Trophic Biology of *Ethmalosa fimbriata* (Bowdich, 1825; Pisces: Clupeidae) in the Cross-River Estuary, Nigeria

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ABSTRACT

The study was conducted to investigate the food and feeding habits of Ethmalosa fimbriata in Cross River estuary using standard methods. A total of 301 specimens were examined, 69 (22.92%) were small sized group (SSG) while 232 (77.07%) were large sized group (LSG). The length of the fish ranged between 5.2 – 6.7mm and 7.1 – 9.8mm in SSG and LSG respectively. The weight varied between 0.9 to 2.9g and 3.0 to 8.9g for SSG and LSG respectively. The fish feed mainly on algae, mud and sand, but detritus and zooplankton were considered incidental items. Feeding intensity was lesser in male than female. Thus, Small sized E. fimbriata feed more actively and feeding intensity decreased with increased size.

KEYWORDS: ***Ethmalosa fimbriata*, food and feeding habit, Cross River estuary and Nigeria**

Introduction

Ethmalosa fimbriata is a coastal shoaling pelagic clupeid of tropical West Africa. It is one of the commonest surface inshore fishes in West Africa and also one of the most important food fish in Nigeria. A variety of studies lead to a conclusion that the bonga shad is locally adapted to cope with wide range of environmental conditions in terms of its morphology, growth, and reproductive trait (Panfili, Thior, Ndiaye and Albaret, 2006).

E. fimbriata is seen along the West African coastline extending from Villa Cisneros, Angola. This range of distribution (24^0 N to 12^0 S) correspond roughly to the extreme Northerly, and Southerly limits of the 25^0 C isotherms throughout the year (Longhurst, 1962). Although a significant fishery for bonga exists in the Niger Delta, and the wider estuary of the Cross River, which borders with the Cameroon Republic, a small fishery occurs in the Lagoon system and open to the sea at Lagos (Bainbridge, 1963).

Ethmalosa fimbriata occur predominantly over substrate of silt and mud (FAO, 1984) and are less abundant over rock, shell and corel. For this reason, the species is more abundant in East of the Niger Delta where the bottom deposit consists of particularly exposed hard substrate (William, 1968). The species is a non-selective filter feeder subsisting mainly on large diatoms and phytoplankton. The species migrate into and out of the estuaries following seasonal changes in salinity as well as with abundance of plankton in the estuary during the dry season. Its migration is possibly due to spawning and feeding needs (Bainbridge, 1963).

The adult of *E. fimbriata* in the marine environment feed mainly on zooplankton but organic detritus also forms a considerable proportion of the stomach content (Blay and Eyeson, 1982). However, there is no much and recent literature on food and feeding habit of this species in Cross River estuary, hence the need for this study.

Materials and Methods

Description of the Study Area

The Cross River system lies appropriately between longitude $7^0$30'E and 10^0E and latitude 4^0N and 8^0N. The Cross River is a tropical fluvial system draining the rainforest belt of Akwa Ibom and Cross River States. It is formed from numerous tributaries from the Western slope of Cameroon mountain which has two spurs in Nigeria as Oban hills in the South and Obudu hills in the North (Akpan, 2002).

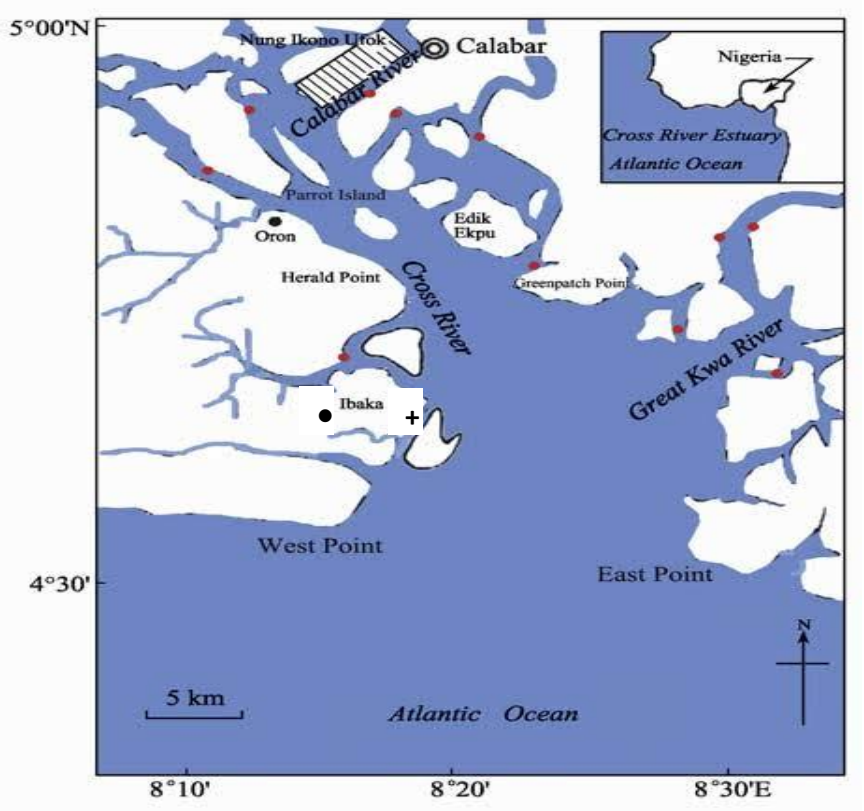

Figure 1: Map of Cross River estuary showing sampling Location

Collection of Fish Samples

Samples of fish were collected over a 8-months period from the catches landed by artisanal fishers in the morning hours. The specimens were taken to the laboratory of Animal and Environmental Biology Department, University of Uyo for examinations. Prior to examinations, the specimens were preserved in 10% formalin in plastic containers.

Morphometric Measurement

The total lengths and standard length of the fish were measured to the nearest 0.1mm using measuring board while the fish weight was measured to the nearest 0.1g using top loading tripod balance.

Analysis of Gut Contents

Fish specimens were dissected using a dissecting blade and the stomachs were slit open. Stomach contents of each specimen were placed on a clean petri dish and aggregates dispersed with few drops of distilled water. The contents were then examined macroscopically and microscopically using X10 and X100 magnifications. Each opened stomach based on the content was allotted points such as; empty stomach - 0%, one quarter full - 25%, half full- 50%, three quarter full - 75% and full stomach 100%. Stomach fullness (SF) indices and mean stomach fullness (MSF) were used to evaluate feeding intensity.

Determination of Food Composition

The number of food items ingested was considered as food richness. The frequency of each item as dominant (by volume) and non-dominant stomach contents were noted, and the method used to assess food composition were relative frequency (RF) which examined the varieties of food items in the stomach, relative dominance (%RD) which determined the numerical abundance of the food item and Index of food preponderance (%IFP) which identified food preference of the fish.

Determination of Fish Size Composition

The fishes were divided into two sized groups; small sized group (SSG) (<7.0cm TL) and large sized group (LSG) (≥ 7.0cm TL). Ontogenic variations in food were assessed based on the size groups.

RESULTS

Size Composition

A total of 301 specimens of *Ethmalosa fimbriata* were collected. Total length ranged between 5.2 – 9.8mm. There was a significant difference between the mean total length of male and female at different sized groups. The weight ranged between 0.9 – 7.5g for males and between 1.1 – 8.9g for female respectively.

Food Composition

The main food items identified were zooplankton which comprises *Paracalanus sp*, Penaeid larva, Gastropod larva and Coelosphaerium. Other food items were algae (*Coscinodiscus sp* and *Navicula sp*), detritus which comprises coarse particulate organic matter (CPOM), fine particulate organic matter (FPOM), mud and sand grains. Zooplankton had 0.54% IFP, Algae, 0.22% while detritus, 0.07%, and mud and sand grains had 0.17% (Table 1).

The Ontogenic variation in trophic spectrum of *Ethmalosa fimbriata* shows that zooplankton in the small sized group had 39.26% IFP, Algae had 34.22% IFP while mud and sand grains recorded 20.96% and detritus had 6.17%. For large sized group, zooplankton had 34.48% IFP, Algae had 31.42% while mud and sand grains had 32.03% and detritus, 2.03% (Table 2).

Variation in food composition with sex (Table 3), shows that detritus in males had 7.65% IFP, zooplankton had 50.77%, while mud and sand grains had 15.80% IFP, and Algae recorded 25.80%. Also, 101.05% were recorded for zooplankton and 31.21% was recorded for Algae and mud and sand grains had 9.73% IFP.

Table 1: The trophic spectrum of *Ethmalosa fimbriata* from Cross River estuary, Nigeria

Food Items	%RF	%RD	%IFD
ZOOPLANKTON			
Paracalanus	5.23	5.32	0.053
Penaeid larva	22.22	24.92	0.24
Gastropod larva	16.44	20.60	0.19
Coelosphaerium	6.25	5.32	0.06
Total	**50.41**	**56.16**	**0.54**
ALGAE			
Coscinodiscos sp	8.08	6.65	0.07
Navicula sp	15.52	14.29	0.15
Total	**23.60**	**20.94**	**0.22**
MUD/SAND GRAINS			
Mud	13.22	13.29	0.13
Sand grains	4.89	3.99	0.04
Total	**18.11**	**17.28**	**0.17**
DETRITUS			
CPOM + FPOM	7.89	5.65	0.07

RF = Relative frequency, RD = Relative dominance, IFP =Index of Food Preponderance, CPOM = Coarse Particulate Organic Matter, FPOM = Fine Particulate Organic Matter

Food Items	Small sized group (<7.0mmTL)			Large sized group (≥7.0mmTL)		
	%RF	%RD	%IFP	%RF	%RD	%IFD
ZOOPLANKTON						
Paracalanus	-	-	-	5.10	5.17	3.81
Penaeid larva	22.95	32.00	20.05	17.15	23.28	15.02
Gastropod larva	16.39	29.00	16.57	12.80	19.40	11.96
Coelosphaerium	4.14	3.10	2.64	3.02	6.90	3.69
Total	**43.48**	**64.10**	**39.26**	**38.07**	**54.75**	**34.48**
ALGAE						
Coscinodiscos sp	24.62	27.10	18.88	23.15	23.28	17.26
Navicula sp	20.02	22.00	15.34	18.86	19.30	14.17
Total	**44.64**	**49.10**	**34.22**	**42.01**	**42.58**	**31.42**
MUD/SAND GRAINS						
Mud	18.87	25.00	16.01	**19.87**	25.00	16.67
Sand grains	9.56	4.00	4.95	**18.19**	23.31	15.41
Total	**28.43**	**29.00**	**20.96**	**38.06**	**48.31**	**32.03**
DETRITUS						
CPOM	3.46	4.31	2.90	3.36	-	1.25
FPOM	4.29	3.02	3.27	2.10	-	0.78
Total	**7.93**	**7.33**	**6.17**	**5.46**	-	**2.03**

RF = Relative frequency, RD = Relative dominance, IFP =Index of Food Preponderance, CPOM = Coarse Particulate Organic Matter, FPOM = Fine Particulate Organic Matter

Table 3: Variations in the trophic spectrum of *Ethmalosa fimbriata* with sexes

Food Items	Males			Females		
	%RF	%RD	%IFP	%RF	%RD	%IFP
ZOOPLANKTON						
Paracalanus	4.55	5.63	5.23	6.57	6.25	5.72
Penaeid larva	22.17	19.72	21.51	29.55	23.88	23.84
Gastropod larva	17.30	16.90	17.56	20.46	19.72	17.93
Coelosphaerium	6.92	5.68	6.47	6.10	7.51	53.56
Total	**50.94**	**47.93**	**50.77**	0	0	0
ALGAE						
Coscinodiscos sp	7.96	10.33	9.39	19.54	10.35	13.34
Navicula sp	16.46	15.50	16.41	17.05	23.00	17.87
Total	**24.42**	**25.83**	**25.80**	**36.59**	**33.35**	**31.21**
MUD/SAND GRAINS						
Mud	9.30	12.68	11.29	7.96	5.09	5.82
Sand grains	4.23	4.55	4.51	5.00	3.76	3.91
Total	**13.53**	**17.23**	**15.80**	**12.96**	**8.85**	**9.73**
DETRITUS						
CPOM	4.73	3.76	4.36	3.41	3.03	2.87
FPOM	3.11	3.28	3.29	3.05	2.85	26.63
Total	**7.84**	**7.04**	**7.65**	**6.46**	**5.88**	**5.50**
Food Richness			**10**			**10**

Feeding Intensity

The total number of fish examined was 301 out of which 58 (19.27%) had empty stomachs, while 241 (80.07%) had partially filled stomach and 2(0.7%) were with full stomach. Males had significantly more empty stomachs (22.23%) than females (7.04%). There was no significant difference ($p < 0.05$) between the small sized group (4.34%) and large sized group (5.17%) (Fig. 2).

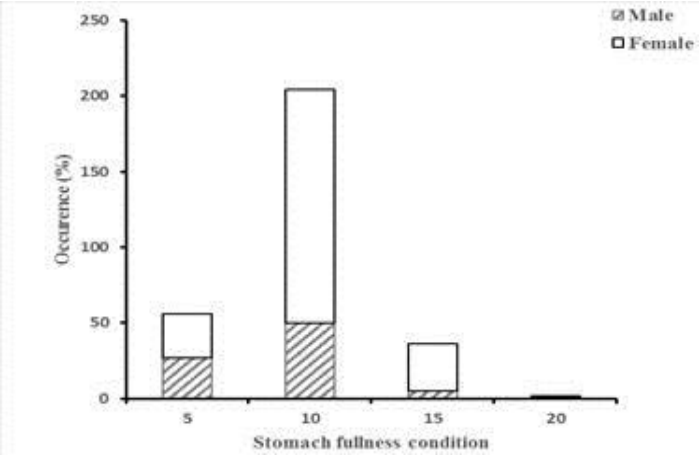

Figure 2: Variations in stomach Fullness of *E. fimbriata* with sexes

DISCUSSION

The fishes ranged in size between 5.2- 2.9cm total length. Female larger than males, probably indicating that they had faster growth than males at juvenile stage. The weight of females was greater than the weight of male, also suggesting that females have high feeding intensities than males. This result is contrary to the study by Doring *et al.* (2017) on the same species carried out in Saloum River, Germany in which the weight of males *E. fimbriata* were greater than that of females. However, the contrasting reports could be attributable to variations in habitat and/or food consumed.

Ethmalosa fimbriata of the Cross River estuary feeds primarily on Algae, mud and sand while detritus and zooplankton were considered accidental items. This is in line with the work carried out by Ekpo *et al.* (2014) on the species at Qua Iboe River estuary where algae and planktonic crustacean were recorded as primary food diet for *E. fimbriata*. Fpom formed the bulk of the detritus. Similar observations have been documented by Blay and Eyeson (1982) on the juvenile at Cape Coast, Ghana. Okon (2000) has reported similar food composition with another chipidae *Ilesha africana* in Qua Iboe estuary.

The results on ontogenic diet composition show that SSG consume less zooplankton and large algae than LSG suggesting diet shift between the two groups. Among the zooplankton, *Paracalanus sp* was completely absent from the food of small sized group. The study also reveals that the large sized group (LSG) had greater number of full stomach than small size group (SSG) indicating high feeding intensity in LSG than SSG. Akpan *et al.* (2002) reported similar result where large sized group fish had higher feeding intensity than small size group. Studies with similar results include Nta *et al.* (2020), Ekpo and Okon (2016).

Males and females consumed similar number of dietaries with equal amount of detritus, zooplankton, Algae, mud and sand grains which is an indication that feeding habit is not gender bias at juvenile stage. However, males had more empty stomach and lower mean stomach fullness (MSF) than females revealing more feeding activities in females. It may also be due to the fact that females are more voracious than males given that females require more energy, and the bulk of it is budgeted in reproductive development.

Conclusion

The *Ethmalosa fimbriata* in Cross River estuary could be considered filter-feeders. The fish had an efficient filtering mechanism for its plankton diet and the fish feeds by borrowing on the benthic deposits.

Recommendation

The study has revealed *Ethmalosa fimbriata* population from Cross River estuary as primarily phytophagous within the study period. However, there is need for further investigations particularly to accommodate seasonal basis in order to enable a definite classification of the species in terms of food preference.

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