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FOOD AND FEEDING HABIT OF SPINY EEL *Macrognathus aral* (Bloch and Schneider) FROM UPPER ASSAM

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Abstract: Food and feeding habits of for *M. aral* were studied by examining a total of 421 digestive tracts during August, 2008 and July, 2010. It is very important to know the feeding habits of the fish in the natural environment in order to conduct stock enhancement by releasing the seedlings, because prevention of starvation, improvements of their growth and effective management can be conducted from this knowledge. The results reveals that the lowest value of relative length of gut (RLG) was found as 0.58(±0.09) in 27-32 cm whereas the highest values as 0.62(±0.12) in 7-12 cm group. Fullness of gut was recorded as18.38% (full); 9.18% (¾ full); 11.23% (½ full); 12.54% (¼ full); 19.77% (nearly empty) and 28.9% (empty). Gastro somatic index (GSI) was ranged from 0.55±0.13 (Feb) to 3.72±1.84 (Jun) for males and that of female from 0.45±0.12 (Feb) to 1.85±0.61 (Aug). In juveniles, a strong positive selection was observed for zooplanktonic organism (46.44%), insect larvae (27%), miscellaneous includes unidentified matter, algal & fish egg (17.16%), annelids (5.38%), sand & mud (2.05%) and crustaceans (1.97%). In adults, the most dominant food item was insect larvae (34.45%) and followed by zooplankton (19.56%); miscellaneous includes unidentified matter, algal & fish egg (15.04%); annelids (11.75%), crustaceans (8.02%), sand & mud (6.02%) and molluscs (5.16%). The index of pre-ponderance values showed that insect larvae were the most preferred food item (63.1%) for this species followed by zooplankton (20.02%) miscellaneous includes unidentified matter, algal & fish egg (10.59%), sand & mud (4.37%), crustaceans (1.30%), annelids (0.52%) and molluscs (0.10%).

Keywords: *M. aral*, RLG, Fullness of gut, GSI, Gut content analysis, Index of pre-ponderance, Upper Assam, India

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Özet:

Yukarı Assam'dan Yakalanmış Dikenli Yılan Balığının *Macrognathus aral* (Bloch ve Scneider) Gıda ve Beslenme Alışkanlığı

Macrognathus aral için gıda ve beslenme alışkanlıkları Ağustos 2008 ve Temmuz 2010 boyunca toplam 421 tane sindirim sisteminin incelenmesiyle yapıldı. Balık yavrularının ortama bırakılarak stok gelişmesini yürütmek üzere, doğal ortamdaki balıkların beslenme alışkanlığını bilmek çok önemlidir. Açlığın önlenmesinden dolayı balıkların büyümelerinin gelişmesi ve etkin yönetim bu bilgiler doğrultusunda yapılıp yönetilebilir. Sonuçlar ortaya koymaktadır ki bağırsağın nispi uzunluğu (RLG) en yüksek değerini 7-12 cm'lik grupta 0.62(±0.12) gösterirken, en düşük değeri 27-32 cm'lik grupta 0.58(±0.09) olarak bulundu. Bağırsak doluluğu; %18.38 (tam dolu); %9.18 (¾ dolu); %11.23 (½ dolu); %12.54 (¼ dolu); %19.77 (nerdeyse boşa yakın) ve %28.9 (boş) olarak kaydedilmiştir. Gastro somatik indeks (GSI) erkek bireyler için 0.55±0.13 (Şubat)' den 3.72±1.84 (Haziran)' e; dişi bireyler için 0.45±0.12 (Şubat)' den 1.85±0.61 (Ağustos)' e değişim göstermiştir. Genç bireylerde, kabuklular (%1.97), kumsal ve çamur (%2.05), halkalılarda (%5.38), alg ve balık yumurtalarında (%17.16), bilinmeyen maddeler içeren şeyler, böcek larvasında (%17.16), zooplankton organizmaları (%46.44) için güçlü pozitif bir seleksiyon gözlenmiştir. Yetişkinlerde en baskın gıda maddesini mollusc (%5.16), toprak ve çamur (%6.02), crusteceans (%8.02), halkalılar (%11.75), alg ve balık yumurtaları (%15.04), bilinmeyen maddeleri içeren şeyler, zooplanktonları (%19.56)i takiben böcek larvaları (%34.45) oluşturmaktadır. Ön ağırlık değerlerinin indeksi bu türler için en çok tercih edilen gıdanın böcek larvaları olduğunu (%63.1) ve bunu da zooplanktonlar (%20.02) bilinmeyen maddelerden oluşan bileşimler, alg ve balık yumurtası (%10.5), kum ve çamur (%4.37), crustaceans (%1.30), halkalılar (%0.52) ve molluscs (%0.10)ların takip ettiğini göstermiştir.

Anahtar Kelimeler: *M. aral*, RLG, Bağırsak içeriği, GSI, Bağırsak içerik analizi, Ön-ağırlık indeksi, Yukarı Assam, Hindistan

Introduction

Study of food and feeding habits of fishes have manifold importance in fishery biology. For successful fish farming a thorough knowledge about the food and feeding habit is necessary. Fish like any other organisms depends on the energy received from its food to perform its biological processes such as growth, development, reproduction and other metabolic activities. Detailed data on the diet, feeding ecology and trophic inter-relationship of fishes is fundamental for better understanding of fish life history including growth, breeding, migration (Bal & Rao, 1984) and the functional role of the different fishes within aquatic ecosystem (Blaber, 1997; Wootton, 1998; Hajisamae *et al*., 2003). Fish food consumption might be influenced by many environmental factors such as water temperature, food concentration, stocking density, fish size and fish behaviour (Houlihan *et al*., 2001). As the nature of food depends to a great extent upon the nature of environment, the problem is interesting from specific, as well as ecological point of view (Bhuiyan *et al*., 2006).

The importance of the study of food and feeding habits, to evaluate the ecological role of the fish species has been emphasized by many workers. Dutta (1989/1990) studied the food and feeding ecology of *Mastacembelus armatus* (Lecep) from Gadigarh stream of Jammu whereas Serajuddin & Mustafa (1994) investigated on feeding specialization of adult *M. aramatus.* Again, Serajuddin *et al.* (1998) investigated the food and feeding habits of *M. armatus* from Kalinadi, a tributary of the Ganga River system at Aligarh. Meanwhile, Ochi *et al*. (1999) studied on the feeding habit of *Caecomastacembelus zebratus* in Lake Tanganyika. Further, Serajuddin & Ali (2005) made a study on food and feeding habit of striped spiny eel *M. pancalus*.

The one-stripe spiny eel, *Macrognathus aral* (Bloch and Schneider), has been gaining importance not only as a food, cultivable fish but also as an aquarium fish for its body shape and behaviour. As per CAMP report (1998) *Macrognathus aral* was included under "Lower Risk near threatened" (LRnt-category). However, Lakra & Sarkar (2006) reported *M. aral* distributed in the Eastern Ghat region of India have found place in the World Conservation Union Red List (2006). Pethiyagoda *et al*., (2008) quoted that in 1992, an illustrated 'Wanted' poster was displayed by the Wildlife Heritage Trust in the sta-

tions of the principal ornamental fish export companies and inland fisheries centres in Sri Lanka, offering a reward of approximately US$ 180 for a single specimen of *Macrognathus aral.*

Further, detail information on different aspects of feeding biology of the aforesaid the species is not available in the north eastern India, which is very vital for sustainable management and conservation of fishery resources. In the north-east India, particularly in upper Assam, the species has very high demand especially when sold alive, fetching a price between Rupees 200 and 280/kg. Without knowledge of the food requirements, feeding behaviour pattern, and predator-prey relationships, it is not possible to understand the predicted changes that might result from any natural or anthropogenic intervention. Therefore, keeping these in view, a study has been proposed encompassing different aspects of food and feeding habits of *M. aral* from upper Assam.

Materials and Methods

Food and feeding habits of for *M. aral* were studied by examining a total of 421 digestive tracts. The specimens of *M. aral* were collected from different landing stations of lentic and lotic water systems in Dibrugarh and Tinsukia Districts of Assam between August, 2008 and July, 2010. The guts were taken out from the specimen after measuring and weighing each specimen to the nearest cm and gm respectively and were preserved in 5% formalin for subsequent analysis. The preserved guts were later uncoiled, cleaned off the attached fat and the length and weight were recorded. The details of the food and feeding habits undertaken for the present study are as follows:-

Relative length of the gut (RLG)

The feeding habit was investigated through RLG. The ratio between the gut length and total length (RLG) was estimated by adopting the following formula (Al-Hussainy, 1949):- RLG = GL/TL; where, GL stands for total length of the gut and TL are the total length of the fish.

Feeding intensity (GSI)

The feeding intensity of the species in different life stages and seasons were estimated by examining the fullness of the gut as well as by gastro-somatic index (GSI) following the formula (June, 1953; Desai, 1970):-

$$G.S.I = \frac{\text{Weight of the gut (g)}}{\text{Total weight of the fish (g)}} \times 100$$

The specimens were properly cleaned in the laboratory and the total length, total weight, sex stage of maturity and degree of fullness were recorded. Degree of fullness of guts were visually classified as full, ¾ full, ½ full, ¼ full, nearly empty and empty depending upon the degree of fullness and the amount of food contained in them (Nwadiaro & Okorie, 1987; Abdelghany, 1993; Bhuiyan *et al*., 2006). Fishes with full, ¾ full stomachs were considered as active feeders, ½ full as moderate feeders and ¼ full and nearly empty stomachs as poor feeders following the methods used by Rao & Rao (2002) and Raje (2006).

Index of Preponderance

After the collection of the specimens the general viscera were dissected and the alimentary tracts were separated. For evaluating the importance of all food items, the 'index of preponderance' method (Natarajan & Jhingran, 1961) was employed.

$$I_i = \frac{V_i O_i \times 100}{\sum V_i O_i}$$

where, I_i = Index of preponderance, V_i and O_i represent the percentage volume and occurrence of particular item of food respectively.

Gut content analysis

Gut content analysis was done for examining seasonal variation in diet components. Further, the data were analysed for different size group to record basic changes in feeding habit. Both volumetric and occurrence methods were used for gut content analysis. Both qualitative (volumetric) and quantitative (numerical) methods of gut content analysis was employed as recommended by Hynes (1950) and Pillay (1952).

Volumetric method (qualitative)

The content of each sample was taken as a unit and various items are expressed as % volume by eye inspection (Pillay, 1952). The content of each gut was vigorously shaken with distilled water and then a drop of the content was examined under microscope. The area occupied by each

food item was estimated arbitrarily. At least ten such drops were examined and the average of each of the drops was recorded.

Occurrence method (quantitative)

In this method, the number of guts containing a particular item of food was expressed as a percentage of the total number of gut examined (Hynes, 1950). The method is carried out in two steps-first, all the food items are sorted out and their presence or absence in a particular gut is recorded. Next, the number of guts in which a particular food item present is noted down and the data for all the food item is pooled and converted into percentages. This method, apart from describing the qualitative analysis of the diet also gives the frequency of a particular food item occurred in the gut and thus helps to understand the preference of any particular food item.

Results and Discussion

Relative length of the gut (RLG) values in *M. aral* showed little variation among different size groups of all the 421 species examined. The lowest value was found as 0.58(±0.09) in 27-32 cm group (Table 1) whereas the highest values as 0.62(±0.12) in 7-12 cm group. As a whole the RLG value was higher in younger size groups in the species. In this study, RLG of individual species ranged from 0.54 to 0.68 and was found to be less than 1 as well as remained constant with the increase in length of the fish. The low RLG value shows that the fish falls in the category of carnivorous fishes. RLG value has close relationship with the nature of food of the fish (Das & Moitra, 1956). The length of the intestine of the fish depends upon the feeding habits. Carnivores fishes normally have short and more or less straight intestine. This is because the meat gets digested more easily (Pandey & Shukla, 2005; Serajuddin & Ali, 2005) wherein herbivores fishes the intestine is long and highly coiled because the vegetable food items take more time for digestion. The intermediate condition is found omnivores. Since, *M. aral* possesses a relatively short and straight intestine, it can be classified as carnivore's fish.

A percentage occurrence of different degree of fullness of gut for *M. aral* in different months has been given in Table 2. Out of 421 gut collected over a period of 2 years, it was found that in 78 individuals were full (18.38%), 39 individuals were ¾ full (9.18%), in 47 individuals were ½ full (11.23%), 51 individuals were ¼ full (12.54%), and in 83 individuals were nearly empty (19.77%) and 123 individuals were empty (28.9%). On the other hand, feeding intensity of different maturity stages (Table 3) showed that higher active feeding (full with 28.79% & ¾ full with 10.53%) were found in maturing (stage II); moderate (1/2 full with 29.55%) were found in immature fish (stage II); highest percentage of poor feeding ($^{1/4}$ full-15.11% and nearly empty-15.11%) were recorded in ripe fish (stage IV). More empty stomachs (76.19%) were found in spent (stage V) than in ripe (69.78%), mature (42.4%), maturing (13.02%) and immature (12.89), which might be due to physiological strain of maturity and spawning.

Table 1. Mean variation of RLG values in different size group of *M. aral*

Size group (cm)	RLG
7-12	0.62 (±0.12)
12-17	0.59 (±0.05)
17-22	0.61 (0.1)
22-27	0.60 (±0.1)
27-32	0.58 (±0.09)

Table 2. Seasonal variations of feeding intensities (fullness of gut) in *M. aral*

Monthly	No. of specimen examined	Active feeding		Moderate feeding	Poor feeding		Empty
		Full	¾ full	½ full	¼ full	Nearly empty	
Jan	35	-	-	5.71	5.71	30.29	58.29
Feb	30	-	-	16.67	16.67	23.33	43.33
Mar	36	13.89	11.11	16.67	11.11	19.44	27.78
Apr	36	16.67	13.89	25.0	21.22	14.89	8.33
May	34	41.18	14.71	11.76	11.76	14.71	5.88
Jun	36	69.44	11.11	5.56	8.33	5.56	--
Jul	35	45.71	22.86	14.29	8.57	8.57	--
Aug	36	22.23	19.44	13.89	13.89	11.11	19.44
Sep	36	5.56	5.56	11.11	15.89	26.22	35.66
Oct	35	5.72	8.57	11.43	11.43	28.57	34.28
Nov	36	-	2.78	2.78	19.44	27.78	47.22
Dec	36	-	-	-	6.56	26.78	66.66
Overall	421	18.38	9.18	11.23	12.54	19.77	28.90

Table 3. Percentage of fullness of gut of *M. aral* in different maturity stages

Maturity stages	No. of specimen examined	Full	¾ full	½ full	¼ full	Nearly empty	Empty
Immature	36	8.33	26.56	29.55	12.89	9.78	12.89
Maturing	95	28.79	10.53	25.05	13.68	8.93	13.02
Mature	73	10.96	10.96	10.96	10.96	13.76	42.4
Ripe	36	--	--	--	15.11	15.11	69.78
Spent	181	--	--	--	9.97	13.84	76.19

Active feeding (full and ¾ full) intensity was high during monsoon (Jun-Aug) with peak in June with a total of 107 species, moderate (1/2 full) during pre-monsoon (Mar-May) with 106 species and poor (1/4 full and nearly empty) and empty during post monsoon (Sep-Nov) and winter seasons (Dec-Feb) with 107 and 101 species respectively (Figure 1). The degree of fullness of guts in spiny eel was found to vary with season as well as advancement of gonads. The intensity of active feeding was high during monsoon and moderate feeding observed during pre-monsoon. The poor feeding was mostly recorded in post-monsoon season and it might be due to occurrence of more number of spawning individuals during this period. In the species, the high percentage of occurrence of empty stomachs during September to March with peaks in December indicates a period of low feeding which also coincide low water temperature and non-availability of adequate amount of preferred food items.

It is no wonder that a large number of fishes were found with empty stomachs in spent specimens. The frequent occurrences of empty stomachs or stomachs with little contents may be probably dependent on the ratio between the size of the fish and size of the prey as cited by Allen (1935) or on the calorific value of the diet as explained by Longhurst (1957) i.e., where fish is an important food item, the daily intake will be less, because of the higher calorific value of the diet and as such empty stomachs will be more common.

As far as gastro somatic index (GSI) in relation to months and seasonal variation for both sexes was concerned, the average monthly GSI of *M. aral* was ranged from 0.55±0.13 (Feb) to 3.72±1.84 (Jun) for males and that of female from 0.45±0.12 (Feb) to 1.85±0.61 (Aug). GSI was relatively high from May to November (Table 4) with the peak being in June (males) and in August (females) indicating active feeding periods. From November onwards the GSI values of both the sexes declined steadily. As a whole, feeding was better in males throughout the year than females in *M. aral*. Again, lower GSI for both the males (0.57±0.19) and females (0.54±0.24) of *M. aral w*as observed during winter (Dec-Feb) and higher value was observed for males (2.37±0.89) and females (1.38±0.54) during monsoon (Jun-Aug).

Low feeding activity in female of *M. aral* might be due to longer spawning period and large number of males in gestating conditions observed in the present study. Mojumdar (1969) and Mojumdar & Dan (1981) also reported low feeding intensity in *Tachysurus thalassinus* and *T. tenuispinis* during their breeding cycle. It may be because more intensive sexual stress in females than that of males as observed by Khumar & Siddiqui (1989). Serajuddin & Ali (2005) also reported less intense feeding during October-December in the species they studied. The feeding intensity was better in monsoon and it is in conformity with the observations made by Venkataraman (1960). Slight difference was observed in the seasonal feeding intensity of the two sexes. The intensity of feeding in males was higher than in females for *M. aral* (Figure 2). It may be related to food abundance during this season and to predominance of immature and maturing fishes which feed actively. Distinctive decline in feeding activity for the species during winter (Dec-Feb) can be attributed to recovering stages of gonads as well as low temperature of water and non availability of preferred food. The intake of food subject to variations of preferred food items from season to season. The variation to a large extent seems to be connected with breeding season of the fishes.

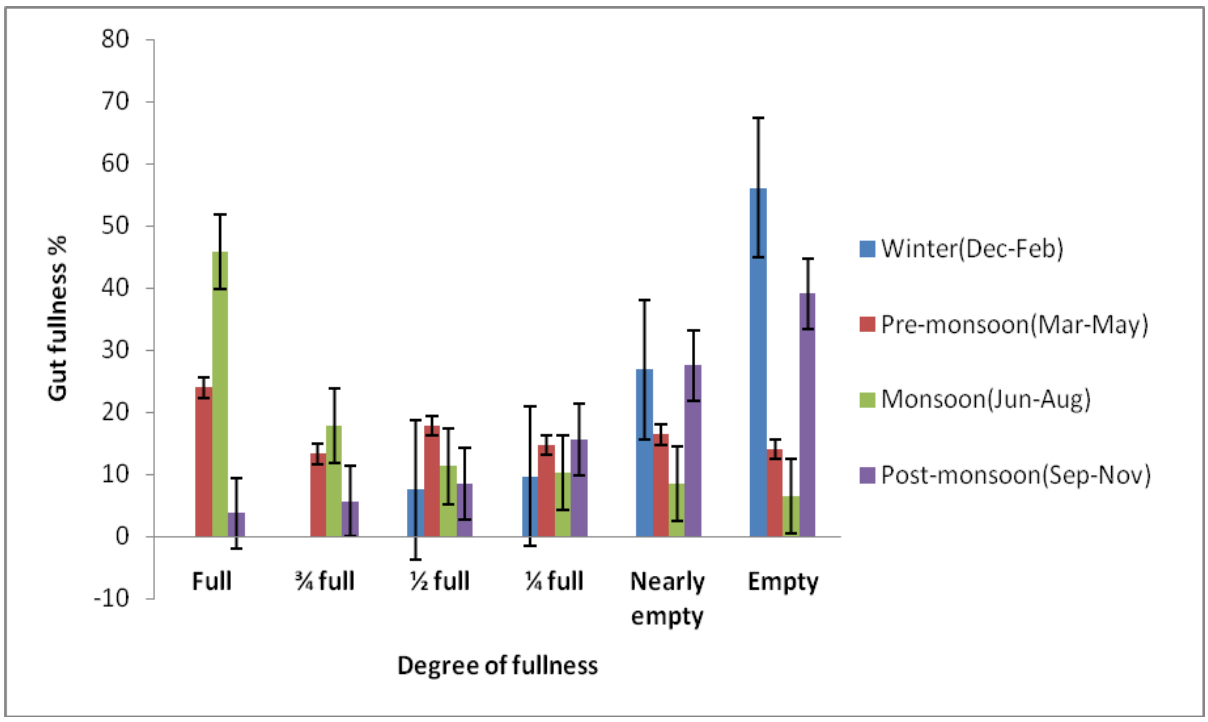

Figure 1. Fullness of gut of *M. aral* at different seasons

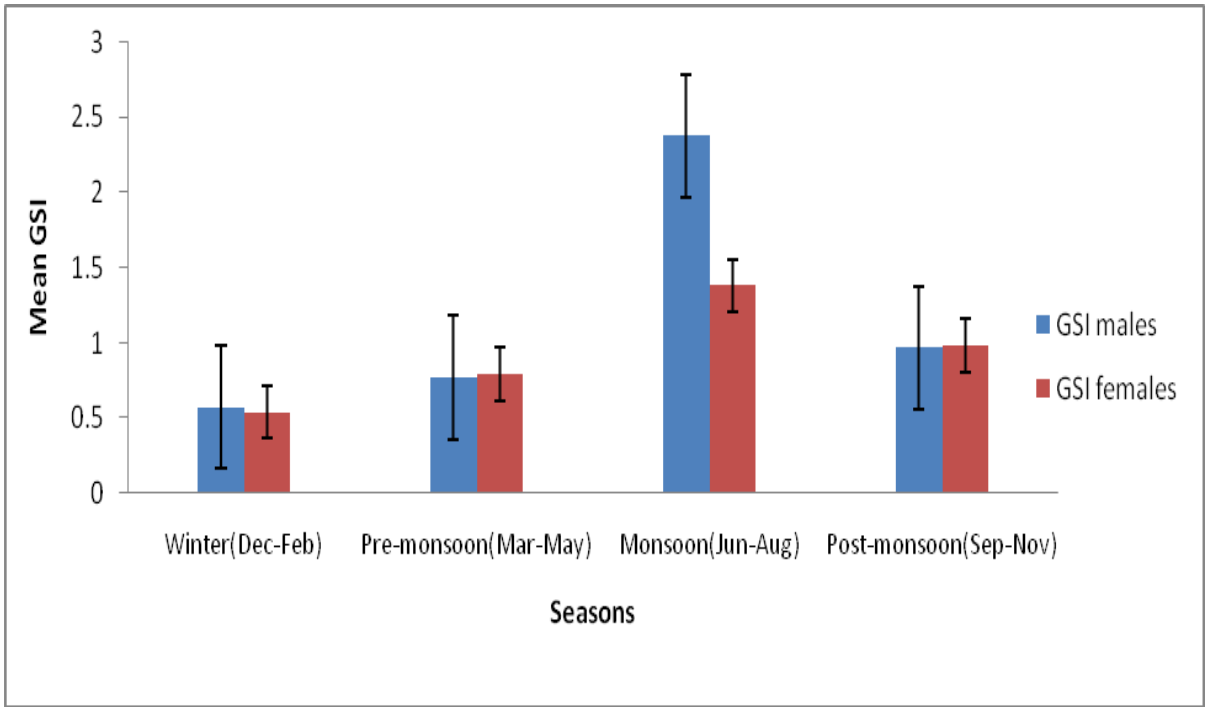

Figure 2. Seasonal variations in Gastrosomatic index of *M. aral*

Table: 4. Monthly variations of Gastrosomatic index (GSI) of *M. aral*

Months	Males	Females
Jan	0.56 ±0.14	0.57 ±0.35
Feb	0.55 ±0.13	0.45 ±0.12
Mar	0.71 ±0.54	0.47 ±0.15
Apr	0.61 ±0.26	0.82 ±0.23
May	1.03 ±0.56	1.39 ±0.58
Jun	3.72 ±1.84	1.11 ±0.26
Jul	1.72 ±1.47	1.17 ±0.54
Aug	1.68 ±0.85	1.85 ±0.61
Sep	1.15 ±0.40	1.15 ±0.27
Oct	0.83 ±0.62	1.12 ±0.12
Nov	0.93 ±0.56	0.66 ± 0.76
Dec	0.60 ±0.32	0.59 ±0.24

Table: 5. Mean variation of GSI of *M. aral* at different maturity stages

Maturity stages	Males	Females
Immature (Stage-I)	1.86 ±0.75	0.78 ± 0.37
Maturing (Stage-II)	1.82 ±0.82	1.17 ± 0.45
Mature (Stage-III)	1.54 ±0.73	1.06 ± 0.48
Ripe (Stage-IV)	1.62 ±0.69	0.71 ± 0.20
Spent (Stage-V)	0.81 ±0.34	0.54 ± 0.14

Table 6. Index of pre-ponderence of different food items of *M. aral*

Food Items	% of Vol.	% of Occ.	V_1O_1	$\frac{V_1O_1 \times 100}{\Sigma V_1O_1}$	Grading
Zooplankton	20.16	24.89	501.78	20.02	II
Insects larvae	40.6	38.95	1581.37	63.1	I
Crustaceans	6.03	5.40	32.56	1.30	V
Annelids	3.46	3.70	12.8	0.52	VI
Molluscs	1.66	1.57	2.61	0.1	VII
Sand & mud	10.15	9.82	109.49	4.37	IV
Misc.(unidentified matters, algal, fish egg)	17.94	15.67	265.45	10.59	III
Total	**100**	**100**	**2506.06**		

Again, GSI in relation to maturity stages, the minimum GSI (0.81±0.34) was observed in spent stage (stage V) and that of maximum (1.86±0.75) in immature (stage I) stage for male *M. aral* on the other hand, minimum (0.54±0.14) and maximum (1.17±0.45) values were recorded in spent (stage V) and maturing stage (stage II) respectively for female *M. aral* (Table 5). This suggests that, at maturing stage, the fish feed more voraciously because of a higher energy demand associated with gonadal development. Khan (1988) and Serajuddin *et al*. (1998) also reported the same type of feeding intensity in relation to the stage of maturity in the freshwater catfish, *Mystus nemurus* and spiny eel, *Mastacembelus armatus* respectively.

The intensity of feeding declined when fish became mature/ripe and were ready for spawning and completely reduced to its lowest level in spent fish. The stress brought to bear on the alimentary canal of the fish by its developed gonads appeared to be the causative factor in the decline in feeding. The occurrence of poor feeding in other fishes coinciding with peak breeding was reported by various workers (Bhatnagar & Karamchandani 1970; Wijeyaratna & Costa 1987; Khan, 1988). Further, the low feeding activities in case of spent fishes coincides with the long spawning season. Khan (1972) and Chaterjee (1974) also reported that fluctuation in feeding intensity in the fishes took place due to maturation of their gonads. In present study too, the feeding activity of spiny eel was found to be fluctuated with season as well as maturity stages.

The index of pre-ponderance values (Table 6) of *M. aral* showed that insect larvae were the most preferred food item (63.1%) for this species, followed by zooplankton (20.02%) miscellaneous includes unidentified matter, algal & fish egg (10.59%), sand & mud (4.37%), crustaceans (1.30%), annelids (0.52%) and molluscs (0.10%). In the index of pre-ponderance, the occurrence of a high percentage of insect larvae followed by zooplankton, and other micro invertebrate fauna in the diet of the species and it revealed that the spiny eel is a carnivorous feeder and feeds in the bottom. Differences in the dominance of different food categories can be attributed to their availability and the habitat where the fish lived at a particular time. According to Desai (1992) food and feeding habits of fish vary as per availability of food, depending on the ecology of the environment. The diet of fish depends on the availability of food which in turn is governed by the biotic factors of the environment. Dutta (1989/1990) and Serajuddin *et al.* (1998) found aquatic insects, crustaceans, annelids, and small forage fish as major food items and indicated stenophagism feeding habit of the species. Similar results were also reported for the closely related species, *M. armatus* by Serajuddin & Ali (2005). Although the basic feeding habit was almost identical, the intake of different food items showed variation in the present from those of Serajuddin & Ali (2005) and Suresh *et al.* (2006).

Gut content analysis reveals that the percentage composition of food items in the gut of spiny eel as observed in different months has been summarized in the Table 7. The food items found in the examined stomachs were grouped into 7 broad categories viz. zooplankton, insect larvae, crustaceans, annelids, molluscs, sand & mud and miscellaneous includes unidentified matter, algal & fish egg. It was seen that there were considerable variations in the percentage of different food items during different months of the year.

***Zooplankton*:** The highest percentage occurrence of zooplankton was encountered in April (29.64) and lowest (8.78) in October

Insect larvae: This item varies from 41.03 (November) to 53.82 (March).

Crustaceans: The highest percentage of Crustaceans was observed in May (12.12) and lowest in October (4.78).

***Annelids*:** The percentage occurrence of Annelids was highest in June (12.33) and lowest in September (1.5)

***Molluscs*:** The highest percentage of molluscs occurred in May (7.22) and lowest in August (2.05)

***Sand & Mud*:** The highest percentage of occurrence of sand & mud in December (27.3) and lowest in May (1.89).

***Miscellaneous (includes unidentified matter, algal & fish egg)*:** The highest percentage was observed in January (74.59) and lowest in May (6.02).

Gut content analysis and occurrence of food item reveals that different types of zooplankton were encountered in relatively large quantities in the stomach content of the species during March

to October. They were scarce in the gut from November to February but as a whole, contributing to an average of 15.33 % of total food intake in *M. aral*. Miscellaneous item include unidentified matter, algal and fish eggs were the next preferred food item in the species and annually contributed 26.88 %. Insect larvae were present moderately in most of the months except December and January and contributed annually 37.96 %. Large amount of sand and mud in the gut of the species were found in October to February and contributing annually as 9.57%. Sand and mud could be taken while fish was burrowing the muddy bottom to prey upon benthic animals. Presence of crustacean in the stomach content in different months showed considerable variation with relatively high percentage of occurrence during March to October. They constituted as 5.49% in the gut content of *M. aral*. Similarly, annelids and molluscs were also not observed in their gut regularly. The average contribution of annelid formed 3.2 % and molluscs as 1.57% of the total intake of food by these species. The percentage of molluscs was very low than other food items in throughout the year.

Table 7. Food composition of *M. aral* in different months

Month	No. of fish examined	Zooplankton			Insects larvae	Crustaceans	Annelids	Molluscs	Sand & mud	Misc.
		Rotifers	Cladocera	Copepoda						
Jan	35	--	--	--	--	--	--	--	25.41	74.59
Feb	30	--	6.82	4.14	45.5	--	3.28	--	8.26	32.0
Mar	36	3.0	12.29	6.51	53.82	5.38	--	4.0	3.75	11.25
Apr	36	7.26	14.03	8.35	48.52	6.43	5.36	--	2.41	7.64
May	34	4.31	12.56	6.72	41.46	12.12	7.7	7.22	1.89	6.02
Jun	36	2.23	14.45	4.3	42.12	8.0	12.33	5.56	2.56	8.45
Jul	35	2.86	16.73	5.27	47.32	9.88	4.29	--	2.57	11.08
Aug	36	2.44	14.96	4.43	46.31	10.40	3.89	2.05	2.32	13.2
Sep	36	2.17	13.27	6.06	47.11	8.89	1.5	--	4.78	16.22
Oct	35	--	*8.78*	--	*42.29*	4.78	--	--	13.86	30.29
Nov	36	--	--	--	*41.03*	--	--	--	19.75	39.22
Dec	36	--	--	--	-	--	--	--	27.3	72.7
Overall	**421**	**2.02**	**9.49**	**3.82**	**37.96**	**5.49**	**3.2**	**1.57**	**9.57**	**26.88**

Table 8. Composition of diets in juvenile and adult of *M. aral*

Food Items	Juvenile (7-12) cm	Adult (>13) cm
Zooplankton	46.44	19.56
Insects larvae	27.0	34.45
Crustaceans	1.97	8.02
Annelids	5.38	11.75
Molluscs	--	5.16
Sand & mud	2.05	6.02
Misc.	17.16	15.04

The gut content analysis predicts that the relative occurrence of different food items varied from month to month. Such variation appeared due to varied production or supply of the food items in the environment. Reddy (1991) reported the presence of sand and mud in the stomach of *Silago sihama* from Karwar waters. The occurrence of sand and mud throughout the year in the gut confirmed the bottom feeding habit of the fish (Blaber, 2000). According to Moyle & Cech (2000), fishes are classified as deteritivores, herbivores, carnivores and omnivores based on the type of food. Within these categories they can be further characterized as euryphagous (eating mixed diet), stenophagous (eating limited assortment of food types) and monophagous (consuming only one sort of food). Thus, spiny eel can be classified as euryphagous carnivores with a wide range prey selection. Seasonal change in temperature not only influence food consumption and rate of digestion but also quality and quantity of available food organisms (Bhuiyan et al., 2006).

As far as food composition in different life stages of spiny eel was concerned (Table 8), in juveniles of *M. aral*, a strong positive selection was observed for zooplanktonic organism (46.44%), insect larvae (27%), miscellaneous includes unidentified matter, algal & fish egg (17.16%), annelids (5.38%), sand & mud (2.05%) and crustaceans (1.97%). The most preferred zooplanktonic organisms were rotifers, cladocerans and copepods. In adults of *M. aral*, the most dominant food item was insect larvae (34.45%) and followed by zooplankton (19.56%) and miscellaneous includes unidentified matter, algal & fish egg (15.04%). Annelids (11.75%), crustaceans (8.02%), sand & mud (6.02%) and molluscs (5.16) formed the rest of the food items in the guts of the *M. aral*.

The gut content analysis of the species in juvenile and adult fishes shows that a little variation in different types of its food items, with the increase in its length. The zooplankton were the most preferred food item in juvenile of the species and an insect larvae was observed to be the most preferred food in the adults of the spiny eel. Juveniles were found to consume mostly rotifers, cladocera, copepod etc. Among zooplankton *Keretella*, *Monostylla*, *Rotaria*, *Daphnia*, *Alona*, *Moina*, *Cyclop*, *Diaptomus* and *Eucyclops* were preferred by the juveniles while aquatic insect larvae (e.g. *Diptera*, *Hemiptera*) and miscellaneous item (unidentified matter, algal & fish) were eaten mostly by the adult spiny eel. Annelids and crustaceans together represented the secondary food for adults. Molluscs were totally avoided by the juveniles in the species.

The food composition in different life stages of *M. aral* reveals that the zooplankton were the most preferred food item in juvenile and an insect larvae was being preferred food in adult. Nikolsky (1963) suggested that variation in the composition of the food with age and size is a substantial adaptation towards increasing the range of food supply of population by enabling the species as a whole to assimilate a variety of food. The fry and fingerlings of major carps were also found zooplankton as the dominant food (Khan & Siddiqui, 1973). The fishes are known to change their feeding habit as they grow (Ajayi, 1972; Ikusemiju & Olaniyan, 1977). Dutta (1989/1990) while carried out stomach content analysis of *M. armatus*, reported it as selective insectivorous fish. The present study may be concluded that the occurrence of different types of the food items in gut contents of the fish in dif-

ferent months depend on their availability rather than selection by the spiny eel. The species is a non migratory fish and remains in a specified habitat throughout its life and has to adopt the food available in the habitat during all seasons of the year. The same species occupy different habitat may feed on different types of food (Hyndes et al., 1997) or even in the same habitat the diet may vary at different times. The diets of most fish species changes with age and growth. The time and extent of changes in food and feeding habits varies from species to species and often with changes in the style or habitat (Blaber, 2000).

Conclusion

The results reveal that the food and feeding habit of *M. aral* vary from season to season. The feeding habit of spiny eel was almost identical in juvenile and adult stages. The juvenile and adults of the species feed on higher percentage of zooplankton and insects and lower percentage of annelids, crustaceans, molluscs, algal materials, fish egg and semi-digested materials etc. The degree of fullness of guts exhibited more or less similar trend in the species. The active feeding was found during monsoon, moderate in pre-monsoon and poor feeding in post monsoon months. It was also observed that the maximum numbers of empty stomachs were recorded during winter season. Again, the poor feeding intensity (GSI) was recorded in spent stage (winter months) while the active feeding intensity was observed in immature and maturing stages (monsoon months). High percentage of sand and mud in the gut indicated that the species is bottom feeder and carnivorous in feeding habit. The diversity and flexibility of food component in the diet observed in this study from wild population of *M. aral* indicates that the fish appears capable of widening the food spectrum in response to habitat availability. Further investigation are required on feeding strategies, diet preferences, and compatibility with other cultivable fish species during different life stages before adapting in to the culture system.

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