RELATIONSHIP BETWEEN FISH SIZE AND DIET COMPOSITION OF FOOD ITEMS OF *Chelon subviridis* IN MERBOK ESTUARY, KEDAH, MALAYSIA

Fatema, K., W. M. W. Omar[1, 2] and M. M. Isa[1, 2]

Department of Fisheries, University of Dhaka, Dhaka1000, Bangladesh; [1]School of Biological Sciences, Universiti Sains Malaysia, 11800 Penang, Malaysia; [2]Center for Marine and Coastal Studies (CEMACS), Universiti Sains Malaysia, 11800 Penang, Malaysia

Abstract

Fish size group and diet composition of food items of *Chelon subviridis* were observed. Fish samples were collected monthly interval from the upstream of Merbok estuary from January to December 2011. A total of 225 fish samples (*Chelon subviridis*) was collected for the analysis of stomach contents. Results showed that this fish species fed on diatom, cyanobacteria, plant materials, zooplankton, detritus and sand grains dependant on size classes. Desmids and pisces were found in the stomach of all size classes except G-5 (22-24cm) and G-3 (18-20cm) size class which consumed more food compared with other classes. Cluster analysis results showed the highest similarity (0.858%) between G-2 (16-18cm) and G-3 (18-20cm) size group as compared to other groups.

Key words: Estuarine ecosystem, fish size, diet composition, *Chelon subviridis,* cluster analysis.

INTRODUCTION

Estuarine ecosystems deliver the variety of goods and services which have high economic and environmental values (Costanza *et al.* 1997). These play an important role in the global economy and biodiversity conservation. Fish shows distinct ontogenetic changes in feeding habits and on prey selection. Many fishes display great flexibility in their feeding ecology (Wotton 1998). Greenback grey mullet, *Chelon subviridis* belongs to the family Mugilidae and locally known as 'belanak' in Malaysia. Mugilids are generally considered as herbivorous, omnivorous, plankton or even micro crustacean feeders (Brusle 1981). *Chelon subviridis* is one of the most important commercial catches in the Merbok estuary.

Diet composition of fish is important in community ecology because the use of trophic resources by organisms has a major influence on population interactions within a community (Lawson and Jimoh 2010). The length of the gut of fish depends on the nature of their food-consume and increases with increasing proportion of food materials (Biswas 1993). Sarpanah *et al.* (2010) found lowest relative gut length (RGL) in the fry stage of fish species, whereas the highest length was found in the aged fish. With the growth of fish, its alimentary tract lengthens and coiled to digest and absorb the vegetative portion of the food resulting in progressive increment of RGL. Therefore, feeding ecology of fish is an important aspect of its life-history strategy to understand the functional role of the fish within their ecosystems (Blaber and Whitfield 1977).

Estuarine area is utilized for human activities, such as navigation (Carlberg 1980), human settlement (Day *et al.* 1989), fisheries and aquaculture practices (Breitburg *et al.* 2009), domestic and industrial garbage disposal (Carlberg 1980) and recreational activities (Costanza *et al.* 1997). Local people depend on it for their livelihood by fishing. Both resident and migratory fish species use this estuary for their breeding and spawning. Thus, the water resource of this estuary is important. The conservation and management of fish resources are important for protecting biodiversity and ensuring long-term productivity and sustainability of recreational and artisanal fisheries. Studies on the feeding habit of mullet fish in Malaysia, especially in Merbok estuary, is scarce (Mansor *et al.* 2012, Fatema *et al.* 2013).

This study was conducted to observe the relationship between fish size and diet composition of the food items of *Chelon subviridis* in Merbok estuary, Kedah, Malaysia.

MATERIAL AND METHODS

Fish samples were collected in monthly interval from the upstream of Lalang and Sameling River from January to December, 2011. The samples were collected from the artisanal fishermen. Before transporting the fish samples to the laboratory for analysis, they were preserved in a labeled polyethylene bag with 10% formalin to prevent digestion of food materials and to stop the enzymatic activity of the stomach contents. A total of 225 fish-samples of *Chelon subviridis* was collected for the analysis of stomach contents. Food items in the stomach of fish were counted following Miah and Siddique (1992) and identified up to genus level according to Ahmad (2009).

For the purpose of stomach content analysis, numerical method was followed. The number of individuals in each food category was recorded for all stomachs and then, the total was expressed as a proportion, usually a percentage, of the total individuals in all food categories (Ikusemiju and Olaniyan 1977). The mean number of individuals per stomach in each food category was calculated.

Feeding intensity was measured by using vacuity index (VI), according to Labroupoulou *et al.* (1997) and Isangedighi *et al.* (2009):

$$VI = (\text{Number of empty stomach} \div \text{Total number of stomachs}) \times 100$$

The gut length was measured with a precision of 0.5cm to acquire the relative gut length (RGL). RGL was calculated by using the following formula (Montgomery 1977):

$$\text{Relative gut length (RGL)} = \text{Gut length (cm)}/\text{Standard length (cm)}$$

The RGL is an index for measuring feeding type. According to Ward-Campbell *et al.* (2005) when, RGL<1, it indicates carnivorous diet; when 1<RGL<3, it indicates omnivores, and when RGL values>3, the designated diet is based on plant material or detritus.

The composition of *C. subviridis* diet was analyzed based on numerical percentage for each food item of the different size classes. The size classes were grouped from the lowest to the highest total length (TL) with an interval of 2cm. In *C. subviridis*, minimum total length was found 14.1cm whereas maximum was 23.00cm and the samples were divided into five classes (G-1 to G-5).

The similarity distance among all food items for particular size groups was calculated by using Unweighted Pair Group Method (UPGMA) (Van Tongeren 1995) and Multi Variate Statistical Package (MVSP) (Krebs 1994) using numerical percentage approach for each food item. The constructed dendrogram from the similarity distance demonstrated the relationship among size classes based on diet composition.

RESULTS AND DISCUSSION

Out of the 225 stomachs of *Chelon subviridis* examined. 211(93.78%) contained food in their stomach while the remaining 14 others (VI=6.22%) were empty. The ontogenic variations in the vacuity index of *C. subviridis* are shown in Fig. 1; 14-16cm (TL) group had the highest vacuity index while 18-20cm (TL) group had the lowest index.

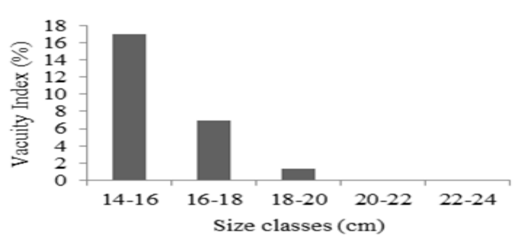

Fig. 1. Ontogenic variation in the vacuity index of *C. subviridis*.

The monthly measurements of total length, standard length, weight, gutted body weight; stomach weight, content weight, and relative gut length of *C. subviridis* are presented in Table 1. The relative gut length (RGL) is the ratio of gut length to standard length. The standard length (SL) ranged from 13.34±1.61 to 16.50±0.571 cm. The gut length (GL) ranged from 33.00±9.11 to 53.93±8.70 cm. The relative gut length varied from 2.25±0.3 to 3.27±0.509 cm. Results showed that average RGL for *C. subviridis* is 2.77 and according to Ward-Campbell *et al.* (2005) this fish may be termed as omnivorous.

Table 1. Monthly length and weight measurements of *C. subviridis* (n = 225).

Month	TL(cm)	SL(cm)	BW(g)	GBW(g)	SW(g)	CW(g)	GL(cm)	RGL
Jan	15.8 ±1.54	13.34±1.61	46.04±14.4	37.22 ±9.76	0.48±0.13	0.018±0.01	33.0±9.11	2.44±0.3
Feb	17.39±1.03	14.51±0.90	53.59±9.53	40.50±7.06	0.52±0.10	0.04±0.02	37.87±5.00	2.61±0.3
Mar	18.23±0.85	15.53±0.90	66.90±10.5	49.63±7.32	0.43±0.04	0.03±0.02	40.80±6.34	2.62±0.3
Apr	18.25±1.71	15.87±1.20	65.56±13.6	51.40±11.7	0.72±0.16	0.06±0.04	48.76±9.07	3.08±0.6
May	18.95±1.09	16.05±0.96	71.20±12.4	55.06±10.2	0.63 ±0.12	0.06±0.02	49.87±5.57	3.11±0.3
June	19.47±0.62	16.50±0.57	80.76±5.71	61.64±5.45	0.49±.078	0.05±0.01	53.93±8.70	3.27±0.5
July	18.00±2.04	15.29±1.81	66.57±25.1	50.17±18.2	0.39±0.15	0.03±0.02	43.35±14.73	2.78±0.7
Aug	16.12±1.78	13.51±1.52	46.48±16.8	34.62±12.8	0.29±0.11	0.04±0.08	35.60±6.95	2.62±0.2
Sept	16.03±1.74	13.68±1.59	44.94±16.0	34.48±13.0	0.28±0.09	0.03±0.01	47.07±8.46	3.43±0.3
Oct	15.73±1.57	15.45±1.77	50.18±9.91	39.62±7.74	0.48±0.10	0.04±0.02	39.31±5.39	2.57±0.4
Nov	18.88±2.68	15.51±2.25	74.67±31.5	66.21±29.3	0.30±0.16	0.01±0.01	35.07±9.28	2.25±0.3
Dec	16.54±1.02	13.8±0.811	47.16±8.13	36.78 ±5.72	0.41±0.07	0.03±0.02	36.53±3.81	2.65±0.2

TL=total length, SL=standard length, BW=body weight, GBW=gutted body weight, SW=stomach weight, CW=content weight, GL=gut length, RGL=relative gut length

According to size classes of *C. subviridis* the mean±standard deviation (SD) values of relative gut length are shown in Table 2. The G-3(18-20) cm class size showed the highest RGL value (2.5±0.47). As the fish grew, the length of gut increased. In smaller fish, the relative gut length values were lower and had a tendency to increase as the fish grew until a certain size. However, the values decreased as the fish grew larger beyond this point.

The total length of collected fish samples varied from 14.1 to 23cm which were divided into five groups. Numerical distribution of food items varied among the size classes. Plant materials constituted the most consumed food item in the five size groups (51.36, 68.22, 70.28, 69.85 and 85.12%) (Table 3). Diatoms were the next and were found in the five size classes 31.1, 19.00, 18.41, 23.95 and 7.29%, respectively (Table 1). The G-3 (18-20cm) size class fishes consumed more food than the other size group fishes.

Table 2. The Mean ± SD values of relative gut length according to the size classes of *C. subviridis* in Merbok estuary (n = 225).

Size classes (cm)	SL(cm)	TL(cm)	BW(g)	GBW(g)	SW(g)	CW(g)	GL(cm)	RGL
G-1 (14-16)	12.83± .50	15.28 ± .57	38.66± 4.80	29.56 ± 3.85	0.31 ± .11	0.03±.04	34.49± 5.96	2.26 ± .38
G-2 (16-18)	14.39± .50	17.14 ± .56	52.37± 6.72	40.94 ± 5.09	0.47 ± .13	0.04±.02	40.74± 8.37	2.37 ± .46
G-3 (18-20)	15.99± .68	18.87± .55	70.91 ± 8.60	54.62 ± 5.86	0.53± .15	0.05±.02	47.31± 9.46	2.5 ± .47
G-4 (20-22)	17.55± .63	20.86 ± .63	95.42 ± 14.6	75.61 ± 11.9	0.68 ± .23	0.06±.04	50.71± 10.6	2.44 ± .53
G-5 (22-24)	18.67± .29	22.63± .32	122.43± 5.95	111.43± 5.95	0.57± .06	0.02±.01	36.00± 2.00	1.59± 0.11

The G-5 (22-24cm) size class consumed 85.12% plant materials (Table 3) in comparison to other class group of fishes. On the other hand, the G-1 (14-16cm) size class consumed 11.92% cyanobacteria in compare with other groups (Fig. 3). Interestingly, the size classes (14-16cm) and (18-20cm) of fishes consumed almost similar percentage of food items (viz. 2.26% and 2.50%, respectively) (Table 2).

Table 3. Percentage of food categories in the stomachs of *Chelon subviridis* in Merbok estuary from January to December, 2011(n= 225).

Food items	G-1 (14-16cm) TL		G-2 (16-18cm) TL		G-3 (18-20cm) TL		G-4 (20-22cm) TL		G-5 (22-24cm) TL	
	No.	%N	No.	%N	No.	%N	No.	%N	No.	%N
Diatoms	552	31.19	839	19.09	933	18.41	441	23.95	76	7.29
Cyanobacteria	211	11.92	358	8.14	320	6.31	65	3.53	57	5.47
Desmids	9	0.508	16	0.364	8	0.158	2	0.109	0	0
Plant materials	909	51.36	2999	68.22	3562	70.28	1286	69.85	887	85.12
Zooplankton	84	4.75	183	4.16	241	4.76	46	2.5	22	2.11
Detritus	-	-	-	-	-	-	-	-	-	-
Sand grains	-	-	-	-	-	-	-	-	-	-
Pisces (bones, scales)	5	0.282	1	0.023	4	0.079	3	0.163	0	0

TL= Total Length where, Group 1(G-1), Group 2(G-2), Group 3(G-3), Group 4(G-4), Group 5(G-5), % N=numerical

Based on the numerical analysis of percentage for all the food items, the cluster analysis of all size classes could be divided into two main clusters. The first cluster consisted of four sister groups, while the second cluster comprised of a single group of the G-1 (14-16cm) length class (Fig. 2). The similarity index between pair wise comparisons of size classes varied from 0.508 to 0.858 (Table 4). The highest similarity was found between size class G-2 (16-18cm) and G- 3 (18-20cm) with 85.8% compared to other classes.

Table 4. Similarity distance matrix of the length classes of *C. subviridis* from Merbok estuary.

Node	Group 1	Group 2	Similarity	Objects in group
1	16-18	18-20	0.858	2
2	Node 1	20-22	0.734	3
3	Node 2	22-24	0.675	4
4	14-16	Node 3	0.508	5

Present study found the vacuity index of 6.22% for *C. subviridis* was a sign of high feeding intensity. Bowman and Bowman (1980) reported that feeding intensity is positively correlated to the degree of fullness and negatively related to the percentage of empty stomachs. Wells (1984) found that *Mugil cephalus* is an opportunistic feeder and feeds round the day and its high feeding intensity also reflected the availability of food resources in the study area.

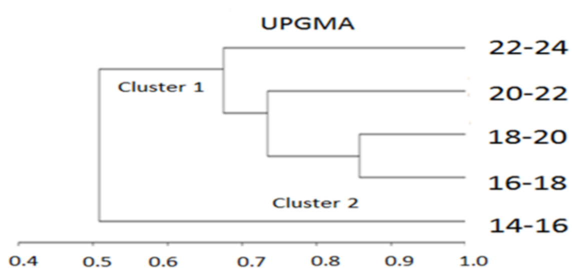

Fig. 2. The UPGMA (unweighted pair group method) dendogram of cluster analysis of food item in the stomach contents of *C. subviridis* in different length groups (cm) of fishes from the Merbok estuary.

In the present study, the small size classes had the highest vacuity index compared to large size classes. This high percentage of empty stomachs found in small size classes suggest that the mullets of small size might have digested their food while being holding in the nets and some fish might have disgorged their food following capture. Odum (1970) mentioned that many mullet are likely to have digested their food and disgorged their food following capture while being holding in the nets. Whereas, small vacuity index of big size fishes suggest that feeding intensity was more pronounced in larger specimens. Isangedighi *et al.* (2009) studied the feeding activity and diet composition of *Mugil cephalus* and classified food items into three groups, such as, primary (coarse particulate organic matter, mud, diatoms and green algae), secondary (coarse particulate organic matter, blue-green algae, dinoflagellates, macro arthropods, prey fish, debris and nematodes) and incidentals dietaries (micro arthropods). Labropoulou *et al.* (1997) studied the ontogenic and trophic biology of striped red mullet and recorded amphipods and decapods as prominent diet of the fish and the fish feed on a narrow range of prey items.

The present study showed that RGL values were low in smaller fishes and tended to increase as the fish grew. Previous study by Sarpanah *et al.* (2010) reported that RGL value was correlated to the fish size which was the lowest in the smaller fishes and highest in the older fishes. They also reported that with the growth of fish sizes, the alimentary tract become longer and coiled for efficiently digesting and absorbing the food materials which causes progressive increment of relative length of gut.

In the present study diatom, cyanobacteria, plant materials, zooplankton, detritus and sand grains in *Chelon* fish species stomach were found, irrespective of size class. On the other hand, all size classes except G-5 (22- 24cm) of *C. subviridis* desmids and pisces were found. Abdel-Aziz *et al.* (1993) reported that fish food consumption might be related with the body size of the fish, age, spawning activity and food availability. The G-3 (18- 20cm) size classes of fish in the present study showed the highest variability in food items of *Chelon* fish species, demonstrating greater adaptability of size range. Subsequently, cluster analysis showed the highest similarity between G-3 (18- 20cm) size groups and other groups. It might be due to high spawning activity, increased food consumption and rate of metabolism of these groups. Bandpei *et al.* (2009) reported decreased metabolism rate of older fish insisting them to consume low amount of food item.

This study revealed that the G-3 (18-20cm) size class showed the highest variability in food items suggesting a greater adaptability at or around size ranges. Smaller size fishes preferred plant materials as well as diatoms, whereas large size fishes preferred mostly plant materials. This study is important to understand food web structure in an ecosystem. Thus, investigations on aquatic habitat should be a high priority for conservation. Information on the feeding habits of fish exhibits predator-prey relationship that is useful to assess the role of fish in the ecosystem. Methodological approach and this type of ecological study may be replicated in the estuaries of Bangladesh which could provide necessary information for policy-making on estuarine ecosystem management.

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