty, G. and Biswas, S.P., 2003. Food and feeding habits of *Oreochromis mossambicus* (Peters) from a sub-tropical environment. *J. Inland Fish. Soc. India*, *35*(2), pp.57-61.

Hossain, M.A., Nahiduzzaman, M.D., Saha, D., Khanam, M.U.H. and Alam, M.S., 2010. Landmark-based morphometric and meristic variations of the endangered carp,

kalibaus *Labeo calbasu*, from stocks of two isolated rivers, the Jamuna and Halda, and a hatchery. *Zoological studies*, *49*(4), pp.556-563.

Hynes, H.B.N., 1950. The food of fresh-water sticklebacks (*Gasterosteus aculeatus* and *Pygosteus pungitius*), with a review of methods used in studies of the food of fishes. *The journal of animal ecology*, pp.36-58.

IUCN, Bangladesh. 2000. Red book of threatened fishes of Bangladesh. In MA Islam, M Ameen, A Nishat, eds. Dhaka, Bangladesh: The World Conservation Union (IUCN).

IUCN Bangladesh. 2015. *Red List of Bangladesh Volume 5: Freshwater Fishes.*IUCN, International Union for Conservation of Nature, Bangladesh Country Office,Dhaka, Bangladesh, pp xvi+360.

Khumar, F. and Siddiqui, M.S., 1989. Food and feeding habits of the carp *Labeo calbasu* Ham. in north Indian waters. *Acta ichthyologica et piscatoria*, *19*(1).

Laghari, A.M., Narejo, N.T., Jalbani, S., Dastagir, G. and Khan, P., 2016. Studies on Food and Feeding Habits of Carp, *Labeo calbasu* from Keenjhar Lake District Thatta, Sindh, Pakistan. *Sindh University Research Journal-SURJ (Science Series)*, *47*(1).

Lalit, K., Sharma, B.K., Sharma, S.K., Upadhyay, B. and Mishra, V., 2015. Food and feeding habits of *Catla catla* (Hamilton) from lake Udai sagar, Udaipur. *International Journal of Fauna and Biological Studies*, *2*(5), pp.06-08.

Miah, M.J.U. and Siddique, W.H., 1992. Studies on the food and feeding habits of mola, *Amblypharyngodon mola*. *Bangladesh Journal of Agricultural Sciences*, *19*(2), pp.165-170.

Pillay, T.V.R., 1952. A critique of the methods of study of food of fishes. *Journal zoology Society India.*, 4: 1885-200.

Prakash, S., 2015. Seasonal variation in food and feeding habit of Indian major carp (*Labeo calbasu*) in Baghel Taal, Bahraich, UP. *UP International Journal of Fisheries and Aquatic Studies*, *3*(2), pp.483-486.

Prescott, G.W., 1962. Algae of the western Great Lakes area. Wm. C. Brown, Dubuque Iowa.977p.

Rahman, M., 2013. Feeding ecology of spotted snakehead *Channa punctata (*bloch, 1793) of a perennial Habitat in Bangladesh (Doctoral dissertation).

Rana, N. and Jain, S., 2018. Analysis of DNA Content in *Catla catla* (Hamilton, 1822).

Rao, L.M., Ramaneswari, K. and Rao, L.V., 1998. Food and feeding habits of Channa species from East Godavari district (Andhra Pradesh). *Indian Journal of Fisheries*, *45*(3), pp.349-353.

Sarkar, U.K. and Deepak, P.K., 2009. The diet of clown knife fish *Chitala chitala* (Hamilton–Buchanan) an endangered notopterid from different wild population (India).

Shafiqul, M.I., 2000. *Food and feeding habit and fecundity of Dhela Osteobrama cotio cotio (Ham.) M. Sc* (Doctoral dissertation, Thesis).

Singh, P.R. and Singh, H.R., 2000. Feeding biology of *Labeo calbasu* (HAM.). *Proceedings of the National Academy of Sciences India. Section B, Biological Sciences*, *70*(2), pp.179-183.

Ujjania, N.C., 2003. Comparative performance of Indian major carps *(Catla catla, Labeo rohita and Cirrhinus mrigala)* in Southern Rajasthan (Doctoral dissertation, Central Institute of Fisheries Education; Mumbai).

Vinci, G.K. and Sugunan, V.V., 1981. Biology of *Labeo calbasu* (Ham.) of the Nagarjunasagar Reservoir (AP). *Journal of the Inland Fisheries Society of India*, *13*(2), pp.22-39.