DIET AND FEEDING HABITS OF *Chrysichthys nigrodigitatus* FROM ORETA AXIS OF LAGOS LAGOON, IKORODU, NIGERIA

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ABSTRACT
Chrysichthys nigrodigitatus plays a pivotal role in the ecology and fisheries management of brackish water ecosystems. Study on the Diet and Feeding habits of C. nigrodigitatus from Oreta Axis of Lagos Lagoon was carried out between June and August 2017. Parameters such as occurrence and numerical abundance methods, condition factor and stomach condition were evaluated using Windell, 1978, Job and Nyong, 2005 and Asuquo, 2000 procedures respectively. The results on the diet and feeding habits of C. nigrodigitatus showed that the species fed mostly on bivalves and some plant materials. Other food items that were isolated from the gut of the species included; crustaceans parts, small fish, mud/sand particles and detritus. The condition factor computed for the species varied during the study period with a mean value of 0.85 in June, 0.91 in July and 1.05 in August. According to the food items isolated from the gut of the C. nigrodigitatus, the species could be considered as a predatory cum omnivorous category of fish found in Oreta Axis of Lagos lagoon while the progressive increase in the value of the condition factor of the species may indicate a period of high productivity of food preference in the Axis of Oreta.
Key words: Food, Trophic, Lacépède, Brackish Ecosystem

INTRODUCTION

The unsustainable exploitation and reduction in fisheries resources from our water bodies has been on the rise due to population expansion and improved technology in terms of fishing gear and crafts. This however has impacted negative influence on the primordial effect of the healthy and sustainable aquatic environment. The negative effect of unsustainable exploitation and reduction in aquatic resources has brought together the researchers to investigate the potential yield of water bodies in terms of fish production and the eventual management of such resources by studying diet and feeding ecology of fish species for aquaculture purposes (Abdul and Omoniyi, 2007). The information from food and feeding habitats and stomach content assessment from these fish species can therefore be used during species selection and culturing technique for aquaculture purpose especially polyculture in order to meet the nutritional requirements of the cultured species (Ubong and Edidiong, 2015, Fagbenro *et al*., 2000).

The economically important fish species from Oreta Axis of Lagos Lagoon are mullets, tilapia, catfishes and other non-commercial or migratory fish species. One of the most common fish species in this axis is *Chrysichthys nigrodigitatus*. *Chrysichthys nigrodigitatus plays* a pivotal role in the ecology and fisheries of brackish water ecosystem. They occupy a significant trophic level in the ecosystem and have been introduced into many artificial lakes and reservoirs. Its affordable price makes it a choice of good source of animal protein at the center of meal in most African home (Ande *et al*., 2013). In terms of classification, *C. nigrodigitatus* (Lacépède) belongs to the family of Bagridae and has a common name "catfish" and it is found in fresh and coastal waters in West Africa (Muyideen *et al.*, 2010; Holden and Reed, 1991).

Morphologically, *C. nigrodigitatus* dorsal fins possess spines and adipose fins; the caudal fin is fork-shape. The colour is white in this species, with a basic grey/silver body colouration and a white underside. It is a fish without scales and the head is flattened with inferior mouth parts bearing well-developed barbels. *C. nigrodigitatus* can attain maximum length of 1.5m and can survive in the water with temperature range of 23ºC – 26ºC and pH range of 6.0-7.2. At maturity, the male usually prepare spawning and nests ground for female in their natural habitat (Ubong and Edidiong, 2015).Furthermore, the understanding of the relationships between food, feeding habit and morphometry of C .*nigrodigitatus* will provide straight forward replicas of stomach content dynamics that will assist the fish nutritionist to formulate a well-balanced ration that will sustain *C .nigrodigitatus* in the culture system. The present study was aimed at understanding the food and feeding habits of *C. nigrodigitatus* from Oreta Axis of Lagos Lagoon.

Study Area

The location of Oreta Axis is in the southwest region of Ikorodu which falls into the northern region of Lagos State. The geo-referenced points of Lagos lagoon is between 6° 27′ 0″ N, of the equator and between 3° 23′ 0″ E with a stretch of about 50 km long and 3 to 13 km wide, separated by a barrier from the Atlantic Ocean. The Lagos Lagoon surface area is approximately 6,354.7 km² with a typical tropical climate of wet and dry seasons and two distinct period of low and high rainy seasons and low and high dry seasons. The temperature range in Lagos is fairly small, generally staying between a high of 91°F (33°C) and low of 70°F (21°C) with an average temperature of 77°F (25°C) with average annual rainfall is 1693 mm. The lagoon is fairly shallow with average temperature of 27.0 °C and is not plied by ocean-going ships, but by smaller barges and boats. The lagoon receives the discharge of the Ogun River and the Osun River. Lagos Lagoon empties into the Atlantic via Lagos Harbour, a main channel through the heart of the city, 0.5 km to 1 km wide and 10 km long (Ajao, 1996)

Sampling Duration

The study was conducted between June 2017 and August 2017 and the fish samples are randomly collected monthly from landing site located atOreta Axis of Lagos Lagoon. The fish samples were examined, sorted, coded and identified based on fish classification charts.

Materials and Methods

Structure and Laboratory Specimen Assessment Survey

A total of 120 specimens were collected for the study (n=40 in June. n=40 in July and n=40 in August). The length of each sample was measured in centimeters using a measuring board and the weight in grams using a sensitive weighing balance (model EK5055 of electronic kitchen scale). The gut of each specimen was removed and preserved ina specimen bottle containing 4% formaldehyde. Each stomach was cut open and the contents washed into a petri dish using 4% formaldehyde. The laboratory analyses (*ex-situ)* for all the samples collected from Oreta Axis of Lagos Lagoon ecosystem during the study period were carried out in the central laboratory of National Institutes for Oceanography and Marine Research, Lagos Nigeria.

The food volume of each gut was determined by displacement method following (Windell, 1978). This was done by placing each gut, one at a time in a glass cylinder of 50ml capacity containing known volume of tap water. Some quantity of water (mls) was displaced by the gut, giving the food volume of the gut (windell, 1978). Each food volume reading (mls) was observed with each of standard length (cm) and weight (g) of the fish sample under consideration. Each preserved gut was cut open by the use of a pointed nose pair of scissors and the content scrapped out with aspatula into a watch glass in a petri dish following Job and Nyong (2005).The gut contents were observed under a light microscope for chit components which could not be identified with naked eyes. A magnification of x40objectives with oil immersion was used and x100 objective with oil immersion following Ajah *et al.,* (2005). Each diet component was identified based on the morphological features with the use of guides and schemes. The identified diet components were matched with their respective standard lengths and weights following Asuquo (2000).

Data Analysis

The data collected for 3months and the outcome of the laboratory analyses were subjected to the following indices.

Guts Repletion Index (GRI): Guts repletion index is number of non-empty guts divided by total number of guts examined, multiply by 100. Represented as:

$$GPI = \frac{Number\ of\ non-empty\ guts}{Total\ number\ of\ guts\ examined} \times 100$$

The food of the species was analyzed using Numerical and Frequency of occurrence method (Hyslop, 1980).

Numerical Method:

This involved counting the number of each food item present in the stomach of the species and summing up these numbers to obtain the grand number of all food items in its guts. The number of each foodwas expressed as a percentage of the grand total number of food items. Usually expressed as:

$$Percentage\ number\ of\ food = \frac{Total\ number\ of\ a\ particular\ food\ item}{Total\ number\ of\ all\ food\ items} \times 100$$

This method expresses the numerical importance of different food items, and gives relative importance of each food item.

Frequency of Occurrence Method:

This involved counting the number of times a particular food items occurs in the stomach and expressing this as a percentage of the total number of stomachs with food (empty stomachs excluded). This is usually expressed as:

$$Percentage\ occurence\ of\ food\ items = \frac{Total\ number\ of\ stomach\ with\ a\ particular\ food\ items}{Total\ number\ of\ stomachs\ with\ food} \times 100$$

This method presents the food spectrum of the species. Hence, the importance of the food items relative to the population of the species could probably be guessed. Data were presented in tables, graphs and charts to enhance the understanding of the diet components which formed the bulk of the diet of the fish.

Numerical and Relative Abundance of Diet Components:

Each diet component was enumerated separately to know the total number (w) following Marioghae (1982), Job and Udo (2002) and Job and Nyong (2005).This was then used in calculating the relative abundance of the individual diet component (n) using the fomula: %Ra=n x 100 (Marioghae, 1982; Job & Udo (2002) and Job &Nyong, 2005). Where; %Ra= relative percentage abundance n= number of individual diet components N= total number of all diet components from all analyzed guts with food.

Stomach Condition:

This study examined how prey type and *conditionofstomach* contents influenced identification of prey and the species diet preference

Condition Factor (K):

Condition factor which shows the corpulence status of an organism was calculated for this speciesusing the standard formula propose by Ricker (1971) given as:

$$K = \frac{W(100)}{L^3}$$

Where: w =weight of the fish and L = length of the fish

RESULTS

The food preference of *chrysithchys nigrodigitatus* from stomach analysis obtained consists of bivalves, mud/sand particles, plant materials, crustacean's parts, small fish and detritus. The results obtained from Numerical abundance, Relative Abundance of the food items, Frequencies and Percentage Frequencies method used in the analysis of the stomach contents are shown in Tables 1, 2 and 3.

Stomach Condition:

The percentage variations of the diet component discovered in the gut of *C. nigrodigitatus* during the study period is represented graphically in Fig. 1. The percentage shows the food preference of *C. nigrodigitatus* that was observed during the study period. On visual examination of the stomach, it was observed that only 5 of the whole specimens has an empty stomach and at 5.6%,50 of the stomach were half full representing 55.6%, 35 of the stomach were one quarter full representing 22.2% while 30 of the specimen has three quarter full stomach representing 16.7% of the total sample.

Condition Factor (K):

The total condition factor of *C. nigrodigitatus* in June was 34.05 with a mean of 0.85; in July it was 36.50 with a mean of 0.91, whereas in August it was 42 with a mean of 1.05

Table 1: Shows the Numerical, Relative Abundance of the food items, Frequencies and Percentage Frequencies (June. 2017)

S/N	Food items	Numerical Abundance(n)	Numerical and Relative Abundance(n/N *100)	Frequency	Percentage (%)
1	Bivalves	650	96.30	12	32.43
2	Mud/sand particles	4	0.59	6	16.22
3	Plant materials	6	0.89	4	10.81
4	Crustaceans parts	4	0.59	5	13.51
5	Small fish	6	0.89	5	13.51
6	Detritus	5	0.74	5	13.51
	TOTAL	**675**	**100**	**37**	**100**

Total no. of guts examined in Aug 2017	40
Total no of empty guts	6
Total no. of guts containing food	34
% of empty guts (1/40x100)	15%
% of guts containing food (36/40x100)	90%
GRI=36/40x100/1	90%

Table 2: Shows the Numerical, Relative Abundance of the food items, Frequencies and Percentage Frequencies (July 2017)

S/N	Food items	Numerical Abundance(n)	Numerical and Relative Abundance(n/N *100)	Frequency	Percentage (%)
1	Bivalves	670	97.52	15	53.57
2	Mud/sand particles	5	0.73	4	14.29
3	Plant materials	3	0.44	2	7.14
4	Crustaceans parts	2	0.29	2	7.14
5	Small fish	4	0.58	3	10.71
6	Detritus	3	0.44	2	7.14
	TOTAL	**687**	**100**	**28**	**100**
Total no. of guts examined in July 2017		40			
	Total no of empty guts	3			
	Total no. of guts containing food	37			
	% of empty guts (3/40x100)	7.5%			
	% of guts containing food (37/40x100)	92.5%			
	GRI=39/40x100/1	92.5%			

Table 3: Shows the Numerical, Relative Abundance of the food items, Frequencies and Percentage Frequencies (August 2017)

S/N	Food items	Numerical Abundance(n)	Numerical and Relative Abundance(n/N *100)	Frequency	Percentage (%)
1	Bivalves	689	98.99	17	70.8
2	Mud/sand particles	2	0.28	2	8.3
3	Plant materials	2	0.28	2	8.3
4	Crustaceans parts	1	0.14	1	4.2
5	Small fish	1	0.14	1	4.2
6	Detritus	1	0.14	1	4.2
	TOTAL	**696**	**100**	**24**	**100**
	Total no. of guts examined in June 2017	40			
	Total no of empty guts	1			
	Total no. of guts containing food	39			
	% of empty guts (1/40x100)	2.5%			
	% of guts containing food (39/40x100)	97%			
	GRI=39/40x100/1	97.5%			

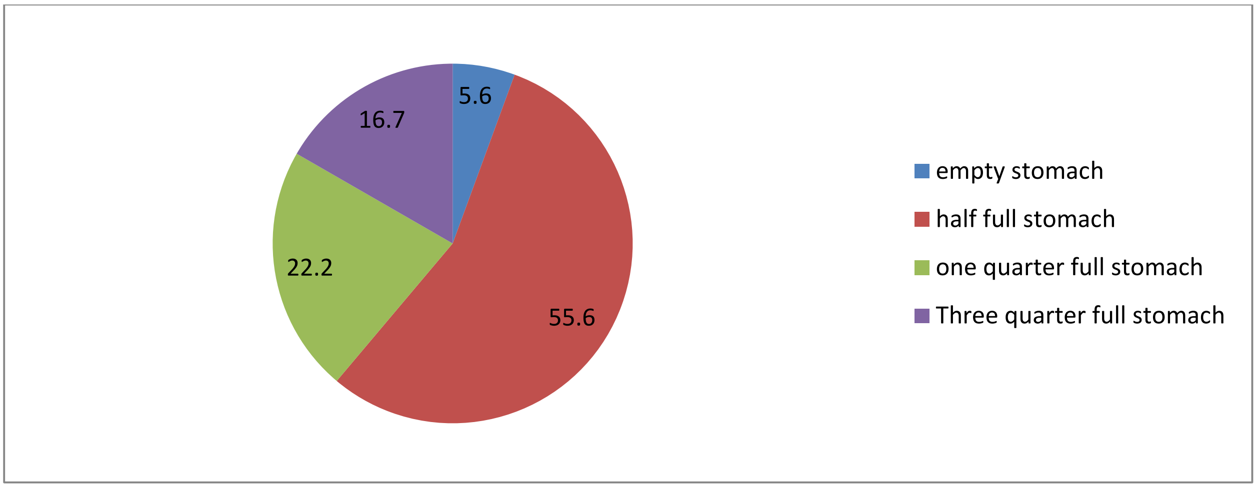

Fig.1 stomach conditions (%) of *C. nigrodigitatus*

DISCUSSION

Chrysichthys nigrodigitatus is a benthic species. It occurs in superficial water level of lakes of less than 4 m in volume, over mud and fine sand bottom, in rivers and in swamps. It is an omnivorous fish that feeds on seeds, insects, bivalves and detritus (Reed *et al.*, 1967). They occupy a significant trophic level in the ecosystem and also, regarded as a carnivore that feeds throughout the water column (Ajani, 2001).Age and size of C. *nigrodigitatus* determines the types, kinds and size of food to be taken (Laleye 1995). Gut analyses shows that the food samples found in *C. nigrodigitatus* caught from Oreta Axis of Lagoon Lagos includes; bivalves, sand particles, plant materials, crustaceans, small fish, detritus and some optically unidentified elements. The analyses shows that *C. nigrodigitatus* feeds on both plant and animal material which corresponds with the findings of Asuquo (2000) and Yem *et al.*, (2009) on the examinations of the stomach contents of *C. nigrodigitatus* from Cross River estuary and kanji lake respectively. However, the fishes are extremely mobile, showing extensive longitudinal, vertical and horizontal movements therefore the variety of food items present in the stomach of fishes often reflect trophic flexibility or opportunistic feeders as suggested by Warren (1993); the ability of fishes to switch from one diet to another depending on food availability.

Similarly, Inyang and Ezenwaji (2004) also reported that *C. nigrodigitatus* feeds on both plant and animal materials with the animal components being dominant this supports the present study that showed bivalves as being preferred by *C. nigrodigitatus* to other food items that were present in the environment. Meanwhile, the burrowing mode of life of bivalves and demersal habitat of *C. nigrodigitatu*s, this seemingly shared habitat could be responsible for high preference on bivalves by *C. nigrodigitatu*s being an omnivorous fish species. The study showed that *C. nigrodigitatus* are bottom feeders which support the work of Idodo-Umeh (2003) who reported that *C. nigrodigitatus* could be considered as bottom feeding mesopredators in River Ase, Delta State, although he opined that they can easily fit into the omnivorous category. However, this was not in agreement with Dada and Araoye (2008), who reported that plant materials was a major food for the species in Asa Dam and this could be as a result of unspecialized mode of feeding by the fish.

The present study clearly showed that *C. nigrodigitatu*s from Oreta axis of Lagos lagoon prefers bivalves to other animal matter. This finding may perhaps be due to the abundance of bivalves in this axis as a result of food and feeding habit of bivalves. Oreta axis of Lagos lagoon is known for abundant decayed materials from aquatic macrophytes and deposits from riparian community that encourages detritus formation as food for bivalve. This supports the work of Ikusemiju and Olaniyan (1977) who reported that the species of the fish feeds mainly on adult mollusk in Lagos Lagoon. The inclusion of mud and sand particles in the stomach of fish has been attributed to accidental ingestion along with other food items (Fagbenro *et al*., 2000).

The observable variations in the numerical abundance of the diet components consumed by *C. nigrodigitatus* during the study period are in the following sequence; In June 675, in July 687 and in August 696. The numerical abundance variations in different months could be due to hydrological period of high and low rainy seasons that affect the abundance of bivalve population in the ecosystem between June and August. The rainy season influences the reduction in population of bivalves in the ecosystem. The rainy season in northeastern Brazil influences the population of *A. brasiliana*, causing reduction in the number of clams (Oliveira *et al*., 2011).

Also, the physiological need of the fish might be responsible for the numerical abundance of diet components in the gut as emphasized by Laleye (1995) who reported that feeding of *C. nigrodigitatu*s becomes specialized with age and size. The various percentages of the stomach condition of fish might be due to struggle-induced vomit when they are caught in the net. Stomach condition could also be due to the diet effect which determines the time and duration of feeding (Lagler *et al.,* 1972, Nelson, 1984). The stomach condition may possibly due to the time it takes before the fishermen reaches the harbour which allowed for partial digestion of prey before landing (Nelson 1984). The dietary habits of fish, based on stomach analyses, is widely used in fish ecology as an important method to investigate trophic relationships in aquatic communities (Fagbenro *et al*., 2000)

The Condition Factor of fish refers to a scientific formula for determining the physiological status of a fish, including its reproductive capacity. It is computed by dividing fish weight by length cubed (W/L). The heavier a fish for a given length, the higher its condition factor (K). Condition factor is one parameter that may be considered when making assessments of fish health. The trends of Condition Factor of *C. nigrodigitatu*s during the 3-month study period shows that during June (high rainy period) the condition factor was 34.05 g/cm^3 with a mean of 0.85 g/cm^3 while in August (moderately low rainy period) the condition factor was 42 g/cm^3 with a mean of 1.05 g/cm^3 with month of July having the mid-value of 36.50 g/cm^3 with a mean of 0.91 g/cm^3. The above values indicated that the numerical abundance of food items in August plays vital roles in fish condition factor and the driving force behind this is the hydrological period that favours the abundance of bivalves during the period of moderately low rainy season being the most preferred diet for *C. nigrodigitatu*s. The species had good and varied diet components which might have been unconnected with favourable ecological conditions (Ubong and Edidiong, 2015).

Condition factor is an index of the degree of fatness or wellbeing of *C. nigrodigitatu*s from Oreta axis of Lagos Lagoon (Bagenal and Tesch 1978). The study of condition factor is important to understand the life cycle of fish species, and contributes to an adequate management of the species and to the maintenance of the ecosystem equilibrium (Haruna and Bichi 2005). Condition index may be used to determine the reproductive time of fish species without sacrificing the organisms, and this could be a valuable tool to develop monitoring programs for the species fisheries and culture programs (Arellano-Martinez and Ceballos-Vazquez, 2001).The results of stomach content analysis and condition factor on *C .nigrodigitatus* are important in providing straight forward models of stomach content dynamics. The understanding of the relationships between body structures, behaviour, feeding habit and fish related diets could also help the fish nutritionist in formulation of well-balanced fish feed for good growth of C. *nigrodigitatus* in their culturing environment. In order to enhance the sustainability and availability of *C. nigrodigitatus* from Oreta Axis of Lagos lagoon, bivalves and other food components identified in this study should be given adequate ecological protection.

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