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Research Article

Food, feeding habit and condition factor of Silver Catfish (*Chrysichthys nigrodigitatus*) (Geoffrey Saint Hilaire, 1808) from Cross River estuary, Nigeria

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ABSTRACT

Fish exploit the diversities of food organisms and habitats in their aquatic environments according to their structural morphology and feeding habits, hence its ecological roles and functions. Four morphological features and dietaries of 327 stomachs of *Chrysichthys nigrodigitatus* in the Cross-River estuary, Nigeria. Three methods (frequency of occurrence, gravimetric and numerical) were used to study food, feeding habit and condition factor. Dietaries reveal 7 identified food items and an unidentified mass. Unidentified mass was the most abundant food item by occurrence (70.38%) methods followed by algae (59.26%) while mollusk, shrimp and mud (3.71% each) were the least abundant. In terms of the gravimetric method unidentified mass (59.31%) was the most abundant followed by fish bones (12.75%) while mollusk is the least (0.09%). Considering the numerical method, algae was the most abundant (85.28%) while mollusk was the least (0.20%). Generally, unidentified mass, algae, insect parts, fish bone and mud constituted major proportions in fish ranging in size from 36.0 to 56.5 cm standard length while unidentified mass, algae, and fish parts formed the major proportions in fish ranging from 56.6 to 77.0 cm. The feeding activities were highest in July and lowest in August. The lowest mean monthly condition factor for male were recorded in June (1.61 ± 0.04) and September (1.66 ± 0.00) while female was recorded in October (1.59 ± 2.82). The highest mean monthly condition factor for males occurred in August (1.93 ± 0.14) while females occurred in May (2.06 ± 0.13) and June (2.02 ± 0.89). On the whole, females were in better condition compared to the males.

INTRODUCTION

The silver (*Chrysichthys nigrodigitatus)* is a common silver coloured African catfish (local name: Inaha) which belongs to the family; Bagridae, order; Siluriformes, class; Actinopterygii ray finned fish) and are widely distributed in Nigeria and several West African countries including Senegal, Gambia, Ivory Coast, Liberia, Zaire and Gabon (Holden and Reed, 1972, FAO, 1990). It is among the dominant highly valued food-fish species of commercial importance in Nigeria (Ezenwa *et al.,* 1986). *Chrysichthys nigrodigitatus* is a demersal potamodromous and survives in a climate with temperature 22°C - 28°C; 15°N - 13°S.

Biological assessment had been carried out by many authors including Ezenwa (1982), Ekanem (2000) and Nwachi, (2016) to determine the quality of the population and growth of the species in different water bodies in Nigeria. Results reveal that *C. nigrodigitatus* experiences frequent growth fluctuations due to changes in food consumption, environmental variables and spawning conditions. It is generally omnivorous. However, environmental degradation, including oil spillages, pollution and destruction of mangrove swamps have had considerable impacts on the breeding and nursery ground of the fish, particularly in Nigeria (Anyanwu 1991; Ekanem 1992). Hence *C. nigrodigitatus* is being adopted for aquaculture in the country.

In fisheries science, food study is essential since it provides the most reliable method of determining the nature of biological interactions among the species (Caddy and Sharp, 1986). Analysis of the stomach contents of fishes provides information on the niche, trophic dynamics and food webs essential for appropriate fisheries management. As aquaculture is the only alternative means of food-fish

production, diet study plays a significant role in the provision of guide for the formulation and manufacture of sustainable least-costed feed for cultivable fish species. The study of the food and feeding habits of fish species is therefore, a subject of continuous research. This research was therefore conducted to study the food, feeding habit and

MATERIALS AND METHODS

The study was conducted in Cross River and samples were landed at Ayadehe head bridge fishing port in Itu Local Government Area, Akwa Ibom State, Nigeria. Cross river is situated in the south-east of Nigeria and has an area of about 1500 km^2. The tidal flood which includes about 50% of this area is open water while the other half is occupied by amphibious mangrove (*Rhizophora Racemose*) species. The Cross-River estuary is connected with the neighboring estuarine water in the south west of Cameroon. It is the largest estuary along the West Africa sub-region in the southeast Nigeria.

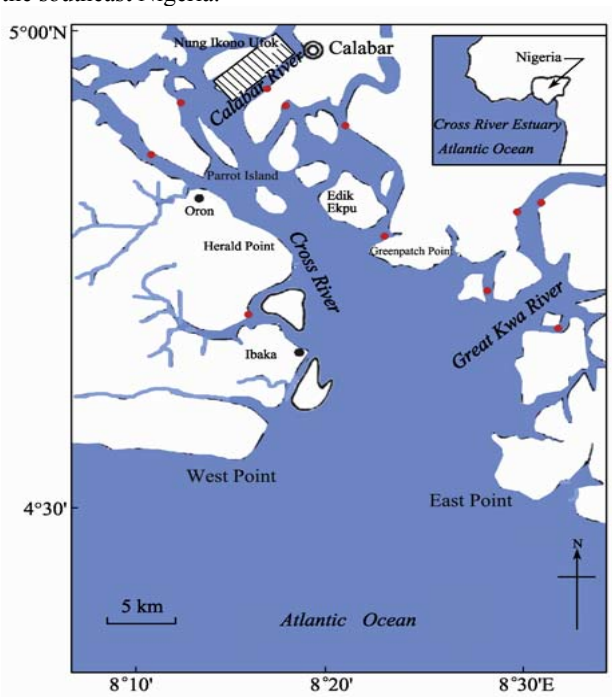

Fig.1. Map of the study Area

Location

The area is located between longitude 8^{0}30^{0}E and latitude 4°32$^{'}$S and 5°12'N (Ntekim 1987 and Akpan and Ofem 1991). The study site was Ayadehe head bridge fishing port in Itu Local Government area.

Climate

The climate of the area is tropical humid which reveals a year-round precipitation. The area has two seasons (wet and dry). Wet season last between 8-9 months starting from mid-march till end of November while dry season has a short duration between last week of November or early December and last till early march. The level of rain fall is between 13010-3000 mm, with temperature ranging from 15°C-30°C.

Vegetation

The vegetation found in this study area is mangrove of the species *Rhizophora racemose* and this mangrove system serves as spawning and feeding grounds for shrimps of the area and *C. nigrodigitatus*. It comprises mangrove swamps and flood plain mangrove. It could be said to be a tropical rainforest.

Human Activities

Human activities carried out in this area include farming, fishing, timber cutting and marketing. There was also an exchange of goods and farm products which took place below and around the bridge. Automobile services was done close to the bridge, parking and repairing of heavy duty trucks.

Reconnaissance survey

Prior to sampling, study site was first visited for familiarization with fisher folks. This opened a platform for free collection of data and made sampling easy.

Sampling Regime

Specimens were randomly procured monthly (May - October 2017) from artisanal fishers using wooden canoes at landing points and specimens were taken to the laboratory.

Collection, Preservation and Transportation of Samples

Fishes were obtained from the local fishers from Itu fishing settlement, preserved in a cooler containing ice blocks soon after capture and transported to the in the Department of Fisheries and Aquatic Environmental Management, University of Uyo laboratory prior to further examination. This was done to prevent post humus digestion.

Measurement of fish length and weight parameters

The fish were serially numbered, the standard, fork and total length (in centimeters) were measured using a meter rule and weights (in grammes) were determined using a weighing balance.

Calculation of Condition Index of Fish

Condition index was calculated for individual fish for each month using conventional formula by Fulton (1902).

$$K = \frac{Wx100}{L^3}$$

Where K=Fulton's condition factor, L= standard length of a fish (cm), W=fish weight (g)

Dissection of Fish to Remove Cut

Specimens were washed properly with clean water and were dissected using dissecting sets. The stomachs were

removed by slitting the fish from the anus to throat and then cutting off the intestine.

Weighing of Fish Cut/Measurement of Cut Volume

Each gut length was measured using a meter rule and weight of each gut was taken using a sensitive weighing balance. The volume of each gut was recorded using a measuring cylinder. Each gut was transferred into a specimen bottle containing 4% formalin and examined in the laboratory microscopically.

Dissection of Fish Gut

Each gut was spilt open and contents emptied into a Petri-dish. Empty guts were then weighed and the difference in weight between the full and empty guts was recorded as the weight of gut content. The whole sample was examined and food items identified using the dissecting microscope. Gut content were analyzed using numerical, frequency of occurrence and gravimetric methods (Hynes, 1950).

Statistical Analysis

Data obtained were subjected to T-test ($P<0.05$), by means of (SPSS, 2016). Results with $P \leq 0.05$ were considered significant.

RESULTS AND DISCUSSION

Food items found in the guts of C. nigrodigitatus

A total of 327 fish; 194 (59.26%) females and 133 (40.74%) males were caught during the study. Food was present in all guts of *C. nigrodigitatus*. The summary of stomach content of *C. nigrodigitatus* is presented in table 1.

Table 1: Food items of *Chrysichthys nigrodigitatus* in the lower Cross River.

Food items consumed	Frequency of occurrence		Gravimetric		Numerical	
	Occurrence	%	Weight (g)	%	No.	%
Algae	16	59.26	4.06	9.05	446	85.28
Mollusk	1	3.71	0.04	0.09	1	0.20
Insect parts	2	7.41	0.33	0.74	11	2.11
Fish bones	3	11.11	5.07	12.79	45	8.67
Fish parts	3	11.11	3.24	7.22	15	2.87
Mud	1	3.71	4.07	10.54	-	.
Shrimp	1	3.71	0.13	0.29	4	0.77
Unidentified mass	19	70.38	26.62	59.31	-	.

Unidentified mass was the most abundant food item by occurrence (70.38%) methods followed by algae (59.26%) while mollusk, shrimp and mud (3.71% each) were the least abundant. In terms of the gravimetric method unidentified mass (59.31%) was the most abundant followed by fish bones (12.75%) while mollusk is the least (0.09%). Considering the numerical method, algae was the most abundant (85.28%) while mollusk was the least (0.20%). Unidentified mass was not quantifiable with the numerical method.

Fish size and food of C. nigrodigitatus

Two size classes of *C. nigrodigitatus* were grouped in the study. The food composition in each size class using numerical, gravimetric and frequency of occurrence methods are shown in table 2. The three methods showed that, unidentified mass, algae, insect parts, fish bone and mud constituted major proportions in fish ranging in size from 36.0 to 56.5 cm standard length. In the other hand, unidentified mass, algae, and fish parts were the major proportions in fish ranging from 56.6 to 77.0 cm. Mud was only consumed by smaller size class while mollusk, fish parts and shrimps were only consumed by larger size class. Mud and unidentified mass were not quantifiable with the numerical method.

Table 2: Variation in the dietary items consumed by different length groups of *C. nigrodigitatus*

Size of fish	36.0 – 56.5 (395)			56.6 – 77.0 (232)		
Dietary items	**FO**	**N**	**G**	**FO**	**N**	G
Algae	47.06	71.74	9.24	70	75.83	8.95
Mollusk	-	-	-	10	0.47	0.13
Insect parts	5.89	10.87	2.01	10	0.47	0.11
Fish parts	-	-	-	36	7.11	10.32
Fish bones	5.89	17.40	5.56	20	21.33	16.39
Mud	5.89	-	31.66	-	-	-
Shrimp	-	-	-	10	0.47	0.44
Unidentified mass	58.83	-	39.56	90	-	63.17
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**

Data are in percentages. N = numerical method, FO= frequency of occurrence method and G=gravimetric method.

Feeding Activity of C. nigrodigitatus from Cross river estuary

The feeding activities of *C. nigrodigitatus* express as mean percentage weight of food per body weight of fish was highest in the Month of July and lowest in August as shown in fig. 1.

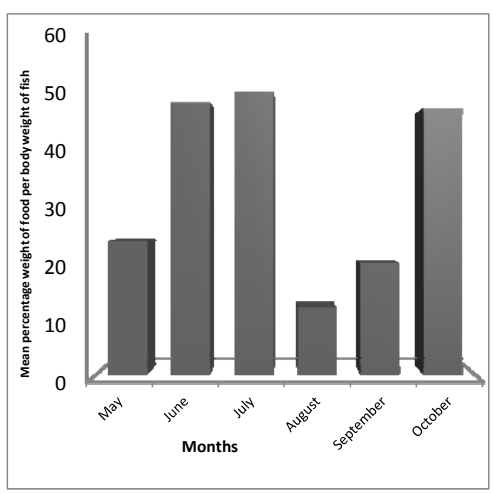

Fig. 1: Variation in feeding activity of *C. nigrodigitatus*

Condition Factor of C. nigrodigitatus Caught in Cross River Estuary

The lowest mean monthly condition factor occurred in October (1.59 ± 2.82 cm) while the highest mean monthly condition factor was recorded in August (1.93 ± 3.74 cm). The mean values obtained for each month and their standard deviation are tabulated on table 3. The values obtained (1.59 – 1.93) showed that the fish were in good condition throughout the period of investigation. There was no stomach without food during the period of investigation.

Table 3: Monthly mean condition factor of *C. nigrodigitatus* and percentage of fish with empty stomach

Sampling month	Total fish examined	Condition factor		% of fish with empty stomach
		Mean	Standard deviation	
May	4	1.89	3.10	0
June	5	1.86	3.62	0
July	5	1.89	3.68	0
August	5	1.93	3.74	0
September	4	1.82	2.97	0
October	4	1.59	2.82	0

The lowest mean monthly condition factor for male were recorded in June (1.61 ± 0.04) and September (1.66 ± 0.00) while female was recorded in October (1.59 ± 2.82). The highest mean monthly condition factor for males of *C. nigrodigitatus* occurred in August (1.93 ± 0.14) while females occurred in May (2.06 ± 0.13) and June (2.02 ± 0.89) as shown in figure 3.

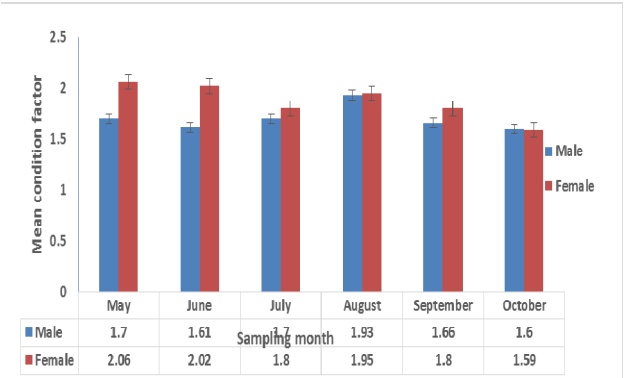

Fig. 2: Mean monthly condition factor of male and female *C. nigrodigitatus* caught from Cross River-Nigeria

On the whole, females were in better condition compared to the males. However, there was no significance difference between condition factor (k) among sampling occasion of *C. nigrodigitatus* from the lower cross river Nigeria.

DISCUSSION

The feeding habit of any fish is often reflected in its general morphology. The general morphology of *C. nigrodigitatus* suggests that it is an efficient bottom feeder although stomach content may prove otherwise. The variety of food items contained in the stomach of fish often reflect the ability of fish to obtained food from different locations. *Chrysichthys nigrodigitatus* in the lower cross river feeds on a variety of food items of which algae, fish bones, fish parts, and insect parts were of primary importance and other food items that probably serve as supplementary are mollusk, shrimp and mud indicating that *C. nigrodigitatus* is an omnivorous feeder. Similar results have been obtained for *C. nigrodigitatus* by Udoh and Ekpo (2017) in the same site. This is an indication of flexibility in trophic level which gives the fish an ecological advantage to feed effectively on different categories of diet based on the availability of food items. Similar observation had earlier been recorded by George and Atakpa (2015). Yem (2009) who studied the food habit of the catfish *C. nigrodigitatus* in Kainji Lake, Nigeria reported that the species ecological advantage enables it to switch from one food category to another in response to fluctuation in abundance and also enable species to utilize a number of different food items effectively.

The composition of food consumed by *C. nigrodigitatus* showed that algae were consistently included and dominant in the diet. Similar results have been obtained by Lawal *et al*, (2010) who studied the morphometry and diet of *C. nigrodigitatus* in Epe Lagoon, Nigeria and concluded that the quantity of algae consumed by *C. nigrodigitatus* is not surprising due to the fact that algae contribute largely to the diet of most fishes. It should, however, be noted that algae in the tropics may occur at any period of the year depending on the favorability of the physical and chemical conditions of the particular ecosystem. The occurrence of fish part and bones in the diet of *C. nigrodigitatus* showed its carnivorous nature. This agrees with Ayoola and Abotti (2010) that the dietary components for *Gymnarchus niloticus* a typical carnivourous fish are whole fish and fish parts. This is so because the intestines of carnivorous fish have evolved for processing a highly digestible, nutrient dense diet that is high in protein and low in carbohydrate. Correspondingly, abilities to digest protein are well developed, but carbohydrate digestion is low compared to omnivorous and herbivorous fish (Buddington *et al.*, 1997).

The occurrence of shrimps, mollusk and insect in the diet of *C. nigrodigitatus* implies that the species is an opportunistic feeder in the water column. The inclusion of mud in the diet of *C. nigrodigitatus* may be attributed to accidental ingestion along with other food items. This agrees to Idodo-umeh (2003) who reported that *C. nigrodigitatus* could be considered as the bottom feeding mesopredators in River Ase, Delta State, Nigeria, due to the inclusion of sand grains and mud in the fish stomach. Similarly, mud/sand particles serves as food for some fish species (Abdul *et al*., 2016). This is because it contains amino acid and other products of decay which together with saprophytic bacteria and other protozoan microorganisms constitute a rich source of crude protein as discussed by Welcome (1979).

The high percentage inclusion of unidentified mass in the diet of *C. nigrodigitatus* could be as a result of post humus digestion of food items from the time of capture to the time of landing of the species. However, Lagler *et al.* (1977) recorded that time of capture and other factors influence the stomach fullness of any fish.

The larger size classes of *C. nigrodigitatus* consumed a larger variety of food items than any other small food items. Food items that constituted a major compound for larger

size class were present in the environment whereas other food items preferred by smaller size class were constantly fluctuating in the abundance throughout the study period. Similar observations have been recorded by Nwani, *et al*, (2006) for *Campylomormyrus tamandua* in Anambra River, Nigeria. This is so because as fish increases in individual size, the size of their diet items also increases.

The general increase in the feeding activity of *C. nigrodigitatus* in July could be due to the increase diversity and abundance of food items in the environment as the rain and flood set in. Similar observations have earlier been recorded by Ndome and Victor (2002) for *Epiplatys senegalensis* in a black-water pond in Benin City. Oluwatosin and Alex (2011) also reported that *C. nigrodigitatus* from Abia reservoir was better at exploiting prey items during the wet season.

The lowest condition factor recorded in October suggest that it was a spawning month for *C. nigrodigitatus*. This agrees with Idodo-umeh (2003) who reported that *C. nigrodigitatus* breeds between July and October. The lowest condition factor in October could have been due to spawning pressure by females, poor environmental condition and reduce availability of food items.

With respect to the sex ratio, the large number of male specimens with no female specimen recorded in the month of August in the study could be due to the fact that fishing gears were not set in the breeding grounds. Yem (2009) who had similar result in Kainji Lake posited that the males possibly emigrate from spawning areas towards feeding grounds located in shallow part where they are captured. Ham (1981) also reported that females could go towards submerged vegetation, and rocky areas to avoid the fishers and protect their offspring. On the other hand, there was no male specimen recorded in October suggesting that fishing gear where set close to the breeding ground.

In this result females dominate the male and this disagree with Fagade and Adebisi (1979) who recorded that in African water bodies, it is common that in the population of fish the males dominate because they generally present more growth than females with a risk situation for the fishery. From the study, there was no significant difference ($P>0.05$) between mean monthly condition factor (k) between male and female *C. nigrodigitatus*. This suggests that the species were in relatively the same (good) condition during the period of investigation.

CONCLUSION

The silver catfish is omnivorous as it fed on a variety of food items from algae to animals' materials. Unidentified mass formed greater portion of the stomach fullness. They relied on the same food items at juvenile and adult stage which were dominant throughout the study period. This made them to live in relatively good condition. This information is useful in the formation and production of diet for the culture of this species.

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