Studies on the food habits of three species of Mastacembelidae

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Abstract
To identify the food habits of three species of Mastacembelidae namely *Mastacembelus armatus*, *Mastacembelus pancalus* and *Macrognathus aculeatus*, the gut content analysis was performed by three methods i.e. occurrence method, points method and index of fullness method. All three species were found to consume prawn, molluscs, insects, earth warm, debris and plant materials. *M. armatus* and *M. pancalus* were found to feed mainly on animal food items and 84.68% of different types of animal food were taken by *M. armatus* and 62.72% by *M. pancalus*. *M. aculeatus* was found to consume 44.86% of different types of animal food items, 53.51% of debris and plant materials which indicated that this fish feeds almost equally on animal and plant food. Analysis of the food habits showed that both *M. armatus* and *M. pancalus* are carnivore in nature with higher feeding preference for animal food namely prawn, crabs, fishes, molluscs etc. On the other hand, *M. aculeatus* is an omnivore in nature feeding almost equally on animal and plant food.

Key words: Food, Food habit, Mastacembelidae

Introduction

Food and feeding habit of fishes has a great significance in aquaculture practice. It helps to select such species of fishes for culture which will utilize all the available potential food of the water bodies without any competition with each other but will live in association with other fishes. This will allow the best utilization of the food sources of water body and will give an optimum yield. Food and feeding habits of fish vary with the time of day and season of the year. Food consumption of fishes is influenced directly or indirectly with changes of temperature, pH, light and dissolved oxygen of water (Keast 1968). However, analysis of stomach contents is a method for determining the food and feeding habits of fishes by which we can easily find what the fish take as food.

The freshwater eels such as *Mastacembelus pancalus* and *M. aculeatus* are also called small indigenous fish species but *M. armatus* is relatively larger than those species. These fishes are the inhabitants of rivers, canals, beels, ponds and inundated fields (Rahman 1989). These are now considered as endangered species. Considering the consumers preference, nutritional value and market preference and to preserve the biodiversity, *Mastacembelus* spp. should be protected from being extinct. However, for

developing culture technologies, biological studies of these species are indispensable. Very little attempt has been made in the country to promote their breeding and culture. Therefore, a research work was carried out to identify the food habits of *M. armatus*, *M. pancalus* and *M. aculeatus* to generate base-line information for facilitating the future aquaculture practice of these species.

Materials and methods

Collection and preservation of fish sample
The fishes were collected from the Brahmaputra river on several occasions. Immediately after collection, the whole alimentary canal of each fish was dissected and preserved in 10% formalin to prevent further digestion of food.

Laboratory studies and stomach analysis
In the laboratory, the stomach content (lying between the esophagus and intestine) was taken out from the preserved vial into a petridish with the help of fine forceps. The method practiced was similar to the methods followed by MaComish (1967), McKechnie and Fenner (1971) and Dewan (1973). For the qualitative and quantitative analyses of different food items eaten by fish, several methods have been used. The commonly used methods ar: i) numerical method, ii) weight method, iii) volumetric method (index of fullness method), iv) points method and v) percentage of frequency of occurrence method. In the present study percentage of frequency of occurrence method, points method and index of fullness method were used.

Counting procedure
To study the gut content each stomach was analysed separately. The stomach of individual fish was cut open and removed on to a petridish with the help of very fine forceps. The percentage of occurrence of a particular food item was calculated on the basis of the following formula:

$$\text{Percentage of occurrence of a food type} = \frac{\text{Number of gut where the food occurred}}{\text{Total number of gut analysed}} \times 100$$

To apply the points method all the food items eaten by the species were identified. Then the volume of the stomach contents of each fish was estimated by observation and recorded on an absolute scale and points were allotted to each stomach according to the volume of its contents.

The stomach with largest volume was allotted 100 points, and each of the stomachs as examined was then rated in one of the following point categories; 0, 3, 6, 12, 25, 50 and 100 points, according to volume of the food present. The categories were based on inspection and estimation of stomachs of all categories made from extra stomach and was used in relating absolute volumes to assigned point values. Then the occurrence of each

and every food item in the individual stomach was recorded and point allotted for every food item.

In case of Index of fullness method, the index of fullness of the stomach was recorded irrespective of the size of the stomach of the fish using '0' for empty; '1' for one fourth full; '2' for half full, '3' for three fourth full and '4' for full stomach.

Results

The gut contents of 45 fishes of each species of Mastacembalidae was performed by three methods namely frequency of occurrence method, points method and index of fullness method. It is well known that no single method is adequate for analysis of stomach contents of food. The total length ranges of the fishes studied were 30 to 56 cm for *M. armatus*, 10 to 16 cm for *M. pancalus* and 17 to 26 cm for *M. aculeatus*.

Types and amount of food taken by the three species

The major food items found in the stomach content analysis of 45 fishes from each species showed that the fish fed on a variety of food items. The food types recorded are prawns/shrimps, plants, small fishes, small crabs, molluscs, insects, earth worms, fish eggs, debris, soil and 'others' which include unidentified items.

Food habit in M. armatus determined by frequency of occurrence and points methods

The gut analysis in *M. armatus* (Table 1) shows that prawn is the most frequently ingested food item (obtained in 77.78% fish) followed by debris (40%), small fish and plant (each 22.22%) and then molluscs (20%) which indicated that the fish fed mainly on animal food. Some other types of food were also identified but in much less frequency, e.g. earth worm (8.89%), small crab (6.67%), insect (2.22%), fish egg (2.22%) etc.

Analysis by points method which reflects the percent contribution of a particular type of food in total volume of gut content shows (Table 1) that also prawn is the most important food type (36.58%) in *M. armatus*. Then comes sequentially the small crab (22.41%), small fish (15.80%), debris (6.31%), plant material (5.48%) and earth worm (4.72%). Table 1 also shows the feeding pattern in different size group in *M. armatus*. It shows that prawn as a food item was very important in all three size groups both according to frequency of occurrence as well as percent contribution in gut content. Occurrences of small fishes and molluscs were highest in Group III which composed of largest size fish. This probably indicates that with increase in size the fish reaches in more advantageous position to predate on or engulf these large live food.

Food habit in M. pancalus determined by frequency of occurrence and points method

Stomach content analysis by percentage of occurrence method in case of *M. pancalus* shows (Table 2) that debris is the most frequently encountered (obtained in 57.78% fish) food item followed by prawn (55.55%), plant material (40%), fish egg (22.22%), earth worm (13.33%) and small insects (11.11%) for this species.

Table 1. Relationship of size and patterns of feeding and average composition of diet of 45 fishes of *Mastacembelus armatus* based on food categories, according to percentage of occurrence and percentage of total points

Items	Percentage of occurrence				Average points per fish				Percentage of total points			
	Group I (30-36) cm	Group II (37-43) cm	Group III (44-56) cm	Average	Group I (30-36) cm	Group II (37-43) cm	Group III (44-56) cm	Average	Group I (30-36) cm	Group II (37-43) cm	Group III (44-56) cm	Average
Prawn	80.00	66.67	86.67	77.78	7.20	6.53	12.53	8.75	59.65	29.51	33.33	36.58
Earth worm	6.66	6.67	13.33	8.89	0.67	0.73	2.00	1.13	5.55	3.30	5.32	4.72
Small fish	13.33	26.67	26.67	22.22	1.87	3.07	6.40	3.78	15.49	13.87	17.03	15.80
Mollusc	13.33	20.00	26.67	20.00	0.53	0.67	2.13	1.11	4.39	3.03	5.67	4.64
Small crab	0	13.33	6.67	6.67	0.93	8.47	6.67	5.36	7.71	38.27	17.74	22.41
Insect	0	0	6.67	2.22	0	0	1.00	0.33	0	0	2.66	1.38
Plant material	0	33.33	33.33	22.22	0	1.20	2.73	1.31	0	5.42	7.26	5.48
Fish egg	0	6.67	0	2.22	0	0.33	0	0.11	0	1.50	0	0.46
Debris	20.00	40.00	60.00	40.00	0	1.13	3.40	1.51	0	5.11	9.04	6.31
Other	6.66	0	13.33	6.66	0.87	0	0.73	0.53	7.21	0	1.94	2.22

* The no. of fish in each group was 15
The average was calculated by taking in consideration the fishes of all 3 groups together

Table 2. Relationship of size and patterns of feeding and average composition of diet of 45 fishes of *Mastacembelus pancalus* based on food categories, according to percentage of occurrence and percentage of total points

Items	Percentage of occurrence				Average points per fish				Percentage of total points			
	Group I (10-11) cm	Group II (12-13) cm	Group III (14-16) cm	Average	Group I (10-11) cm	Group II (12-13) cm	Group III (14-16) cm	Average	Group I (10-11) cm	Group II (12-13) cm	Group III (14-16) cm	Average
Prawn	60.00	53.33	53.33	55.55	5.67	9.80	16.13	10.53	32.09	41.88	38.77	38.22
Earth worm	6.67	13.33	20.00	13.33	2.00	2.47	5.53	3.33	11.32	10.56	13.29	12.09
Small insect	13.33	6.67	13.33	11.11	1.07	1.00	1.40	1.16	6.06	4.27	3.37	4.21
Plant material	26.67	33.33	60.00	40.00	1.80	4.20	7.67	4.56	10.19	17.95	18.44	16.55
Fish egg	26.67	26.67	13.33	22.22	2.07	2.13	2.47	2.22	11.72	9.10	5.94	8.06
Debris	60.00	53.33	60.00	57.78	4.33	3.33	7.40	5.02	24.51	14.23	17.79	18.22
Other	26.67	13.33	20.00	20.00	0.73	0.47	1.00	0.73	4.13	2.00	2.40	2.65

* The no. of fish in each group was 15
The average was calculated by taking in consideration the fishes of all 3 groups together

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According to points method the greatest amount is contributed by prawn (38.22%), followed by debris (18.22%), plant material (16.55%) and earth worm (12.09%) which is shown in Table 2. All the size groups of *M. pancalus* show almost similar type of preference for fish egg as food (Table 2). Apart from other food types Group I also shows preference for fish egg as food. Thus 'fish egg' was found in 26.67% of fish in Group I and it contributed about 11.72% of total gut content. On the contrary in only 13.33% fishes belonging to Group III took fish eggs and this food contributed only 5.94% of the gut content.

Food habit in M. aculeatus calculated by frequency of occurrence and points methods

In *M. aculeatus* debris was found in the highest number of fish (82.22%) as well. The second highest frequency of occurrence was of earth worm (37.78%) followed by plant material (26.67%) and prawn (17.78%) (Table 3).

According to points method the debris was found to be the greatest contributor to gut content as well. Earth worm was second (37.35%), followed by plant materials (12.72%) and prawn (7.51%) (Table 3). Unlike two other species 'debris' was the most predominant type of food in all three size groups of *M. aculeatus* (Table 3). The second most important food type was earth worm in all three size groups.

Relationship between fish size and feeding pattern based on average index of fullness and average points for fish

The patterns of feeding in different size groups of fishes in three species of Mastacembelidae are shown in Table 4. To determine the size and pattern of feeding, the total number of fishes- 45 of each species was divided into 3 groups; Group I, Group II and Group III.

Average index of fullness

The value of average index of fullness showed little variations in different size groups. However, a rather higher value of average index of fullness were recorded in size Group I of all the three species with values of 2.3 in *M. armatus*; 2.6 in *M. pancalus* and 1.9 in *M. aculeatus*. The lowest value of average index of fullness was recorded in size Group III for all of the three species i.e. 2 in *M. armatus*; 2.4 in *M. pancalus* and 1.7 in *M. aculeatus*. The values of size Group II was more or less similar among all three species.

Average points per fish

The values of average points per fish showed interesting variations with the increase in size of the fish. The highest values of average points per fish 38 in *M. armatus*, 42 in *M. pancalus* and 30 in *M. aculeatus* were recorded in size Group III. The lowest values of the same were recorded in size Group I. Therefore, the values of average points per fish were found to increase with the increase in size of the fish.

Table 3. Relationship of size and patterns of feeding and average composition of diet of 458 fishes of *Macrognathus aculeatus* based on food categories and according to percentage of occurrence and percentage of total points.

Items	Percentage of occurrence				Average points per fish				Percentage of total points			
	Group I (17-19) cm	Group II (20-22) cm	Group III (23-26) cm	Average	Group I (17-19) cm	Group II (20-22) cm	Group III (23-26) cm	Average	Group I (17-19) cm	Group II (20-22) cm	Group III (23-26) cm	Average
Prawn	6.67	26.67	20.00	17.78	0.20	2.93	1.80	1.64	1.56	12.82	6.03	7.51
Earth worm	33.33	33.33	46.67	37.78	4.73	7.67	12.07	8.16	36.98	33.55	40.41	37.35
Plant material	6.67	46.67	26.67	26.67	0.80	3.53	4.00	2.78	6.26	15.44	13.39	12.72
Debris	86.67	73.33	86.67	82.22	7.06	8.33	11.33	8.91	55.20	36.44	37.93	40.77
Other	0	6.67	6.67	4.45	0	0.40	0.67	0.36	0	1.75	2.24	1.65

* The no. of fish in each group was 15
The average was calculated by taking in consideration the fishes of all 3 groups together

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Table 4. Relationship of size and pattern of feeding of three species of the family Mastacembelidae based on average index of fullness and average points per fish

Items	M. armatus			M. pancalus			M. aculeatus		
	Group I (30-36) cm	Group II (37-43) cm	Group III (44-56) cm	Group I (10-11) cm	Group II (12-13) cm	Group III (14-16) cm	Group I (17-19) cm	Group II (20-22) cm	Group III (23-26) cm
Number of fish examined	15	15	15	15	15	15	15	15	15
Number of total points	181	332	564	265	356	624	192	343	448
Average points per fish	12	22	38	18	24	42	13	23	30
Average index of fullness	2.3	2.3	2.0	2.6	2.4	2.4	1.9	1.7	1.7
Average length in cm	33.2	39.1	47.5	10.8	12.5	14.2	16.8	20.6	24.5

Discussion

Prawn was the most preferred live food items of *M. armatus* and *M. pancalus*. On the other hand, for *M. aculeatus* earth worm was the most preferred animal food type. All three species had a considerable amount of debris and plant material in their guts. *M. armatus* consumed 85.99% of different type of animal food items and 14.01% of debris, plant material and others which indicated that the fish fed mainly on animal food (Table 1). The most dominant food item of the fish was prawn (36.58%) followed by small crab (22.41%), small fish (15.80%), earth worm (4.72%), mollusc (4.64%), insect (1.38%) and fish egg (0.46%) among animal food items and debris (7.61%) followed by plant material (5.48%) and others (2.22%) among plant food.

M. pancalus consumed 62.85% of different type of animal food items and the rest 37.42% of plant material, debris and unknown which indicated that the fish fed mainly on animal food. The most dominant food item of the fish was prawn (38.22%) followed by earth worm (12.09%), fish egg (8.06%) and small insects (4.21%) among animal origin and debris (18.22%) and plant materials (16.55%) among plant origin and unknown food (2.65%).

M. aculeatus ingested 44.86% of different type of animal food items and the rest 55.14% of debris, plant materials and others which indicated that the fish fed mainly on plant food. The most dominant food item of the fish was debris (40.77%). The second dominant food item was earth worm (37.35%) followed by plant materials (12.72%), prawns (7.51%) and unknown materials (1.65%).

From the above findings it is evident that both *M. armatus* and *M. pancalus* are carnivore in nature with higher feeding preference for animal food like prawn, crab, fish, mollusc etc. However, they consistently took some plant materials and debris along with their animal food. On the other hand, *M. aculeatus* was omnivore in nature feeding almost equally on food of animal and plant origin. Dewan (1973) studied the food habit

of *M. pancalus* by percentage of occurrence method and volumetric method and supported the above findings.

The determination of food habit was also reported by Saha and Dewan (1979) for *Tilapia nilotica;* Mustafa *et al.* (1980) for *Nandus nandus;* Bisht and Das (1981) for *Puntius ticto, Cyprinus carpio, Tor tor, Nemaechilus rupicola* and *Channa gachua;* Bhuiyan and Rahman (1983) for *Channa gachua;* Nargis and Hossain (1987) for *Anabas testudineus;* Reddy and Rao (1987) for *Mystus vittatus;* Sivareddy and Rao (1989) for *Heteropneustes fossilis;* Choudhury and Thakur (1990) for *Clarias batrachus;* Ahmed *et al.* (1993) for *Nandus nandus, Mytus vittatus* and *Puntius stigma;* Bais *et al.* (1994) for *Channa punctatus;* Dutta (1994) for *Channa punctatus* and Alam (1995) for *Gudusia chapra.* They categorised these fishes either as carnivore or omnivore.

On the other hand, the values of average points per fish increased with the increase in size of fish. The highest values of average points per fish were recorded in size group III. The lowest values of the same were recorded in size group I. Thus from the results of average points per fish, it can be concluded that the amount of food in the stomachs increases with the increase in size of fishes. This might be due to increased size of the stomach as the fish increased in size. These findings agree with the findings of Dewan *et al.* (1977) in *Labeo rohita.* From the above discussion it can be concluded that both *M. armatus* and *M. pancalus* are carnivorous and *M. aculeatus* is omnivorous.

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