Food andFeeding Habits of *Mystustengara* (Hamilton, 1822) of Gomati River and Rudrasagar Lake, Tripura, India

ABSTRACT

Mystus tengara is a popular food fish species due to its taste, andone of the potential ornamental fish species in ornamental trades. A total of 237 specimens of *Mystus tengara* (Hamilton, 1822) specieswere collected from Rudra SagarLake and Kemtali.47 food items were observed in the gut of *Mystus tengara*. The present study has been performed on the food and feeding habits, Gastro Somatic Index, Relative Length of Gut, Fullness and feeding Intensity, and Gut Content Analysis of *Mystus tengara*. Results of the study revealed that *Mystus tengara* is a carnivorous fish andzooplankton is the basic food group for this fish species; rotifer has also been observed as the most preferable food class.The species showed isometricgrowth which indicates the well-being condition of the fish.

Keywords: Gastro Somatic Index, Relative Length of Gut, Gut Fullness, Feeding Intensity, Gut Content Analysis

Introduction

*"Mystus tengara*species commonly inhabit both flowing and standing fresh waters. The species is distributed in India, Nepal, Bangladesh, and Pakistan" (Talwar and Jhingran, 1991). "It is a preferred food fish due to its taste; in recent times it has gainedvalue inornamental trading and also has been reported to be exported from India" (Gupta and Banerjee, 2014). "This fish species is a single spawner having a short breeding period; it is a monsoon breeder". [17]"The male and female fish attain their first maturity at 8.5–9 cm and 9–9.5 cm in length respectively" (Gupta and Banerjee, 2013). "During the breeding season, females have swollen abdomen while in males, the genital papilla (which is present only in males) becomes very prominent. The success of good scientific planning and management of fish species largely depends on the knowledge of their biological aspects, in which food and feeding habits include a precious portion" (Dinh et al., 2023;Sarkar and Deepak, 2009). The study of food and feeding habits of fish have manifold importance in fishery biology and fisheries management, it was playing crucial role in day to day

fish conservation practices has been proven earlier scientific works(Mahesh et al., 2018; Soe et al., 2022).

Materials and methods

Mystus tengara Species were collected randomly from January to June during the year 2021 from Rudrasagar lake (Latitude: 23º29'N, Longitude: 90º01'E), Gomati River at Kemtali (Latitude: 23º49'N, Longitude: 91º18.14') and local markets (Kemtali and Udaipur market),Tripura. Fishing gear such as cast net, gill net, drag net, scoop net, and other local contrivances were employed for the collection of specimens. The collected fish weight and length were takentothe sampling site and the gut was removed from the fish and preserved in 4% formalinfurther specimens were preserved in 10% formalin and transported to the laboratory for further studies.

Relative gut length (RGL)

The RGL of the fish will be determined by using the general formula (Al-Hussaini, 1949) given below:

$$RGL = \frac{\text{Total Length of Gut}}{\text{Total Length of Fish}}$$

Gastro-somatic index (Ga.SI)

The variation in the feeding intensity of the different size groups in each fish will be calculated by using the standard formula (Bhatnagar and Karamchandani, 1970) given below:

$$Ga.S.I = \frac{\text{Weight of Gut}}{\text{Weight of Fish}} \times 100$$

Index of Fullness

The distension of the stomach was observed and classified as 'full or distended', 'moderate', 'half', and 'empty' by eye estimation (Pillay, 1952).

Gut content analysis

Volumetric and numerical methods(Wolfert and Miller, 1978) with modification will be used for analyzing the gut content. The gut content will be identified by using a light microscope. The frequency of occurrence will be used under the numerical method

$$\text{Frequency of occurrence} = \frac{\text{No. of fish containing particular food item}}{\text{No. of fish with food in their stomach}}$$

Qualitative and quantitative analysis of gut content

Stomach content analysis provides important insight into fish feeding patterns as the diets of fishes represent an integration of many important ecological components that includebehavior, condition, habitat use, energy intake, and inter/intra-specific interactions. Methods of gut contents analysis are broadly divisible into two categories viz., qualitative and quantitative. The qualitative analysis consists of a complete identification of the organisms in the gut contents. The quantitative methods of analysis are three types viz., numerical, gravimetric, and volumetric. All these types of analysis are widely employed by different workers. However, in the present study, the volumetric method and numerical method (Wolfert and Miller, 1978) with a little modification were used.

Thus, for the quantitative analysis, freshly preserved samples of fish were dissected longitudinally and the respective guts of each fish were weighed and preserved in 4% formalin. The gut contents were removed from the gut and transferred into a graduated measuring cylinder to know the volume of gut content after its settlement. This gut content was identified by using a phase contrast microscope up to the generic level depending upon the state of digestion or completeness of the food item. The numerical methods were adapted in different ways to assess the relative importance of food items which was done by following methods:

Frequency of occurrence method

The simplest way of recording data obtained from stomach contents is to record the number of stomachs containing one or more individuals of each food category by using the frequency of occurrence method.

$$\text{Frequency of occurrence} = \frac{\text{No. of fish containing particular food item}}{}$$

No. of fish with food in their stomach

Results

Index of Fullness

Gut fullness wascategorized into five classes namely: full, ¾ full, ½ full, ¼ full, and empty. In *Mystus tengara*, full guts were observed in March. Fishes with ¾ full gut were observed from January to June with the highest percentages being observed in Feb and April. Fishes with ½ and ¼ full gut were recorded throughout the season the highest percentages being observed in January. Fishes with empty guts were observed in June(Table 1).

The fullness indices determined are 22.35, 10.48, 28.32, 8.08, 29.89.

Table 1: Monthly variation of gut fullness in*Mystus tengara*

Months	Full gut	¾ gut	½ gut	¼ gut	Empty
Jan	21.62	5.4	32.43	13.51	24.32
Feb	27.5	17.5	20	15	15.06
March	32.5	10	35	5	17.5
April	32.5	12.5	25	2.5	27.5
May	15	10	42.5	2.5	30
June	5	7.5	15	10	65
Indices	22.35	10.48	28.32	8.08	29.89

Gut content analysis of *Mystus tengara*

Atotal of 350 specimens were collected with sizes ranging from 3.58 cm to 12.3 cm total length for gut content study. There are 47 food items observed during gut content analysis which were categorized into 6 groups namely zooplankton (Cladocera, Rotifer, Copepod, Protozoa), fish body parts, insects body parts, aquatic insects, phytoplankton (Bacillariophycea, Chlorophycea,

Cynophycea, Dinophycea) and miscellaneous items. Zooplankton contributed highest followed by fish body parts and aquatic insects.

An average of 30.28% was contributed by zooplankton. Cladocerons and Copepods were forming the highest food items in the fish gut. Cladocera is observed throughout the year. Daphnia and Moina were the most commonly found genus of Cladocera. Cyclops and Diaptomus were the commonly found genus of Copepods.

An average of 24.28% was contributed by fish body parts. It was forming the second highest group of food in the gut. Scales and shells were the dominant items and scales were found throughout the year.

An average of 20.21% was contributed by aquatic insects. It was forming the third most abundant group of food in the gut. Lepidoptera, Coleoptera, and Ephemeroptera larvae were found. The dominant among them was chironomid larvae.

An average of 13.27% was contributed by phytoplankton. Bacillariophycea, Chlorophycea, and Cyanophycea were the dominant group and Dinophycea were rarely observed. In Bacillariophycea, Cocconeis, Nitzchia, and Synedra were commonly observed. In Chlorophycea, Zygnema, Mogoutia, and Chlorella were found. In cyanophycea,Ocillatoria and Anabaena were commonly found(Table 2).

Miscellaneous items were observed with an average of 3.35%. Semi-digested matter and plant twigs were common items. Its abundance was found during May.

It had also noticed that it consumed more of animal matter so its feeding habit is carnivorous. Aquatic insects, fish body parts were noticed more in larger size groups whereas zooplanktons were maximum in smaller size groups.

Table 2: Mean contribution of different food items of *Mystus tengara*based on percentage volumetric method (points)

Sl no.	Food groups	Average % volumetric (points) method
A.	**Animal matter**	

1	Zooplankton	30.28
2	Cladocera	1.09
3	Rotifera	19.2
4	Copepod	7.9
5	Protozoa	1.09
6	Fish body parts	24.28
7	Insects body part	9.42
8	Aquatic insects	20.21
B.	**Plant matter**	
1	Phytoplankton	13.27
2	Bacillariophycea	4.64
3	Cyanophycea	3.41
4	Cholophycea	4.57
5	Dinophycea	0.65
6	Micellaneous items	3.55

Relative length of gut (RLG)

The Size-wise relative length of the gut of *Mystus tengara* is depicted in the graph. In the case of the species, the values ranged from 0.137 to 0.357 with the lowest value recorded during March and the highest value found during June. The values were found less than 1 throughout the year which indicated the species is highly carnivorous.

Gastro-somatic index (GaSI)

In general, the gastro-somatic index indicates the fullness of the stomach. In the present study, the lowest monthly mean GaSI value was found during June and the highest value was found during March. In general, fishes show less feeding intensity with a low value of GaSI during the spawning season (Table 3).

Table 3: GaSI Variation

Months	Mean GaSI
January	1.02 ± 0.56
February	1.80±0.85
March	2.09±1.04
April	0.89±0.76
May	1.43±1.12
June	0.77±0.23

The relative length of the gut and gastro-somatic index

It is important to know about fish diet and mode of feeding as it is beneficial in the culture, rearing, and larval control. The RLG of different size groups and Ga.SI of different months for *Mystus tengara* was analyzed and plotted graphically. The coefficientb, the coefficient of determination R^2 of the species was analyzed.

The regression equation for *Mystus tengara* was obtained as Y= 0.406x-1.5496 which depicts that a unit increment in the size TL increases the gut length by 0.406 in the species. The extent of variation in gut length was 21%.

In *Mystus tengara*, the RLG values were observed to vary from 0.137cm to 0.357cm. The lowest value was noticed in the size group 4.6-5.5cm and the highest value in 11.6-12.5cm. The

observation of feeding intensity was based on the Gastro-somatic index taken every month. Mean monthly values of the Gastro-somatic index varied from 1.022-0.765 in *Mystus tengara*. The values of Ga.SI was observed to become high during March and started to fall in June.

Discussion

The present study deals with *Mystus tengara*to correlate food and feeding. The species were mainly collected from the floodplain area Rudra Sagar at Kemtali.

Relative length of gut and Gastro-somatic index

AlHussaini (1947) earlier enlisted "the RLG values for carnivorous (0.5–2.4), omnivorous (1.3–4.3), and herbivorous (3.7–6.0) fishes. Das and Moitra (1963) later also mentioned that RLG value is generally low in carnivorous fish, higher in omnivorous fish, and highest in herbivorous fish. Thus, observation of RLG values in the present study depictsthe carnivorous feeding habit of *Mystus tengara"*.

"In this study, the low values of GaSI along with the declining trend from June to August depict the poor feeding activity for this fish species during this period which is in correspondence to their intense breeding periodicity as observed by" (Gupta and Banerjee, 2013). "GaSI has been observed to increase gradually after the spawning season with increasing feeding activity and during the pre-spawning season feeding activity has been found to increase maximally represented by high GaSI values during that period". [17]

"The maximum feeding activity during the pre-spawning season is related to food abundance or to storing energy for spawning as found in the present study and it is supported by" (Serajuddin et al., 1998; Kanwal and Pathani, 2012). "The changing trend of monthly GaSI values is in synchronization with the changing percentage of gut fullness. The high values of GaSI from March to May correspond to the availability of a high percentage of fishes with full gut during this period; fishes with 3/4 full gut have also been observed with high percentages during this period. Then from June onwards percentage of fish with full gutswas found to decrease while the percentage of fish with empty guts has been observed to increase gradually resulting in a gradual decrease of GaSI". [17]

“In this study percentage of empty gut-containing fish has been observed to become high during June to August, the intense breeding period for this fish species. High occurrence of empty gut-containing fish during the intense breeding season due to decreased feeding activity since the mature and ripe gonads occupy more space in the peritoneal cavity, compressing the gut and making feeding more difficult during this period as observed by” (Serajuddin et al., 1998).

Index of Fullness

The FI (22.35,10.48, 28.32, 8.08, and 29.89% for full, 3/4 full, 1/2 full, 1/4 full and empty guts, respectively) depict high feeding activity for this fish species all through the season in the study. Fishes with medium gut fullness (3/4 full and 1/2 full) have been observed almost all through the season and even when fishes with empty guts have been observed with high percentages, the total percentage of fishes with food in their gut has been found to surpass the percentage of fishes with empty gut. This suggests that feeding has never been discontinued and even during the breeding season no cessation of feeding has been observed there. A high percentage of fish with gut-containing food also suggests good food availability all through the season in the waterbody from where the fish species have been collected and similar results were found (Ikusemiju and Olaniyan, 1977).

Gut content analysis

Gut content analysis has revealed zooplankton as the most abundant group among the food classes with an index of preponderance value of 30.28%. Fish body parts have been found as the second most abundant food class with an index of preponderance value of 24.28%. Aquatic insects have been observed as the third most abundant food class with an index of preponderance value of 20.21%. Rotifera (19.2%) have been observed as the next abundant food class followed by Phytoplankton (13.27%), insect body parts (9.42%), Copepod (7.9%), Bacillariophycea (4.64%) and Micellaneous items (3.55%). Similar results were reported in *Mystus nemurus* (Khan et al., 1994).

Conclusion

The study indicated that *Mystus tengara* has both economic and ornamental value in the market. It is suggested that further study on other aspects of the biology of this fish species is required for

its successful breeding. Thus, it would help the farmers in the future to increase fish production in various aspects. The natural resources of this species are gradually declining due to over-exploitation climate and habitat changes and are mainly found in weedy, muddy places of ponds, streams, and rivers. This study would provide the necessary guidelines for breeding programs and fisheries rules and regulations for the conservation of its natural habitat.

Ethical Approval

The fish species studied in the present study arenot protected under The Wildlife Protection Act, 1972 (Last amended in 2013), Government of India, and the experiment was approved by the Institutional Animal Ethics Committee (IAEC) of the College of Fisheries (Central Agricultural University, Imphal), India. All the guidelines on animal use and care were followed accordingly.

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