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Food and feeding habits of peacock eel, *Macrognathus aculeatus* (Bloch, 1786) from Eastern Uttar Pradesh, India

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Abstract
Feeding intensity in relation to season and maturity stages and food items of peacock eel, *Macrognathus aculeatus* (Bloch, 1786) were investigated. Slenderical body, well developed dentition, modified gill rakers, strongly built stomach and short intestine are some of the characteristics that were related to fish's dietary composition. There was no major shift in from the basically carnivorous orientation of the fish during its various life stages. Forage fish and annelids were the basic food of adult while aquatic insects and annelids were eaten by juveniles. Feeding intensity was high in stage III at which gonad ripens and was relatively low in the specimens with ripe gonads. Large size fish consumed more food during autumn while smaller individuals feed heavily during post monsoon and autumn. Juveniles and adults both consumed lesser quantity of food during winter, but there was no cessation of feeding in any period of their life.

Keywords: Peacock eel, feeding intensity

1. Introduction
The Peacock eel, *Macrognathus aculeatus* (Bloch, 1786), is a common species of teleosts (Mastacembelidae) found in Asia. It is economically important inland-water fish which is quite palatable as a table fish and nutritive too. This fish has been reported from India, Pakistan, Sri-Lanka, Bangladesh, Myanmar, Thailand, Malaysia and southern China. It occurs in a variety of freshwater habitats in the plains as well as in the hills of India. Rahman reported the availability of spiny eels in rivers, canals, beels, and ponds and inundated fields throughout Bangladesh [1]. Despite of its palatability and consumer appeal a little information is available on the biology of this fish. The studies carried out on this fish are related to the seasonal variation in fat and water contents and functional anatomy of digestive organs [2, 3]. Keeping in mind the paucity of information on the biology of this species, the present study focusing on the food and feeding habits of *M. aculetus* was undertaken, which would be useful for the artificial propagation of this fish in aquaculture.

2. Materials and Methods
Monthly samples (each sample comprising 25-40 fish) of peacock eel ranging between 4.0 - 22.5 cm in size were collected by using cast and drag nets from rivers of Sant Ravidas Nagar Bhadohi district (25°9′ 32″ N 82°14′ 82″ E) for a period of 12 months from January to December, 2015. The time of collection was fixed during the early hours of the morning to minimize the possible effects of diet on feeding and differential digestion of food items. Total length of each fish was measured by using fish measuring board to nearest 0.1mm and their weight was recorded on an electric balance sensitive up to 0.001gm. Males and females were separated and divided into two length groups. Close examination of anatomy and morphology of alimentary canal of each specimen was carried out. After removing different parts of alimentary canal from fresh specimens they were fixed in Boin's fluid. Sections of 10-20um of different organs of alimentary canal were cut after staining in Heidenhain's iron haematoxylin, Mellory's triple stain and Azan's technique. Relative length of gut (RLG) (length of alimentary canal/total body length) was computed. The intensity of feeding was recorded on the basis of the state of distention of the gut and by determining the gastro somatic index (gut weight expressed as percentage of body weight). For quantitative gut content analysis, the methods like the frequency of occurrence, numerical count and gravimetric method as suggested by Lagler [4] were applied.

The prey items were identified and categorized according to their systematic status using the keys as given by Endmondson [5] and Needham and Needham [6]. All the statistical analysis was done with the help of software GraphPad Prism 5.

3. Results

The adaptation of the digestive organs and certain external morphology of *M. aculeatus* were found to be greatly influenced by the type of food they consumed and by the way of their feeding. The percentage of the body width with respect to the total body length in all life stages of this fish was 10.5% of total body length, which indicated towards agile life style of the fish suited for its predacious nature. A significant correlation (r=0.98) was noted between body width and body length.

3.1 Morphology and Anatomy of the Organs Concerned with Feeding and Digestion

The alimentary canal, a tube of variable diameter, of peacock eel is comprised of kopfdarm (buccal cavity and pharynx) and rumpfdarm consisting of foregut (esophagus and stomach), midgut (intestine) and hindgut (rectum) with a pair of appendices epiloicae. The sub terminal mouth is bounded by firm jaws where upper jaw is more muscular and longer than the lower one forming an inverted ′Y′ shaped slit of the mouth. The ventral shallow groove in the upper jaw leads into mouth that helps in directing the food towards mouth. Both jaws bear small well developed and strong, sharp, pointed villiform, backwardly directed mandibuler teeth. The teeth do not show any enlargement with canine and incisor type of dentition. Buccal cavity is narrow anteriorly and wide posteriorly, and containing poorly developed epithelial folds. Two pairs of oval shaped superior pharyngeal teeth are present in front of gullet on the roof of pharynx. The second pair of superior pharyngeal teeth is large compared to first pair and situated near to the second, third and fourth gill arches. Opposite to the superior pharyngeal teeth, there are two pairs of inferior pharyngeal teeth near to the third and fourth branchial arches. The teeth of both jaws are small, pointed and backwardly directed towards gullet. Widely spaced double rows of gill rakers are in the form of horny notches. Four pairs of gill clefts perforating the pharynx ventro-laterally at both sides. Esophagus, a long, tubular, broad anteriorly and narrow posteriorly, bears a longitudinal and straight mucosal folds throughout the wall, and it continues with the mucosal folds of stomach. The elongated stomach with thick muscular wall is well developed that can be distinguished into cardiac and pyloric regions, and having a pair of appendix, epiloicae. The mucosal folds of stomach are similar to that of esophagus and converged at the pyloric end of the stomach. Stomach opens into ′V′ shaped and straight thick walled intestine known as duodenum and ileum respectively. There is no any external demarcation between duodenum and ileum, but they differ internally as ileum containing mucosal folds having cavities that are irregular in shape. Rectum is short, tubular and narrow. A reddish brown single lobed liver situated on the ventral side of the alimentary tract and extends up to ileum, which is anteriorly narrow and broader posteriorly. A small and spherical gall bladder is situated at the posterior end of the liver, and remains connected with duodenum through a bile duct.

3.2 Relative Length of Gut

The values of relative length of gut of different age groups of peacock eel are given in Fig.1. The ratio in the entire size range of fish inclusive of both juveniles and adults varied from 0.53 to 0.63 with an average value of 0.56. The absence of appreciable difference in this ratio in juveniles and adults indicated that growth of *M. aculeatus* does not involve any major shift in the basically carnivorous habits. The relation between gut length and body length was expressed by the equation:

Log gut length =- 0.26431+1.0342 Log body length (cm).

A significant correlation (r=0.731) (p<001) was found between gut length and body length.

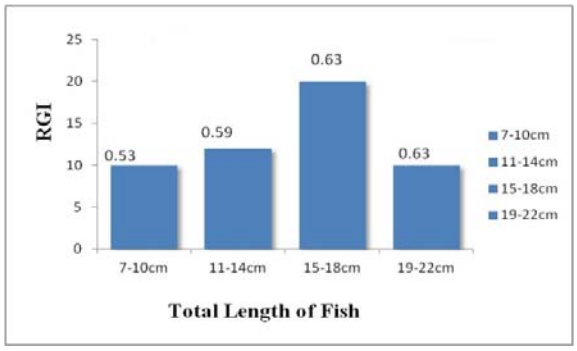

Fig. 1: Relative gut index of different sizes in *M. aculetus*

3.3 Intensity of Feeding in Relation to Seasons and Maturity Stages

The values of gastro somatic index (GSI) of both sexes of different age group for different months are given in Table 1 and Fig. 2. Individuals in the size range 16-20 cm consumed more food during the period of March-April (autumn) while younger specimen in the size range 10-15 cm were found to feeding heavily during March-April (autumn) and August - October (post monsoon). The juveniles and adults both consumed a lesser quantity of food in the month of December (winter). In female specimens, maximum values of GSI were recorded in the months of March and April in the size ranges 10-15 cm and 16-20 cm respectively. A higher GSI was recorded for male individuals of all sizes in March. Maximum number of empty guts was found during spawning and winter seasons.

Feeding intensity in males and females at different stages of their maturation is given in Figs.3 (A-B) and Table 1. In both sexes of peacock eel, it was found that the most active feeding period is the stage at which gonad ripens i.e., the third stage of sexual cycle. The feeding intensity was comparatively reduced in the ripe stage (IV) as maximum numbers of empty guts were encountered during this stage in both males and females of peacock eel. Occurrence of fish with medium gut fullness in all maturity stages during the whole year suggest that there was no cessation of feeding in any period of their life.

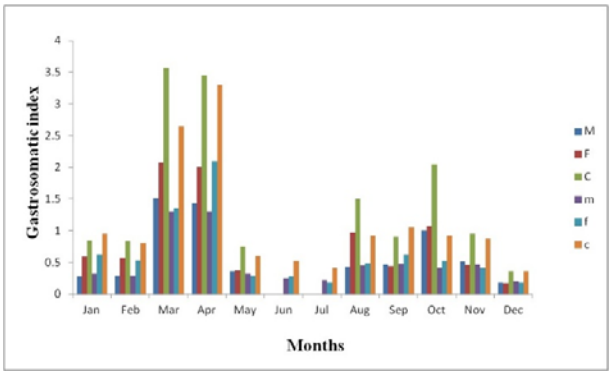

Fig. 2: Gastrosomatic index of *M. aculetus* in different seasons

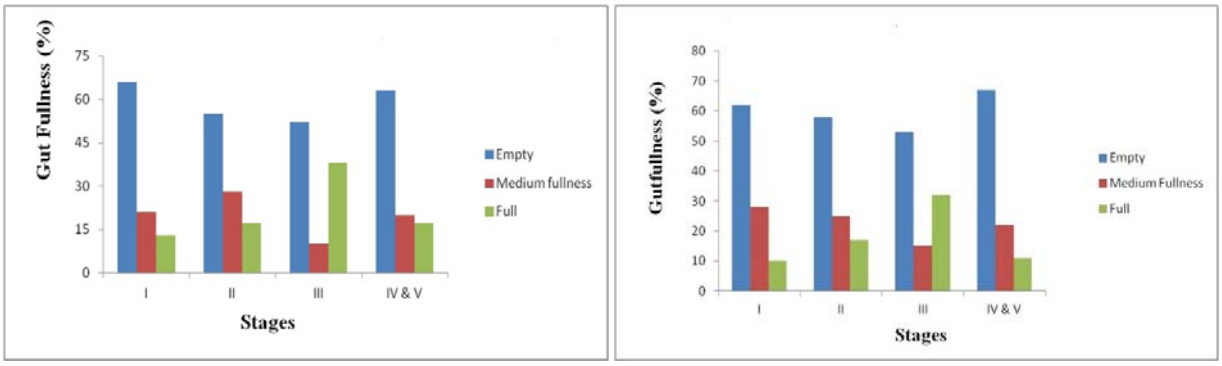

Fig. 3: Feeding Intensity of (A) male and (B) female *M. aculeatus* in different stages of maturation

Table 1: Gastrosomatic index (GSI) of *M. aculeatus* in different seasons

Months	Size ranges of sexes					
	10-15 cm			16-20 cm		
	Male	Female	Combined	Male	Female	Combined
January	0.28	0.59	0.85	0.32	0.62	0.95
February	0.29	0.57	0.84	0.29	0.53	0.81
March	1.51	2.08	3.57	1.3	1.36	2.65
April	1.43	2.00	3.45	1.3	2.10	3.3
May	0.36	0.37	0.75	0.32	0.29	0.60
June	-	-	-	0.25	0.28	0.52
July	-	-	-	0.22	0.18	0.41
August	0.43	0.97	1.50	0.45	0.49	0.92
September	0.47	0.44	0.90	0.48	0.62	1.05
October	1.01	1.07	2.05	0.41	0.52	0.92
November	0.51	0.46	0.95	0.47	0.41	0.87
December	0.18	0.17	0.36	0.20	0.18	0.36
Mean ± SE	0.65 ±0.14	0.87 ±0.20	1.52 ±0.34	0.50 ±0.10	0.63 ±0.15	1.11±0.25

3.4 Food Composition

The diet of peacock eel investigated in the present study belonging to five different categories is given in Table 2 and Fig. 4. Teleostomi (*Puntius*) was the most preferred prey organisms of peacock eel. According to the criteria of frequency of occurrence, the other preferred organisms of the present fish were dipterans larvae, prawn, earthworm, brine shrimp and hemipteran larvae. The remaining prey categories of lesser importance were gastropods and some unidentified materials.

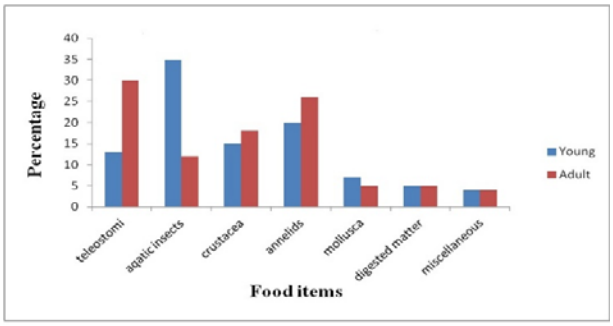

Fig. 4: Percentage composition of broad categories of food item

Table 2: Gut contents of the spiny eel, *M. aculeatus*

Food items	Numerical count	Frequency of Occurrence (%)	Gravimetric Index (%)
Teleostomi			
Puntius	14	45	82.2
Esomus	08	10	
Aquatic insects (larval stage)			
Ephemeroptera	Numerous	17.1	6.20
Diptera	Numerous	32.5	18.81
Hemiptera	04	16.5	0.51
Unidentified	35	7.4	3.32
Crustacea			
Prawn	78	25.6	66.4
Eubranchipus	79	20.1	0.91
Daphnia	15	10.2	
Annelids			
Earthworms	Numerous	22.2	16.6
Mollusca	05	3.8	0.21
Gastropods			
Digested matter		34.9	34.5
Miscellaneous		10	6.41

4. Discussion

The slenderical shape of the body, pointed mouth, well developed dentitions, modified gill rakers, well developed stomach, almost straight and short intestine together with the dominance of animal matter in the gut contents described the carnivorous and active predacious nature of peacock eel. A shallow groove that present in upper and lower jaws helps in directing the food particles towards mouth. Pointed mouth helps and facilitates the probing of the food materials, which are concealed under submerged objects and bottom deposits. The mandibular, superior and inferior pharyngeal teeth together with chitinous ridges of the upper jaw immobilize and prevent the prey organism from their escape. Das and Moitra [7] have emphasized that the buccopharyngeal region with well-developed pharyngeal system performs the functions of holding, biting and rasping the prey. Different workers described the role of gill rakers in feeding behavior [8, 9]. In peacock eel, gill raker was modified into uneven horny notches that play an important role in sieving and immobilizing the ingested prey items. Al- Hussaini [10] and Das & Moitra [7] also reported that the gill rakers provide additional hold for gripping the prey in carnivorous fishes. The alimentary canal of peacock eel is thick, elastic and muscular tube that adapted to accommodate the small to medium sized fish, prawn and annelids which are ingested and swallowed whole with no mastication. The fish lacks structural adaptation to consume items like molluscs etc. which require oral grinding. The gape of the mouth and diameter of buccopharynx and esophagus are wide and accommodating to support intake of large prey organisms. Elongated shape with thick muscular wall and remarkable distensibility of the stomach described its capacity and capability to receive the sizeable items and to perform its mechanical function of macerating the food in addition of digestion. The straight mucosal folds of esophagus and stomach provide enough space for gastric glands for their effective function in digestion of animal origin substances. The honey comb shaped mucosal folds in duodenum, irregular elongated cavities in ileum and straight mucosal folds in rectum provide large and enough surface for the absorption of digested food materials. Similar report was given by many workers [10, 11, 12]. The low values (1>) for gut length/ body length ratio also support the carnivorous orientation of the fish. Several workers correlated the relative length of gut with feeding habits of fish [8, 13, 14]. The absence of any appreciable difference in the index of relative length of gut in juveniles and adults of peacock eel pointed that growth does not involve any major shift in the basically carnivorous orientation of the dietary habit. Similar observations were reported by Serajuddin and Ali [15] in closely related species *Mastacembelus armatus* and *Macrognathus pancalus* respectively.

The gastrosomatic index is generally used to study the intensity of feeding in fishes [16]. The finding of the present study indicated that foraging activity of peacock eel fluctuated with season and maturity stages, but it never discontinued even during breeding season as it was indicated by the presence of medium gut fullness in almost all the months. Low intensity of feeding at ripe stage (IV) during breeding seasons in peacock eel may be due to the stress brought about on the alimentary canal by the developed gonad. The occurrence of low feeding intensity during breeding season has been reported in previous studies [17, 18, 19, 20, 21]. Low feeding rate during other months may be due to non-availability of food organisms and affect of certain biotic factors such as temperature and turbidity. High rate of feeding in maturing (Stage III) and spent (Stage IV) individuals during post monsoon period may be because of high demand of nutrition for growth and development in immature fish and replenishment of gonad in spent fish. Working on other species of spiny eels, *M. armatus* similar result was reported by Serajuddin *et al*. 1998.

Following the criteria proposed by Nikolsky [22], food items of peacock eel could be divided into three categories: Teleostomi and annelids as basic food for adults and aquatic insects and annelids constituted the basic food for juveniles (Fig.7). Crustaceans and aquatic insects together represented the secondary food of adults, while forage fish and crustaceans could be considered as a secondary food for juveniles. Molluscs and other miscellaneous items could be regarded incidental items for both juveniles as well as adults.

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6. References

1. Rahman AKA. Freshwater fishes of Bangladesh. Zool Soc Bangladesh Univ Dhaka 1989, 364.
2. Prasad S, Pandey BN, Sinha DP. Seasonal variation in fat and water contents of the Indian freshwater mud eel, *M. aculeatus*. Z. Tierphysiol. Tierer naehr Futtermitot lkd. 1983; 49:117-126.
3. Srivastava VMS. Functional anatomy and digestive organs of freshwater fish *Rhynchobelella aculeata*. Vestnik CS Spol Zool Bohemoslov. 1970; 34:136-142.
4. Lagler KF. Freshwater fishery biology. 2nd ed. Iowa Wm. C. Brown Co., U.S.A, 1956, 421.
5. Endmondson WT. Freshwater Biology. 2nd ed. John Wiley and Sons, New York, London, 1959, 389.
6. Needham JG, Needham PR. A guide to the study of Freshwater Biology. Halden-Day, San Fransicco, 1962, 205.
7. Das SM, Moitra SK. On the correlation between the fish food and fish gut in food fishes of U.P. 42nd Proc Ind Sci Cong 1956; 4:10.
8. Sinha GM, Moitra SK. Studies on the morpho- histology of the alimentary canal of young *Cirrhinus reba* (Ham.) with a comparison to that of the adult in relation to food. Vestn Ces Spol Zool. 1976; 40:221-231.
9. Marsh PC. Digestive tract contents of adult Razorbaceae suckers in lake Mohave, Arizona- Nevada. Trans Am Fish Soc. 1987; 116:117-119.
10. Al-Hussaini AH. The anatomy and histology of histology of the alimentary tract of the bottom feeder, *Mulloides auriflemma* (Forsk.). J Morph. 1946; 73:112-153.
11. Dewes B. The histology of the alimentary tract of Plaice, *Pleuronectes platessa*. Artly. J Micros Sci. 1929, 243-274.
12. Srivastava GJ. A new species of freshwater fish of the genus *Hemiramphus* Cuv from Gorakhpur, Utter Pradesh, India. J Bombay Nat Hist Soc. 1967; 64:93-94.
13. Khan RA. Studies on the biology of some important major carps. Ph.D. Thesis A.M.U. Aligarh., 1972.
14. Serajuddin M, Khan AA, Mustafa S. Food and feeding habits of spiny eel, *Mastacembelus armatus*. Asi. Fish Sci. 1998; 11:271-278.
15. Serajuddin M, Ali R. Food and feeding habits of striped spiny eel *Macrognathus pacalus.* Indian. J Fish. 2005;

52:71-77.
16. De-Silva SS, Wijeyaratne MJS. Studies on the biology of young grey mullet, *Mugil cephalus* L.II. Food and feeding Aquaculture. 1977; 12:157-167.
17. Desai VR. Studies on the fishery and biology of *Tor tor* (Ham.) form river Narbada. J Inland Fish Soc India. 1970; 2:101-112.
18. Bhatnagar GK, Karamchandani SJ. Food and feeding habits of *Labeo fimbriatus* (Bloch) in river Narbada near Hoshangabed (M.P.). J Inland Fish Soc India. 1970; 2:30-50
19. Wijeyaratne MJS, Costa H. The food, fecundity and gonadal maturity of *Valameegil cunnesius* in the Nigombu Lagoon, Sri Lanka. Indian. J Fish. 1988; 35:71-77.
20. Khan MS, Ambak MA, Mohsin. Food and feeding biology of a tropical freshwater cat fish, *Mystus nemurus* C & Vwith reference to its functional morphology. Indian J Fish. 1988; 35:74-78.
21. Rao, Rao KS. Food and feeding behaviour of *Nemipterus japonicus* (Bloch) population of Vishakapatnam, South Ind J Mar Biol Assoc India 33, 33.
22. Nikolsky GV. Ecology of fishes. Academic Press, London 1963, 352.