FOOD AND FEEDING HABITS OF CHACUNDA GIZZARD SHAD, *ANODONTOSTOMA CHACUNDA* (HAMILTON-BUCHANAN, 1882) NEAR MYEIK WATER

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Abstract

The stomach content of *Anodontostoma chacunda* was studied applying the number and occurrence methods. Eight major food groups were observed in the stomach. The dominant diet in the stomach contents was diatoms. The most dominant items were *Bellerocheta* spp., *Coscinodiscus* spp., *Cyclotella sp*., *Lampricsus sp*., *Navicula* spp., *Nitzschia* spp. *Pleurosigma* spp. *Thalassionema* spp. and *Odontella* spp. Larvae also constituted as the main food items. *Anodontostoma chacunda* was omnivores and pelagic feeders.

Introduction

The study of a fish population's food and feeding habits provides valuable data in fishery biology as it helps to determine species distribution. Stomach content analysis supports important insights into fish feeding habits. The quantitative assessment of food intake is essential for the successful management of a fishery and such studies are important in any fishery research program.

Feeding is the dominant activity of the entire life cycle for fish. Food is the basis of their behaviors such as growth, development, abundance, spawning and migration. The analysis of stomach contents can reveal a wide variation in the food and feeding habits among different groups of fishes found at the bottom or at pelagic layers and among different species within a group (Rao, 1965).

The food items of different fishes vary seasonally and locally. Information about the diet of fish can be obtained by analyzing gut content. The information on feeding strategies reveals size and maturation of fish.

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Food availability also influences the movement of fish stock such as horizontal and vertical movement.

Diet composition of Chacunda gizzard shad was studied by Rahardjo *et al*. in Mayangan coastal waters, west Java in 2006. The present study aimed to identify the food items in the diet of *Anodontostoma chacunda*, to determine the most preferred food items and to obtain knowledge about food and feeding habits. Developing a better understanding of *Anodontostoma chacunda* will help fishery management teams to sustainably select fish for culture and to produce optimum yields by utilizing all potential food sources in local waters.

Materials and Methods

The samples for the present study were collected once a month from the local markets and fish landing sites from February 2015 to September 2015. The food items were identified by following the keys of Tomas (1997) and Conway and White (2003). Unidentified food elements in the contents were assigned as miscellaneous. Total lengths of fishes were measured. The belly of the fish was cut open and the sex, stage of maturity and the condition of the stomach were recorded prior to the removal of the stomach. Fish were divided into two groups as immature and mature according to the maturity stage. Those at Stage I-III were considered as immature and those at stage IV and above were mature. After removing the stomach, it was placed in a Petri dish and cut. Water was added and the stomach content of each fish was made up to a known volume (10 ml). After mixing well, a subsample of 1ml was used for microscopic study.

The intensity of feeding was determined by the degree of fullness of the stomach and expressed as actively fed when the stomach was full or ¾ full, moderate when it was ½ full or ¼ full and poor when the stomach was empty or the contents were very little. The number and occurrence methods (Hyslop, 1980) were employed in the analysis of food elements. The number

of stomachs, in which there were food items were recorded and expressed as a percentage of the total number of stomachs examined as follow:

$$F\% = \frac{J_i}{P} \times 100 \qquad \text{(Hynes; 1950)}$$

where, F = Frequency of occurrence

J_i = number of stomachs containing prey i and

P = total number of stomach with food in the sample.

To estimate the percentage in number of each food item, the number of each individual food type in each stomach was counted and expressed as a percentage of the total number of food items in the samples.

Result

The stomach content of *Anodontostoma chacunda* was studied applying the number and occurrence methods (Fig. 1 and 2). The food items found in the stomach of *A. chacunda* were categorized into eight groups: diatoms, dinoflagellates, blue-green algae, protozoans and other zooplankton, crustaceans, larvae, sponge spicules and seaweeds. The diet predominantly consisted of phytoplankton which accounted for 58.1% of the average stomach contents, followed by zooplankton (41.5%) and relatively small quantities of seaweeds (0.3%) and sponge spicules (0.1%) as seen in Fig.3. Phytoplankton food items could be differentiated into three groups as following: (1) diatoms (56%), (2) dinoflagellates (2%) and (3) blue-green algae (0.2%). Zooplankton consisted of larvae (27.6%), protozoans and other zooplankton (12.1%) and crustaceans (1.8%). Partially digested phytoplankton and digested food, such as fragmented carapaces, legs and antennae of zooplankton, were also present but were not included in the diet analysis.

Figure 1. *Anodontostoma chacunda*

Figure 2. Stomach of *Anodontostoma chacunda*

Percentage in numbers

Percentages in number of different food items observed in the stomachs for different months are shown in Table 1 and monthly percentage compositions of different food items are presented in Fig.4. In general, diatoms were the most common food items of *A. chacunda* during the present study period. The percentage in number of diatoms was highest in March (90.7%) and the lowest in June (16.4%). Among the different taxa, *Bellerocheta* spp., *Coscinodiscus* spp., *Cyclotella* sp., *Lampricsus* sp., and *Odontella* spp. were observed throughout the study period.

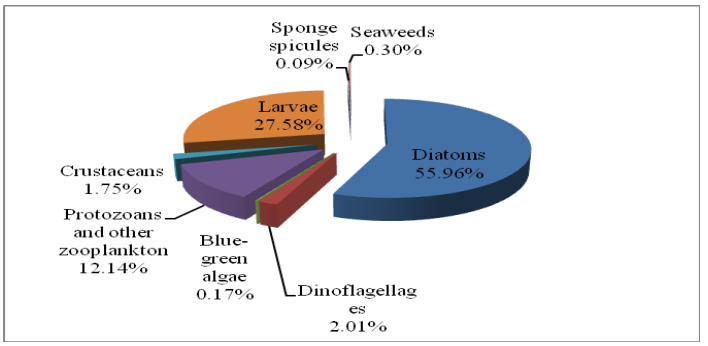

Figure 3. Average percentage compositions of different food items

Dinoflagellates formed a minor portion of the food that occurred during the study period. Their highest percentage (9.8%) in number was in May and the lowest was in March and April. All of the taxa of dinoflagellates found in the stomach were different in the present study. *Ceratium* spp. occurred than more frequently any other dinoflagellate species and *Protoperidinium* spp. occurred second most frequently.

Only one taxon of blue green algae, *Anabaena sp.*, was observed in February, May and June in this study. In these three months, the percentages in number were 0.5%, 0.7% and 0.2% respectively. Overall quantities in the food of *A.chacunda* were very small.

The recorded zooplanktons were categorized in groups such as crustaceans, protozoans and larvae. Four genera of protozoans, *Favella sp.*, *Globigerina* spp., *Leprotintinnus sp.* and *Tintinnopsis* spp. and three taxa of zooplankton *Archnatis sp.*, *Balanus sp.*and *Bolivina sp.* were observed in the present study. They were observed throughout the study period. The highest percentage (56.4%) in number was recorded in February and the lowest (2.6%) in April. Among this group, *Globigerina* spp. were recorded throughout the study except for June and its peak was recorded in February.

The main components of crustaceans were copepods. All of the copepods species, copepod larvae and mysids were found throughout the study period except September. The maximum percentage (5.6%) was recorded in May and the minimum (0.2) was in February. Copepod species were found nearly all months but mysid occurred only in March and May. This item also included the larvae of bivalves, gastropods, worms, crabs and polychaetes. They occurred throughout the study period. On average, it represented the second most abundant food item in the food of *A. chacunda*. Bivalve larvae and worm were observed in almost all months. The highest percentage for this food item was mollusc larvae. Its highest peak (77.1%) was recorded in June and the second highest (67.6%) was in September. Crab larvae were found only in June and gastropod larvae were found only in August.

Sponge spicule were only found in March with a April and its percentage of 0.5% and 0.2% respectively. It was a minor element in the food of *A. chacunda.* Some pieces of seaweed were observed in May and July and their percentage was 0.7% and 1.7 % respectively. It was also a minor component of food items.

Frequency of occurrence

The monthly percentage for frequency of occurrence of different food items of *A. chacunda* is shown in Table 2. In diatoms, the monthly percentage for frequency occurrence of *Coscinodiscus* spp., *Cyclotella sp.*, *Bellerocheta* spp., *Lampricsus sp.* and *Odontella* spp. were in the range of 55.6-100%, 33.3-100%, 10 -100%, 20-100% and 77.8-12.5% respectively. *Melosira sp*. and *Pleurosigma* spp. occurred with a range of 11.1-88% and 12.5-100% but both items were not observed in May. *Navicula* spp., *Nitzschia* spp. and *Surirella sp.* were 11.1-66.7%, 22.2-88.9% and 11.1-70% respectively but these items were not found in September. The percentage of frequency of occurrence of *Thalassionema* spp. varied between 40% and 100% except for August. *Campylodiscus sp*., *Chaetoceros* spp., *Diploneis sp*. and *Teberella sp*.

were only observed during three months with the percentage of frequency of occurrence ranging between 11.1-25%, 22.2-66.7%, 10-33.3% and 11.1-44.4% respectively. The monthly percentage for frequency of occurrence of *Hemiaulus sp*. was 10-33.3% and *Paralia sp*. was 11.1-60% for five months. *Rhizosolenia* spp. ranged between 11.1-77.8% and *Triceratium sp*. was 12.5-80% for four months. *Bacillaria sp*., *Laudaria sp*., *Lucosolenia sp*. *Guinardia sp*., *Helicotheca sp, Proboscia sp*. and *Eucampia sp*. were found in only two months with the frequency of occurrence ranging between 11.1-20%, 11.-66.7%, 20-25%, 11.1-44.4%, 20-22%, 20-22% and 11.1-22.2% respectively. *Gyrosigma sp*., *Planktoniella sp*., *Climacosphenia sp.* and *Staroneis sp*. occurred only in one month and represented 10, 22.2%, 33.3% and 44.4% of percentage of frequency occurrence respectively. The percentages of frequency of occurrence of the remaining diatoms were 11.1%.

The percentages of frequency occurrence of the dinoflagellates were low. Among dinoflagellates, *Ceratium* spp. was more observed than other dinoflagellate species with a percentage between 12.5% and 33.3%. The second most observed dinoflagellates were *Protoperidinium* spp. with the range of 10-88.9. *Diplopsalis sp*. *Gonyaulux sp.* and *Prorocentrum sp*. were only found in two months with their frequency ranging from 20-33.3%, 11.1-12.5% and 22.2-33.3% respectively. The rest of the dinoflagellate species were found in only one month and their percentages were lower, than 22.2%. One species of blue-green algae, *Anabaena sp*., varied from 0.2-0.7% and it was found in February, May and June.

In protozoans and other zooplanktons, the monthly percentage of frequency of occurrence of *Globigerina* spp. varied between 20-60% except July and *Tintinnopsis* spp. were between 11.1-100% but not found in May and September. *Balanus sp. Flavella sp.* and *Bolivina sp.* were observed only in four months with the percentage of frequency of occurrence of 12.5-44.4%, 11.1-20% and 11.1-77.8% respectively. The frequency of occurrence of

Archnatis sp. was 33.3% in February and 90% in August. *Leprotintinnus sp.* occurred only in March and represented 11.1% of frequency of occurrence. The percentage of frequency of occurrence of Crustaceans species varied from 11.1% to 70% except September. Among larvae, frequency of occurrence of 33.3-100% of worms and 20-80% of bivalve larvae were observed more than for other larvae. Gastropod larvae, crab larvae and polychaete larvae were found in only one month and represented 10, 12.5 and 33.3 respectively. In the stomach of *A. chacunda* 11.1% of seaweeds in March and April and sponge spicules 11.1% in May and 20% in July were also observed.

Feeding intensity

The sampled fish stomachs were classified as actively fed, moderately fed and poorly fed based on the fullness of the stomach content. The monthly percentage occurrence of different conditions is shown in Fig.5. The percentage of actively fed ranged from 10 to 50% and was absent in April, July and September. The percentage of fish in the moderately fed group fluctuated in all months and reached its highest (100%) in April and September. Poorly fed fish fluctuated from 0% in, April, June, August and September to 25% in February.

The percentage of stomach contents in various forms of fullness was studied to determine the relationship between feeding intensity and size groups (Fig.6). Most of the size group of 13.1-14cm was observed in the moderately fed category and 16.1-17cm was only in the actively fed category. Only the size group of 14.1-15cm was found in the poorly fed category. The percentage numbers of actively fed, moderately fed and poorly fed in 14.1-15cm were 17.4, 60.9 and 21.7 respectively.

The percentage of occurrence of stomachs in various degrees of fullness was conducted to understand the relationship between feeding intensity and sexual cycle (Fig.7). The percentage among actively, moderately and poorly fed in both immature and mature fish categories did

not vary greatly and more than 71% of both fish categories were classified as moderately fed.

Table 1. Monthly percentage in number of different food items found in the stomach of *Anodontostoma chacund*

	Feb	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sep**
Diatoms								
Actinocyclus sp.		0.2						
Bacillaria sp.			0.2	0.7				
Bacteriastrum sp.				0.5		0.1		
Bellerocheta spp.	6.3	4.2	4.0	0.5	1.8	1.9	0.1	0.8
Campylodiscus sp.		0.1	0.2		0.3			
Certualina sp.		0.1		0.9				
Chaetoceros spp.	0.1			1.6		0.6		
Climacosphenia sp.	0.1							
Coscinodiscus spp.	7.3	2.3	8.1	6.3	3.9	15.6	24.6	18.7
Cyclotella sp.	1.9	4.9	2.0	4.2	0.7	2.3	14.6	0.3
Diploneis sp.		0.3	0.5				0.1	
Ditylum sp.		0.1				0.4		
Eucampia sp.		0.1		1.6				
Fragillaria sp.						0.1		
Guinardia sp.		0.1		10.0				
Gyrosigma sp.							0.5	
Haslea sp.		0.1						

	Feb	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sep**
Helicotheca sp.		0.1	1.8					
Hemiaulus sp.		0.7	0.7	5.8		0.1	0.4	
Lampricsus sp.	6.9	8.6	13.9	19.1	4.5	2.6	0.4	4.3
Laudaria sp.				0.5		4.7		
Lucosolenia sp.					0.3			1.0
Melosira sp.	0.2	0.1	2.5		0.1	5.2	0.9	0.1
Navicula spp.	0.5	23.7	6.0	0.7	1.1	1.1	1.5	
Nitzschia spp.	2.2	21.4	4.0	3.7	0.2	0.8	12.5	
Odontella spp.	0.6	4.3	2.7	4.9	0.1	2.0	0.6	0.7
Paralia sp.		0.1	0.5		0.3		2.4	1.0
Pinnularia sp.		0.1						
Planktoniella sp.						0.6		
Pleurosigma spp.	4.0	10.1	3.8		0.1	8.4	1.8	0.3
Proboscia sp.		0.6	0.5					
Rhizosolenia spp.	0.6	2.1		11.4		0.2		
Staroneis sp.		2.8						
Surirella sp.	0.4	1.5	2.2	0.2	0.2	0.6	4.3	
Teberella sp.		0.1	4.7			1.0		
Thalassionema spp.	8.7	1.3	13.0	4.2	1.8	6.9		1.1
Thalassiosira spp.		0.1		0.7				
Triceratium sp.		0.5			1.0	0.8	3.4	

	Feb	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sep**
Dinoflagellates								
Alexandrium sp.			0.2					
Ceratium spp.	0.1	0.2		7.0	0.2		0.4	
Dinophysis sp.				1.4				
Diplopsalis sp.	0.1							0.3
Gonyaulux sp.					0.1	0.1		
Prorocentrum spp.	0.4			1.4				
Protoperidinium spp.					0.3	2.8	0.1	0.8
Pyrophacus sp.						0.2		
Blue green algae								
Anabaena sp.	0.5			0.7	0.2			
Protozoans and other zooplankton								
Archnatis sp.	0.1						5.0	
Balanus sp.			0.2		0.1	0.4	1.3	2.4
Bolivina sp.		1.4	1.3		2.5	1.9	1.5	
Favella sp.			0.2	0.7	0.1			0.6
Globigerina spp.	55.7	1.3	0.7	4.4		0.2	1.8	0.1
Leprotintinnus sp.		1.6						
Tintinnopsis spp.	0.6	0.1	0.2		0.1	8.4	1.8	
Crustaceans								
Copepod larvae	0.2			1.4				

	Feb	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sep**
Copepods		1	2.0	3.5	0.4	2.6	2.6	
Mysid		0.1		0.7				
Larvae								
Bivalve larvae			17.2	0.7	77.1	17.3	9.9	67.6
Gastropod larvae							0.4	
Crab larvae					0.1			
Polychaete larvae	0.1							
Worms	2.4	3.6	6.5		2.5	8.3	7.1	
Sponge spicules		0.5	0.2					
Seaweeds				0.7		1.7		

Table 2. Monthly percentage of frequency of occurrence of different food items found in the stomach of *Anodontostoma chacunda*

	Feb	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sep**
Diatoms								
Actinocyclus sp.		11.1						
Bacillaria sp.			20	11.1				
Bacteriastrum sp.				11.1		11.1		
Bellerocheta spp.	100	88.9	40	11.1	25	88.9	10	20
Campylodiscus sp.		11.1	20		25			
Certualina sp.		11.1		11.1				
Chaetoceros spp.	66.7			22.2		22.2		

	Feb	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sep**
Climacosphenia sp.	33.3							
Coscinodiscus spp.	100	88.9	80	55.6	75	100	100	60
Cyclotella sp.	33.3	66.7	60	33.3	50	55.6	100	20
Diploneis sp.		33.3	20				10	
Ditylum sp.		11.1				11.1		
Eucampia sp.		11.1		22.2				
Fragillaria sp.						11.1		
Guinardia sp.		11.1		44.4				
Gyrosigma sp.							10	
Haslea sp.		11.1						
Helicotheca sp.		22.2	20					
Hemiaulus sp.		33.3	20	33.3		11.1	10	
Lampricsus sp.	66.7	100	60	66.7	25	77.8	20	20
Laudaria sp.				11.1		66.7		
Lucosolenia sp.					25			20
Melosira sp.	33.3	11.1	20		12.5	88.9	40	20
Navicula spp.	66.7	33.3	60	11.1	50	44.4	40	
Nitzschia spp.	33.3	88.9	60	33.3	25	22.2	70	
Odontella spp.	66.7	55.6	60	22.2	12.5	77.8	30	20
Paralia sp.		11.1	40		12.5		60	20
Pinnularia sp.		11.1						
Planktoniella sp.						22.2		
Pleurosigma spp.	66.7	100	60		12.5	44.4	50	40
Proboscia sp.		22.2	20					
Rhizosolenia sp.	66.7	33.3		77.8		11.1		
Staroneis sp.		44.4						
Surirella sp.	33.3	55.6	40	11.1	12.5	44.4	70	
Teberella sp.		11.1	20			44.4		

	Feb	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sep**
Thalassiosira spp.		11.1		11.1				
Triceratium sp.		44.4			12.5	44.4	80	
Dinoflagellates								
Alexandrium sp.			20					
Ceratium spp.	33.3	22.2		22.2	12.5		20	
Dinophysis sp.				22.2				
Diplopsalis sp.	33.3							20
Gonyaulux sp.					12.5	11.1		
Prorocentrum sp.	33.3			22.2				
Protoperidinium spp.					25	88.9	10	20
Pyrophacus sp.						11.1		
Blue green algae								
Anabaena sp.	66.7			11.1	12.5			
Protozoans and other zooplankton								
Archnatis sp.	33.3						90	
Balanus sp.			20		12.5	44.4	40	20
Bolivina sp.		11.1	40		50	77.8	50	
Favella sp.			20	11.1	12.5			20
Globigerina spp.	33.3	55.6	20	22.2		22.2	60	20

	Feb	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sep**
Leprotintinnus sp.		11.1						
Tintinnopsis spp.	100	11.1	20		12.5	100	30	
Crustaceans								
Copepod larvae	66.7			11.1				
Copepods		33.3	60	66.7	12.5	55.6	70	
Mysid		11.1		11.1				
Larvae								
Bivalve larvae			60	11.1	50	55.6	80	20
Gastropod larvae							10	
Crab larvae					12.5			
Polychaete larvae	33.3							
Worms	100	33.3	80		50	77.8	90	
Sponge spicules		11.1	20					
Seaweeds				11.1		11.1		

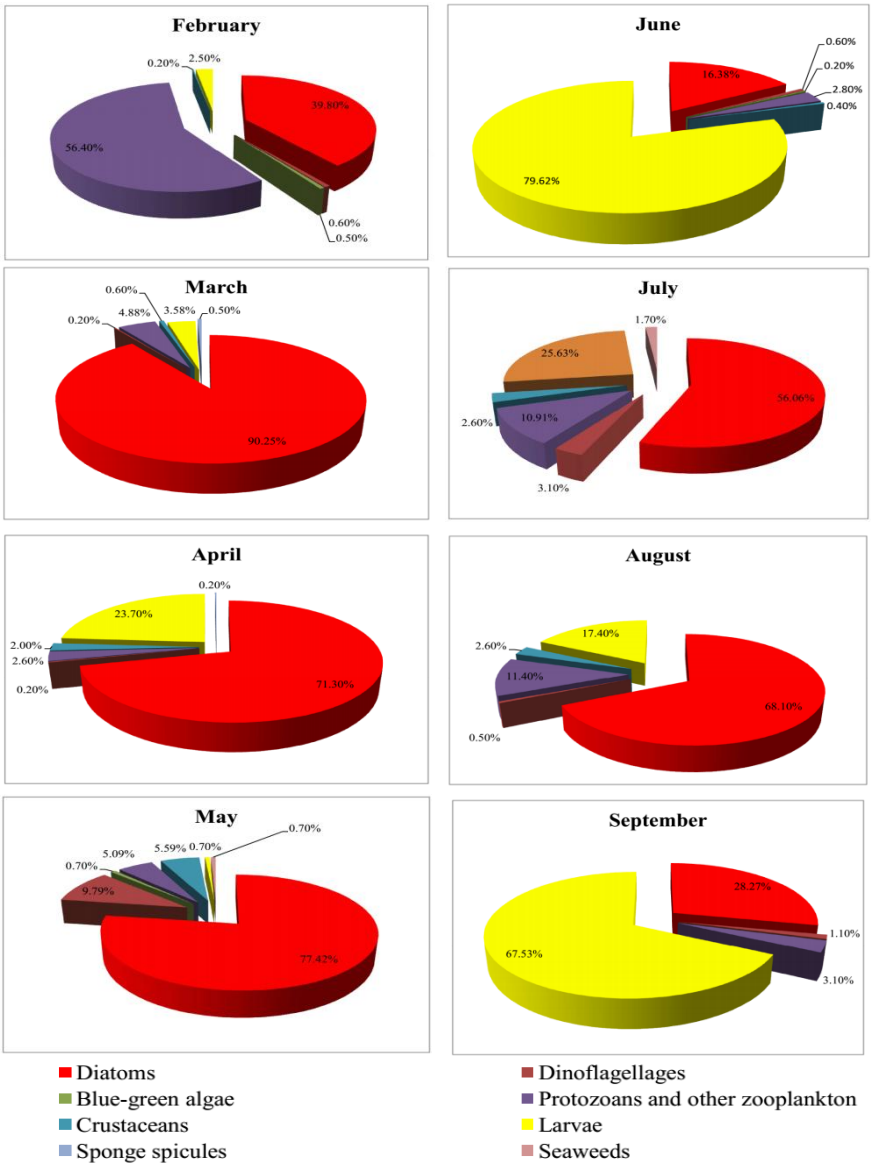

Figure 4. Monthly percentage composition of different food items

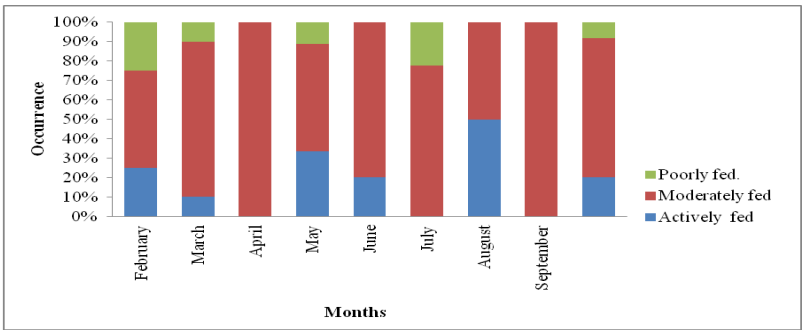

Figure 5. Monthly percentage occurrence of feeding intensity

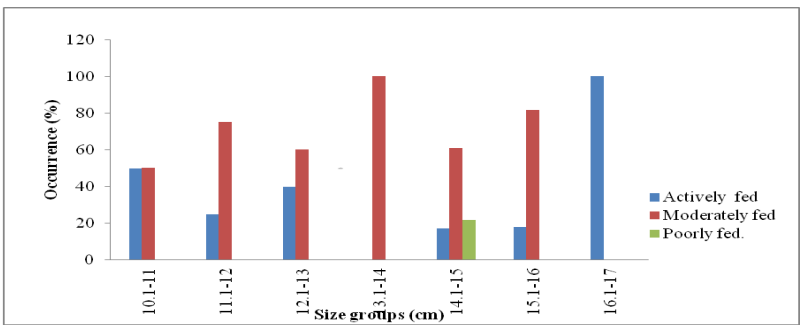

Figure 6. Feeding intensity condition in size groups

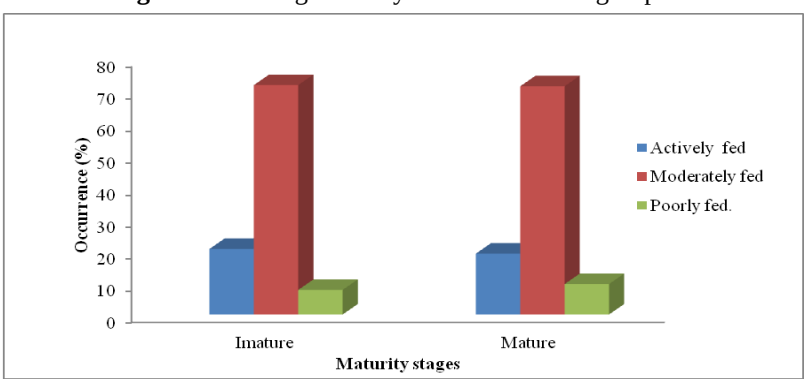

Figure 7. Feeding intensity condition in maturity stages

Discussion

There were eight major food groups found in the stomach contents of *Anodontostoma chacunda*. Diatoms, dinoflagellates, protozoans and larvae were recorded in all months of the study period. Diatoms appeared as the dominant component of phytoplankton in the present study. The percentages of diatoms varied between 16.4% and 90.7% of the total food items. The most dominant diatoms were *Bellerocheta sp.*, *Coscinodiscus* spp., *Cyclotella sp.*, *Lampricsus sp.*, *Navicula* spp., *Nitzschia* spp. *Pleurosigma* spp. *Thalassionema* spp. and *Odontella* spp.

Rahardjo *et al.*, 2006 reported that the dominant diets in the stomach contents of *A. chacunda* were *Coscinodiscus, Pleurosigma,* and *Rhizosolenia* and this supports current data which finds that this fish species prefers *Coscinodiscus, Pleurosigma, Rhizosolenia Gyrosigma, Melosira, Navicula* and copepod. All of these food items were recorded in the sampled stomachs during the study period.

Jambo and Maduako, 2015 showed that the small size group had the highest number of empty stomach and the large size group had no empty stomachs. However, in the present study, empty stomachs were not found in the small size group. The fullness degree insignificantly differed because the feeding behavior was varied from size to size, time to time, and actually it positively correlated to the occurrence and the richness of natural food components (Abdel-Tawwab *et al.* 2004).

Seasonal variation of different food items showed that diatoms formed the most important food items during the study period. Regarding the seasonal variation in the feeding intensity as an index of stomach fullness, Taghavi *et al.*, 2012 reported the maximum number of empty stomachs was recorded during summer season. This is consistent with the findings in the present study. Madkour, 2011 reported that the copepod density was higher during the summer and comparatively low during winter in comparison to other seasons.

In the present observation of total food items, 0.2 % of copepod larvae were found in February and 3.5% of copepod was in May. Small planktonic marine copepods play an important role in pelagic marine food web by serving as prey for icthyoplanktons and other large pelagic carnivores (Nath *et al.*, 2015). Jeyaseelan and Krishnamurthy 1980 stated that *A. chacunda* was omnivore species and it fed on plant and detritus. Therefore, this fish species considered as omnivorous because the gut contents of which contained an appreciable amount of both plant and animals matter in the present study.

Conclusions

The gizzard shad, *A. chacunda*, fed on a variety of food categories. Diatoms and larvae constituted the main food items in the stomach content. According to the results of percentage in number and frequency of occurrence, *A. chacunda* fed on both phytoplankton and zooplankton. Thus they can be considered as omnivores and pelagic feeders. The occurrence of some food items was so low in the stomach contents that it probably was due to accidental consumption. In order to determine if these other food intakes may represent a significant supplementary dietary feature in the food of *A. chacunda*, more research is required. The present observations can be used for further assessment of food and feeding habits of *A. chacunda* and is valuable when then species is selected for culture.

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