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Food and diet relationships of *Parachanna obscura* (Gunther) and *Clarias gariepinus* (Burchell) in a newly impounded Osinmo reservoir, Ejigbo, Nigeria

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ABSTRACT
The food and diet of two economically important freshwater fish species, *Parachanna obscura* and *Clarias gariepinus* were examined in Osinmo reservoir. Gill-net, cast-net and traps were the fishing gears used to collect fish specimens. Morphometric parameters of each fish were taken. Stomach fullness was noted and each stomach preserved in 4% formalin. Frequency of occurrence and Numerical methods was used to analyse the stomach contents of each fish. The study observed by frequency of occurrence that insects, fish, and algae, constituted 73% of the stomach contents of *P. obscura* throughout the sampling period. Similarly the stomach contents of *C. gariepinus* were dominated to the tune of 79% by detritus, mud, fish, algae, insects and diatoms. Slight variation in food items was observed during the dry and rainy seasons. The percentage of non- empty stomachs in dry and rainy seasons increased from 80% to 89% in *P. obscura* and from 74.6% to 83.4% in *C. gariepinus*. The two species of fish fed on many related food items and Schoener overlap index values of 0.05 and 0.02 indicated no diet overlap and competition in dry and rainy seasons.
Key words: Food items, diet relationship, competition, *Parachana obscura, Clarias gariepinus*.

INTRODUCTION

Osinmo reservoir is located in Ejigbo Local Government Area of Osun State of Nigeria. The reservoir was created late 2005 by the impoundment of Osinmo River with a catchments area of about 102 km^2. It is from longitude 04° 21.2' E to 04° 21.7' E and latitude 007° 52.8' N to 007° 53.2' N. This area occupied a fairly undulating terrain with highest altitude of 365.76 m above sea level. The vegetation of the area is a low land rainforest with some area of derived grassland [1]. There is heavy rainfall between July and September of each year with an annual rainfall of 130.88 mm [2]. The substratum of the reservoir is mainly mud and sand with submerged scattered logs of wood. The surface area of the reservoir is about 0.78 sq.km. The highest depth recorded was 6.3m during annual flood while the mean was 3.2 m.

Osinmo reservoir was built primarily to supply potable water to the inhabitants of Ejigbo and adjoining villages. The resulting reservoir has however provided a number of ancillary benefits among which is the production of fish to its communities. The food and feeding habits of freshwater fishes had received much attention over the years because the stomach content of fishes may not accurately reflect the consumers' food. This is because some food items might have digested rapidly, thereby leaving little or no recognizable remains [3]. However, stomach content data such as stomach fullness and the percentage of empty stomach are the most direct evidences of evaluating feeding periodicity. Inland fish species had been reported to have access to a vast store of food of all kinds when rivers overflow their banks in rainy seasons [4]. It had also been reported by [5] that the variety of food eaten by fishes varied within species thereby indicating food selectivity.

The food and feeding habits of predatory fish species had been reported. Such species like *Hepsetus odoe* (African pike), *Lates niloticus* (Nile perch), *Hydrocynus forskalii* (tiger fish), *Parachanna obscura* (snake head) and *Clarias gariepinus* (cat fish) were found to be piscivorous in their habitats. [6], [7] and [8] observed these species as obligate piscivores that fed on cichlids. Although there are literatures on food and feeding habits of fish in inland water bodies, there is still paucity of information on the dietary requirements of *P. obscura* and *C. gariepinus* most especially in a newly impounded reservoir where the species are yet to be fully established. This study aims at providing information on the abundance of natural food items and competition among the species in the habitat.

MATERIALS AND METHODS

Fish specimens for this study were collected between April 2007 and June 2008. Fishing techniques used were gill-netting, cast-netting and traps. The gill-net used was 100 metres long with stretched mesh size of 2.5 cm, and a depth of 4 metres. Gill-net was set overnight at different sites and removed the following morning around 7.00 a.m. A cast-net of 2.5 cm mesh size was used to catch fish species at different sites in the reservoir. Traps made of *Eremospatha* with entrances in form of funnels or non-return valves were baited with ripe palm fruits and set in open water and under vegetation cover along the shoreline. The traps were checked every morning for fish. Fish specimens caught with cast net and traps were immediately put in ice-chest and covered with ice to stop further digestion and regurgitation of food materials in the gut. In the laboratory standard morphometric parameters of each fish were recorded. Fish specimens were slit open from the anus to the pectoral fin and the stomach carefully removed. Each stomach was preserved in 4% formalin. Fish samples were identified using keys prepared by [9] and [10].

Each stomach was slit open and its content carefully removed into a Petri-dish for observation using a compound microscope. Food identification was done to genus and species level where possible with reference to [11]. There are several indices for expressing the quantitative importance of different food items in the diet of fish as reported by [12] and [13]. The present study used the following indices: Gut Repletion Index i.e. the number of non-empty stomach divided by the number of stomachs examined multiplied by 100. The Frequency of occurrence method gave the number of stomach with each food item and this was expressed as a percentage of all non-empty stomachs. The Numerical method also showed the number of food items of a given type found in all specimens examined and this was expressed as a percentage of all food items [12]. Some food items at varying stages of digestion cannot be identified at the species level. Diet similarity among fish species was investigated using Schoener Overlap Index [14] (C);

$$C_{xy} = 1\text{-}0.5 \sum | p_{xi}\text{-}p_{yi} |$$

Where; p_{xi} and p_{yi} are the proportions by number of prey type i in the diet of fishes x and y in the seasons respectively. Values of C ranges from 0 (no-overlap) to 1 (complete overlap). When there is dietary overlap, index values 0.8 are considered to be indicative of major differences [15].

RESULTS

Eight families of fish comprising fourteen species were observed in Osinmo reservoir. The Cichlidae accounted for about 59.06% of all fish caught while Clariidae, Channidae and Hepsetidae families with a percentage of 20.57%, 12.63% and 6.19.0% followed respectively. Other families of fish with 1.6% completed the population (Table 1). The total length, standard length and weight of the smallest *P. obscura* caught were 25.0cm, 21.0cm and 148 g. The biggest fish caught measured 39.9 cm, 35.4 cm and 640 g in total length, standard length and weight respectively (Table, 1). The food items of *P. obscura* showed a variety of algae, zooplankton, and nematode worms while the species fed mostly on fish and insects (Table 2). The monthly percentage of non-empty stomach in *P. obscura* is as recorded in Table 3.

The smallest *C. gariepinus* caught measured 23.1 cm total length 20.6 cm standard length and 91 g. The total length, standard length and weight of the biggest fish were 34.4cm, 30.5 cm and 344 g respectively (Table, 1). As shown in Table 2, fish remains, detritus and insect dominated the stomach contents of this species. Other food items of importance found in the stomach include algae, rotifers, crustaceans, diatoms and nematode worms. The percentage of non-empty stomach recorded for the species as shown in Table 3.

The food of *P. obscura* showed variation in the dry and rainy seasons. As shown in Tables 2 and 3 high proportion of algae, insects and fish remains were fed upon during the rainy season (April to September), while protozoa and nematode worms also complemented the diet during this period. During the dry season of (October to March), insects and rotifers were the major food items of *P.obscura.*

C. gariepinus, had a slight variation in its food items in relation to the seasons. The dry season (October to March) showed predominant food items like detritus, mud, diatoms and rotifers in high proportion, while insects, fish, protozoa and algae are in low proportion. At the onset of rainy season (April to September) food items of importance in *C. gariepinus* included high proportions of insects, fish, algae, crustaceans, and nematode worms (Tables 2 and 3).

In Osinmo reservoir, *P. obscura* fed on algae, rotifers, protozoa, nematode, insects and fish remains. These six food items along with diatoms, mud and detritus were recorded for *C. gariepinus*. By the percentage of frequency of occurrence as shown in Table 2, about 30% of the diet of *P. obscura* was algae followed by fish and insects with 24% and 20% respectively. Rotifers, nematode worms and protozoa were 11%, 9% and 2% each of the diet. Similarly about 22% of *C. gariepinus* diet constituted detritus and mud. Very close to it was fish remains 21%, algae 16% and insects with 14% respectively. Diatoms, rotifers and crustaceans were 10%, 6% and 5% each while the least was nematode worms with 3%. The diet of the two fish species included both green and blue-green algae which were unicellular or filamentous. In *P. obscura*, *Euglena* sp. and *Cosmarium* sp. were very prominent in its diet while *Euglena* sp. and *Microcystis* sp. were the major algae in the diet of *C. gariepinus.* The three main diets of *P. obscura* that constituted 73% of all food intake included fish, algae and insects. In *C. gariepinus*, five main food items constituting 79% of all food taken were fish, detritus, algae, insect and diatoms. Table 3 showed monthly variations in stomach fullness, and the percentage of non-empty stomachs in *P. obscura* and *C. gariepinus.*

Table 1: Relative abundance and the length-weight range of fish species

Family/Species	Number of fish	% of fish	Range		
			Total Length (cm)	Standard Length (cm)	Weight (g)
Osteoglossidae	2	0.07			
Heterotis niloticus Cuvier	2	0.07	25-39.9	21-35.5	148-640
Mormyridae	30	1.06			
Gnathonemus cyprinoides Linnaeus	9	0.32	8.8-27.1	7.4-23.2	6.0-176
Gnathonemus senegalensis Steindchner	10	0.35	17.1-24.1	14.1-20.5	48-150
Mormyrus rume Cuvier & Valenciennes	11	0.39	13.9-40.6	12.4-35.0	17-445
Cyprinidae	3	0.1			
Barbus callipterus Boulenger	3	0.1	7.8-8.1	6.0-6.5	2.0-2.7
Hepsetidae	174	6.19			
Hepsetus odoe Bloch	174	6.19	12.7-44.0	10.2-36.0	12-678
Malapteruridae	8	0.28			
Malapterurus electricus Gmelin	8	0.28	20.2-22.1	16.7-18.2	106-136
Clariidae	578	20.57			
Clarias gariepinus Burchell	578	20.57	23.1-34.4	20.6-30.5	91-344
Channidae	355	12.63			
Parachanna obscura Gunther	355	12.63	25.0-39.9	21.0-35.4	148-640
Cichlidae	1659	59.06			
Hemichromis fasciatus Peter	236	8.4	10.5-14.8	8.4-11.5	21.7-64
Oreochromis niloticus Trewavas	14	0.5	13.2-45.2	10.2-36.0	38-1720
Pelmatochromis taeniatus Sauvage	153	5.45	9.5-16.5	7.5-12.8	11-80
Sarotherodon galilaeus Trewavas	462	16.45	9.5-32.5	7.1-26.1	18.6-632
Tilapia zillii Gervais	794	28.3	8.1-31.7	6.3-22.7	10-508

Table 2: Summary of food items in the stomachs of *P. obscura*, *C. gariepinus* and diet seasonal variation

Food items	Frequency of occurrence				Numerical method				Diet seasonal variation			
	Number		%		Number		%		*P. obscura*		*C. gariepinus*	
	P. obscura	*C. gariepinus*	*P. obscura*	*C. gariepinus*	*P. obscura*	*C. gariepinus*	*P. obscura*	*C. gariepinus*	Dry	Rain	Dry	Rain
Algae												
Oscilatoria sp.	6	8	1.92	1.24	21	48	2.49	1.94	-	+	-	+
Microcytis sp.	11	36	3.51	5.60	36	436	4.28	17.64	-	+	-	+
Coelosphaerium sp	4	-	1.28	-	18	-	2.14	-	+	-	-	-
Spirogyra sp.	-	4	-	0.62	-	80	-	3.24	-	-	+	+
Closterium sp.	15	-	4.79	-	60	-	7.13	-	-	+	-	-
Euglena sp.	27	41	8.63	6.38	31	590	3.68	23.87	-	+	+	+
Cosmarium sp.	18	-	5.75	-	42	-	4.99	-	-	+	-	-
Trachelomonas sp.	-	11	-	1.71	-	10	-	0.40	-	-	-	+
Pediastrum sp.	10	-	3.19	-	51	-	6.06	-	+	-	-	-
Protozoans												
Amoeba sp.	2	-	0.64	-	5	-	0.59	-	+	+	-	-
Paramecium sp.	3	14	0.96	2.18	8	59	0.95	2.39	+	+	+	+
Crustaceans												
Daphnia sp.	-	16	-	2.49	-	37	-	1.50	-	-	-	+
Cladocerans sp.	-	13	-	2.02	-	70	-	2.83	-	-	-	+
Diatoms												
Navicula sp.	-	15	-	2.33	-	88	-	3.56	-	-	+	-
Diatoma sp.	-	27	-	4.20	-	61	-	2.47	-	-	-	+
Synedra sp.	-	18	-	2.80	-	43	-	1.74	-	-	-	+
Flagilaria sp.	-	7	-	1.09	-	54	-	2.18	-	-	-	+
Rotifers												
Filinia sp.	21	-	6.71	-	72	-	8.55	-	-	-	-	-
Rotaria sp.	-	15	-	2.33	-	66	-	2.67	-	-	+	-
Branchionus sp.	14	-	4.47	-	67	-	7.96	-	-	-	+	-
Lecane sp.	-	22	-	3.42	-	48	-	1.94	-	-	-	-
Nematodes												
Nematode worms	29	21	9.27	3.27	81	61	9.62	2.47	+	-	-	+
Vertebrates												
Fish remains	74	137	23.64	21.31	204	251	24.23	10.15	+	+	+	+
Insects												
Insect remains	63	91	20.13	14.15	12.3	438	14.60	17.72	+	+	+	+
Mud	-	25	-	3.89	-	-	-	-	-	-	+	+
Detritus	-	113	-	17.57	-	-	-	-	-	-	+	+
Unidentified food items	16	9	5.11	1.40	23	32	2.73	1.29	+	+	+	+

+ = Food item present - = Food item not available

Table 3: Monthly analysis of non-empty stomach in *P. obscura* and *C. gariepinus*

Month	Number of stomach examined		No of empty stomach		% of non-empty stomach	
	P. obscura	*C. gariepinus*	*P. obscura*	*C. gariepinus*	*P. obscura*	*C. gariepinus*
April 2006	15	28	2	4	86.7	85.7
May "	18	45	1	11	94.4	75.6
June "	16	40	1	7	93.7	82.5
July "	32	20	3	2	90.6	90.0
August "	40	50	7	13	82.5	74.0
September "	28	47	2	9	92.9	80.8
October "	37	29	2	8	94.6	72.4
November "	20	41	1	15	95.0	63.4
December "	18	38	4	7	77.8	81.6
January 2007	21	25	3	6	85.7	76.0
February "	36	50	8	13	77.8	74.0
March "	19	53	7	11	63.2	79.2

DISCUSSION AND CONCLUSION

The main food items of *P. obscura* and *C. gariepinus* in Osinmo reservoir were fish, insect, algae and rotifers while detritus and mud which constituted one of the main food items for *C. gariepinus* were not included in the diet of *P. obscura*. This feeding pattern was also recorded by [8] in upper Ogun River and [16] in Opa reservoir. Other food items include protozoa, diatoms, crustaceans and nematode worms. The presence of detritus and mud in the stomach of *C. gariepinus* suggested that the species was a bottom grazer with high proportion of diatoms in its diet as reported by [16] and [17]. *P. obscura* as shown by its food items was an obligate piscivore [8]. The two species of fish basically fed on many related food items such as fish, algae, insects, rotifers, protozoa and nematodes. The value of Schoener Index of proportional overlap [14] for the two species was 0.02 indicating no feeding overlap.

Similarity in ecological niche of the species show slight differences in the selection of complementary food items. Habitat preference of *P. obscura* was marginal vegetation and flood plain [18] while inshore and flooded banks with allochthonous organic matters was preferred by *C. gariepinus* [16]. *P. obscura* fed mostly on insects and fish in dry season while abundant fish, nematodes and algae were consumed in the rainy season. Detritus, mud diatoms and algae were the food items of *C. gariepinus* in dry season while algae, fish, insects and nematode comprised the main food in rainy season. Food items of each fish in dry and rainy seasons slightly differ and Schoener Overlap Index values for the two species in the seasons were 0.05 and 0.02 respectively. The food items of *P. obscura* and *C. gariepinus* did not overlap in the habitat.

Monthly variations in feeding habits did not affect the stomach fullness of *P. obscura* and *C. gariepinus* in the reservoir. The percentage of non-empty stomachs showed no reduction of food items although slight increase in food composition occurred. There was variation in the proportion of non-empty stomachs recorded in the dry and rainy seasons for the two species. Presently, an average of 83.4% and 89.3% non-empty stomachs were recorded for *P. obscura* in dry and rainy seasons while 74.6% and 80% non-empty stomachs were recorded for *C. gariepinus*. Most stomachs had food and some with remnants of digested food materials. The number of non-empty stomachs recorded might be due to food regurgitation or complete digestion due to struggling by fish to escape in the gill-nets or traps. Cast-net specimens were mostly with food items which gave it an edge over other fishing gears. The rainy season also witnessed high volume of water in the reservoir from the catchments area and additional food items recorded for the species included protozoa and nematode worms.

The diatoms recorded for *C. gariepinus* in the dry season was not found in the diet during the rainy season. However, additional food items for the species included high proportions of crustaceans and nematode worms. As shown in Table 2, *P. obscura*, had 89.3% non-empty stomach in the rainy season between April and Septem

compared to 83.4% non-empty stomach in the dry season October to March. The percentage of non-empty stomach for *C. gariepinus* in rainy season (April to September) was 80.00% as compared to 74.6% non-empty stomach in the dry season (October to March). The relatively low levels of non-empty stomach percentages observed in the rainy season for the species was as a result of increase in the variety of food items available for *P. obscura* and *C. gariepinus* in view of the allochtonous materials brought into the reservoir by flood in the raining season.

The food and feeding habits of *C. gariepinus* in the present study was also observed for *O. niloticus* and *C. gariepinus* in Opa reservoir [19]; [20]. The variety of food items of *P. obscura* in the present study was higher in number compared to the observation of [18] and [16] who reported plant materials and detritus for the species. Also the nineteen food items found in the stomachs of *C. gariepinus* were higher than thirteen food items recorded for the species in Opa reservoir by [16]. There was no competition between *P. obscura* and *C. gariepinus* in the reservoir. Abundance of food materials brought into the newly constructed reservoir was fed upon by the fishes throughout the year. The diet of the fish species did not overlap and being omnivores can thus co-exist in the habitat.

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