Food and Feeding Ecology of *Chrysichthys nigrodigitatus* in the Cross River Estuary, South Eastern Nigeria

Ubong Uwem George[1], Edidiong Okokon Atakpa[2]

[1]Department of Zoology and Environmental Biology, University of Calabar, Cross River State, Nigeria.

[2]Department of Zoology, University of Uyo, Akwa Ibom State, Nigeria.
talk2georgeubong@gmail.com

Abstract: *Chrysichthys nigrodigitatus* are important, highly valued and threatened brackish water species in the Cross River Estuary, Nigeria. Studies on the Food and Feeding Ecology of *Chrysichthys nigrodigitatus* in Cross River Estuary, was studied between July and September 2014 aimed at understanding the food and feeding ecology of *C. nigrodigitatus*. Food items in the gut of *Chrysichthys nigrodigitatus* were evaluated by occurrence and numerical abundance methods. The results on the food and feeding habits of *C. nigrodigitatus* in the Cross River Estuary revealed that the species feed mostly on food from animal origin, although diatoms and other plant materials were also identified. Food items isolated from the gut of the species included; Amphipods, crab/ crab particle, mud / sand particle, diatom, shrimps / shrimp parts, bivalve, mollusk, small fish, Copepods, fish bones, fish scales, prawns, crustacean and detritus which could not be determine empirically. The condition factor calculated for the species varied during the study period with a mean value of 1.38 in July, 1.44 in August and 1.57 in September. Based on the food items isolated from the gut of the *C. nigrodigitatus,* the species could be considered as a voracious Omnivore in the Cross River Estuary, while the variations in the condition factor of the species in the Estuarine system may indicate a period of high yield or otherwise of the species in the Cross River Estuary.

1.0 Introduction

Chrysichthys nigrodigitatus with a common name silver cat fish is a demersal protomodromous species. It occurs in shallow waters of (less than 4m) and is confined to the mud and fine sand bottom. They are Omnivorous in nature feeding on varieties of food stuffs which include seeds, insects, bivalves and detritus (Reed *et al.,* 1967). The richness and variety of various tropical aquatic habitats provide a wide range of possible food organisms for fishes. These originate either from within the aquatic ecosystem itself (autochthonous food sources) or from outside (allochthonous food sources). Feeding becomes specialized with age and size; large *Chrysichthys nigrodigitatus* may feed on decapods and fish (Laleye, 1995). It can grow to 50cm (18 inches) with temperature of 23^0C – 26^0C with pH 6.0-7.2. In Nigeria, *C. nigrodigitatus* is a highly valued food fish and is among the dominant fishes of commercial catches as well as culturable fish species from the wild (Ezenwa *et al.,* 1986, 1990).

C. nigrodigitatus has large eyes (large mouth and relatively small barbels on this species which usually relates to the habitat where it resides, being clear water where large barbels for feeling for food is not needed, hence the large eyes for hunting preys. The dorsal fin is preceded by a spine. Adipose fin is present and can have a relatively long base in some species. The pectoral fin can be serrated. The body is completely naked (they have no scale). The maximum length is about 1.5meters (4.9ft). Fishes of the Bagridae family have four pairs of well-developed barbels covered by a layer of taste bud epithelium (Zhang, *et al*., 2006). The colour is quite in this species, with a basic grey/silver body colouration and a white underside. It has a quite large dorsal fin and a deeply forked caudal fin. It is basically a food fish in its native Africa waters. Its flesh is reported to be quite good and they are fished using all types of capture methods including nets and weirs. The males when fully grown usually have a broader head which they use to dig out their breeding nests in their native habitats.

Information from food studies can be used during species selection in fish culture. This is particularly useful in polyculture because proper selection of fishes with different feeding habits will prevent or significantly reduce competition during culture. Information on the biochemical composition and energy levels of the ingested food and its absorption in the alimentary canal provides base line data useful in artificial feed formulation for fish during their culture. For instance, a fish whose natural food is low in protein will likely not require a high protein feed during its culture. Such information can save the farmer a lot of money during feed formulation. Generally, the costs of producing adequate fed for

predators is higher because they require a lot of protein in their diet; while the feed of herbivores is cheaper since they require less protein. Catfishes require about 40% protein in their diet for proper growth during culture.

Basically, the study of the diet of faunal entities based on the analysis of gut contents of the species caught from their natural habitats is now standard in ecological studies (Thomas, 1966). The establishment of food and feeding habits of species enhances the understanding of the growth, productivity, distribution and abundance of such species in their natural habitat. The present study was aimed at understanding the food and feeding habits of *C. nigrodigitatus* in the Cross River Estuary.

2.0 Material And Methods
2.1 Study Area

The Cross River Estuary is a tropical brackish ecosystem located between $4^030'5.15'N$ of the equator, and between $8^000'8.40'E$ of the Greenwich meridian. It is a part of South-eastern Nigeria rainforest characterised by shallow depth (4-10m) and 5.5km width, and extensive intertidal mud with salinity fluctuating between fresh and brackish water depending on the tidal phase and season (Akpan, 1994). The Estuary is the biggest along the Gulf of Guinea coast with an area of about 1500km^2, the tidal flood plains inclusive. The climate is marked by alternating dry and wet seasons- a long wet season between April and November and a relatively short dry season from December to March (Akpan, 1994). The mean annual air temperature is 28^0c and the mean precipitation is 500mm, surface water temperature varies between 22^0c and 30^0c (Etim, 1991).
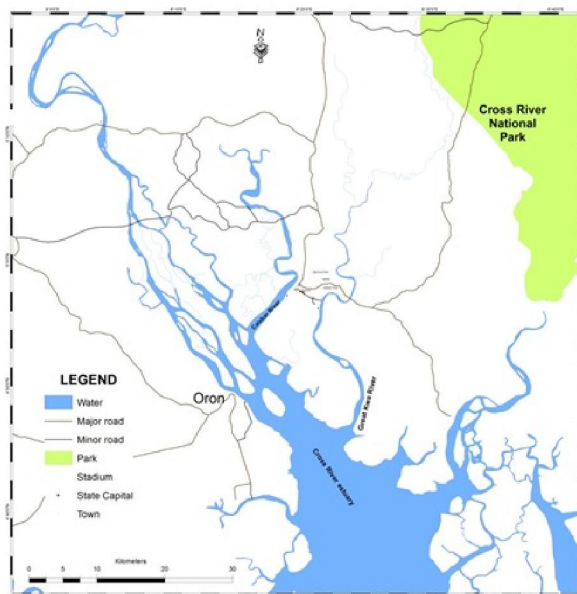

Fig 1. Map of the Study Area

2.2 Sampling Frequency

The study was conducted within 3 months and sampling was done bimonthly. The specimens from artisanal fisher's landings were randomly sampled. The fish bought were examined, sorted and identified using the taxonomic keys of Schneider (1990) and Olaosebikan and Raji (1998).

2.3   Collection of Samples

A total of 150 specimens were collected for the study. Each sampling period samples were stored immediately in ice-chest after collection and transported to the Institute of Oceanography Central Laboratory for analysis. Preserving the samples in ice-chest prevented the breakdown of consumed diet components as a result of autolysis and self-cell eating putrefaction (Smith, 1982).

2.4   Laboratory Procedures

The length of each sample was measured in centimeters using a measuring board, and the weight (in grams) using a sensitive weighing balance. The samples were mopped-dry with a blotting paper or clean towel weighing. This was done to prevent excessive weight on the fish due to moisture.

The fish specimens were dissected and gutted with the aid of a dissected set. This was done by cutting open the abdominal portion of the fish from the end of the rectum to the top of Oesophagus following Lagler *et al* (1977), Schneider (1990), Job and Udo (2002).

The food volume of each gut was determined by displacement method (Windell, 1978, Hyslop, 1980). 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 whime of the gut (Windell, 1978; Hyslop, 1980). Each food volume reading (mls) was watch with each of standard length (cm) and weight (g) of the fish sample under consideration.

Each gut from an individual fish was preserved in 10% formaldehyde solution in glass bottles of 50ml capacity following Haron (1998) for three days to enhance the coagulation of the discrete diet items for each of analysis.

Each preserved gut was cut open by the use of a pointed nose pair of scissors and the contents scrapped out with a spatula into a watch glass a petri dish was also use where the contents were much following Job and Nyong (2005).

The gut contents were observed under a light microscope for chit components which could not be identified with the naked eyes. A magnification of x40 objectives with oil immersion was used and x100 objectives 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 match with their respective standard lengths and wet weight following Asuquo *et. al* (2010).

2.5 Data Analysis
The following indices were used;

2.5.1 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:

GRI = Number of non-empty guts x 100
          Total number of guts examined

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

2.5.2 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 food was expressed as a percentage of the grand total number of food items. Usually expressed as:

Percentage number of food
= Total number of a particular food item x 100
          Total number of all food items

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

2.5.3 Numerical and Relative Abundance of Diet Components
Each diet component was enumerated separately to know the total number (w) following Marioghae (1982), Job & Udo (2002) and Job & Nyong (2005). This was then used in calculating the relative abundance of the individual diet component (n) using the fomula:

%R_a=n x 100 (Marioghae, 1982; Job & Udo (2002) and Job & Nyong, 2005)
    N
Where;
%R_a= relative percentage abundance
n= number of individual diet components
N= total number of all diet components from all analyzed guts with food.

2.5.4 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 occurrence of food items

Total number of stomachs with a particular food item x 100
          Total number of stomachs with food.

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.

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

K =   w(100)
              L^3

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

3.0 Result
3.1 Diet Component Encounter in the Gut of *Chrysichthys nigrodigitatus (*July, 2014*)*
A total of 16 different diet components were recorded in the gut of *C. nigrodigitatus* in July, 2014, showing varying numerical abundance and relative percentage abundance; Amphipods 8(1.2%), Crab/crab particles 59(8.8%), mud/sand particles 102(15.2%), Diatoms 83(12.4%), shrimp/shrimp particles 96(14.3%), bivalve 49(7.3%), Mollusks 54(8.0%), plant material 95 (14.2%), small fish 22(3.28%), fish scales 22(3.3%), fish bones 13(1.9%), prawn 6(0.8%), copepod 2(0.3%), crustacean/part 24(3.6%), polychaetes 35(5.224) and detritus which could not be enumerated empirically. A total of 670 individual diet component were encountered in the gut of the fish in July, 2013 (Table 1.) Also the frequency of occurrence and percentage frequency were noted and recorded for each of the individual diet component, Amphipods 5(2.79%), Crab/Crab particles 17(9.49%), mud/sand particles 18(10.05%), diatoms 13(7.26%), shrimp/shrimp particles 17(9.49%), bivalve 13(7.26%), mollusks 23(12.84%), plant material 11(6.14%), small fish 12(6.70%), fish scales 5(2.79%), fish bones 3 (1.67%), Prawn 3(1.67%), copepod 1(0.56%), Crustacean/part 6(3.35%), Detritus 23(12.84%) and Polychaetus 9(5.02%), (Table 1).

Table 1: Summary of the Numerical, Relative Abundance of the Diet Components and their respective Frequencies and Percentage Frequencies (July 2014)

S/N	Diet components	Numerical abundance (n)	Numerical and relative abundance (n/N *100)	Frequency	%Frequency
1.	Amphipods	8	1.19	5	2.79
2.	Crab /crab particles	59	8.81	17	9.49
3.	Mud/sand particles	102	15.23	18	10.05
4.	Diatoms	83	12.39	13	7.26
5.	Shrimp/shrimp particles	96	14.33	17	9.49
6.	Bivalve	49	7.31	13	7.26
7.	Mollusks	54	8.05	23	12.84
8.	Plant material	95	14.20	11	6.14
9.	Small fish	22	3.28	12	6.70
10.	Fish scales	22	3.28	5	2.79
11.	Fish bones	13	1.94	3	1.67
12.	Prawn	6	0.90	3	1.67
13.	Copepod	2	0.30	1	0.556
14.	Crustacean/part	24	3.58	6	3.35
15.	Detritus	-	-	23	12.84
16.	Polychactes	35	5.23	9	5.02
	Total	670	100	179	100

Total no of guts examined in July 2014 = 50
Total no of empty guts =3
Total no of containing food =47
Percentage of empty guts =3/50 x100 = 6%
Percentage of guts containing food =47/50 x 100
GRI =47/50 x 100 =94%

Table 2: Summary of the Numerical, Relative Abundance of the Diet Components and their respective Frequencies and Percentage Frequencies (August, 2014)

S/N	Diet components	Numerical abundance (n)	Numerical and relative abundance (n/N *100)	Frequency	%Frequency
1.	Crab/particles	54	10.24	13	7.78
2.	Plant materials	65	12.33	12	7.18
3.	Detritus	-	-	24	14.37
4.	Diatoms	43	8.15	7	4.19
5.	Amphipods	9	1.70	6	3.59
6.	Mud/sand particles	89	16.88	18	10.77
7.	Bivalve	21	3.98	5	2.99
8.	Mollusks	40	7.59	17	10.17
9.	Shrimps/Shrimps particles	77	14.61	21	12.57
10.	Crustacean	24	4.55	7	4.19
11.	Polychaectes	41	7.77	11	6.58
12.	Fish egg	6	1.13	2	1.19
13.	Small fish	23	4.36	13	7.78
14.	fish scales	28	5.31	8	4.79
15.	Prawns	4	0.75	2	1.19
16.	Fish bone	3	0.56	1	0.59
	Total	527	100	167	100

Total no of guts examine in August 2014 =50
Total no of empty guts = 3
Total no of guts containing food =47
% of empty guts = 3/50 x 100 =6%
% of guts containing food =47/50 x 100=94%
GRI =47/50 x 100/1 =94%

3.2 Diet Component Encounter in the Gut of *Chrysichthys nigrodigitatus* (August, 2014)

As in July, 2014, 16 diet components were also recorded in the gut of *C. nigrodigitatus* in August, 2014. Variations in numerical and relative percentage abundance were also observed among the diet components. The diet component with their respective numerical and relative percentage abundance were; Crab/particles 54(10.24%), plant materials 65(12.33%), diatoms 43(8.15%), amphipods 9(1.70%), mud/sand particles 89(16.88%), bivalve 21(3.98%), Mollusk 40(7.59%), Shrimps/particles 77(14.61%, Crustacean 24(4.55%), Polychaetes 41(7.77%), fish egg 6(1.13%), small fish 23(4.36%), fish scales 28(5.31%), Prawns 4(0.75%), fish bone 3(0.56%) and detritus which could not be empirically determined.

A total of 527 individual diet components were encountered in the gut of *C. nigrodigitatus* in August, 2014. (Table 2). Also, the frequency were also observed and recorded as follows; Crab/particles 13(7.78%), Plant material 12(7.18%), detritus 24(14.37%), diatoms 7(4.19%), Amphipods 6(3.59%), Mud/sand particles 18(10.77%), bivalve 5(2.99%), Mollusk 17(10.17%), Shrimp/particles 21(12.57%), Crustacean 7 (4.19%) polychaetes 11(6.58%), fish eggs 2(1.17%), small fish 13(7.78%), fish scales 8(4.77%), Prawns 2(1.17%) and fish bone 1 (0.59%) (Table 2).

3.3 Diet Components in the Gut of *Chrysichthys nigrodigitatus* (September, 2014)

In September, 2014, 14 different diet components were recorded in the gut of *C. nigrodigitatus*. Similar variations in numerical and relative percentage abundance were also in the diet of the species during the month of study. These were Mollusks 53(9.33%), Shrimp/parts 102(18.34%), small fish 27(4.85%), Mud/sand particles 99(17.80%), diatoms 44(7.91%), plant materials 25(4.49), Polychaetes 33(5.93%), Fish scales 40(7.19%), fish bone 32(5.74%), Amphipod 12(2.15%), bivalve 17(3.05%), Crab/part 59(10.61%), Crustacean parts 13(2.33%) and detritus with no empirical value. A total of 556 individual diet component was encountered in the gut of *C. nigrodigitatus* in September 2014, (Table 3). Also, the frequency of occurrence and percentage frequency of occurrence were also recorded; Mollusk 17(9.44%), Shrimp/part 22(12.22%), small fish 14(7.77%), detritus 29(16.11%), mud/sand particles 22(12.22%), diatoms 8(4.44%), plant materials 5(2.77%), polychaetes 10(5.55%), fish scales 10(5.55%), fish bone 9(5.0%), Amphipod 6(3.33%), bivalve 7(3.88%), Crab/part 18(10.0%), and Crustaceans part 3(1.66%) (Table 3).

Table 3: Summary of the Numerical, Relative Abundance of the Diet Components and their respective Frequencies and Percentage Frequencies (September 2014)

S/N	Diet components	Numerical abundance (n)	Numerical and relative abundance (n/N *100)	Frequency	%Frequency
1.	Mollusks	53	9.53	17	9.44
2.	Shrimp/ Shrimps particles	102	18.34	22	12.22
3.	Small fish	27	4.85	14	7.77
4.	Detritus	-	-	29	16.11
5.	Mud/sand particles	99	17.80	22	12.22
6.	Diatoms	44	7.91	8	4.44
7.	Plants materials	25	4.49	5	2.77
8.	Polychactes	33	5.93	10	5.55
9.	Fish scales	40	7.19	10	5.55
10.	Fish bone	32	5.75	9	5.0
11.	Amphipod	12	2.15	6	3.33
12.	Bivalve	17	3.05	7	3.88
13.	Crab/part	59	10.61	18	10.0
14.	Crustaceans parts	13	2.33	3	1.66
	Total	556	100	180	100

Total no gut examined in September 2014=50
No of guts containing food =45
% of empty guts = 5/50 x 100 =10%
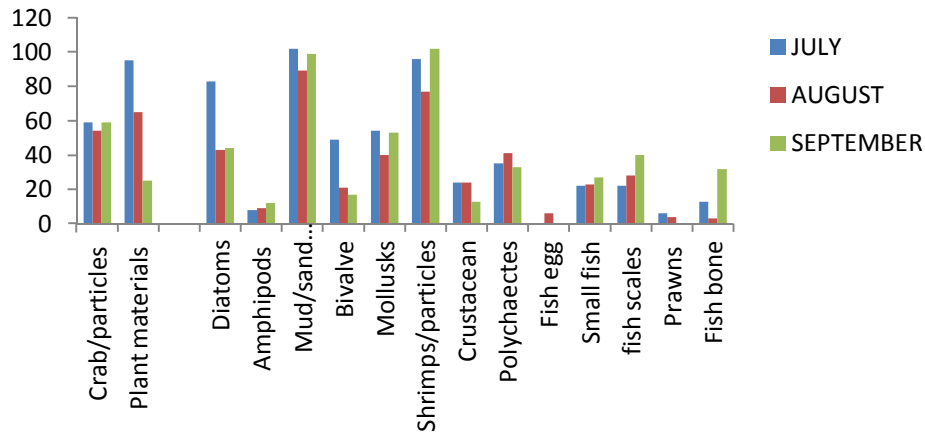% 0f guts containing food =45/50 x 100=90%
GRI =45/50 x 100 =90%

Fig 2: Variation in the numerical abundance of the diet components encounter in the gut of *Chrysichthys nigrodigitatus* during the study (July-September, 2014).

3.4 Variation in the numerical abundance of the diet components encountered in the gut of *Chrysichthys nigrodigitatus* during the study (July-September, 2014).

The variations in numerical abundance of the diet component encountered in the gut of the species during the study period are presented in Fig. 2. The distribution of the diets components in the different months shows that in some months the diets were observed to vary during the study period.

3.5 Condition factor

The total condition factor of the species in July was 68.99 with a mean of 1.38; in August total condition factor was 72 with a mean of 1.44, while in September total condition factor was 78.6 with a mean of 1.57.

4.0 Discussion

Chrysichthys species are regarded as omnivorous detritivores (Oronsaye and Nakpodia 2005, Offem *et al*., 2008 and Yem *et .al*., 2009). The morphology of *Chrysichthys* is adapted for bottom feeding although stomach contents may prove otherwise as the variety of food items contained in the stomach of fishes often reflect the ability of fishes to obtain food from different locations. Morphological features, therefore cannot limit *Chrysichthys* as exclusive bottom feeders (Idodo-Umeh, 2003). *C. nigrodigitatus* has been reported to feed mainly on adult molluscs and crustaceans in Lagos Lagoon (Ikusemiju, 1975; Ikusemiju and Olaniyan, 1977); it is also regarded as a carnivore that feeds throughout the water column (Ajani, 2001).

Examination of the gut contents of *Chrysichthys nigrodigitatus* revealed that the species feeds mostly

on diets of animal origin including Amphipods, crab/ crab particle, mud / sand particle, diatom, shrimps / shrimp parts, bivalve, mollusk, small fish, Copepods, fish bones, fish scales, prawns, crustacean. Some plant matterials and detritus were also consumed. A total of 16 different diet components were encountered in the gut of the species during the investigation. However, diet components were observed to vary in the gut of the species throughout the study months. The availability or otherwise of these diet component in the diet of the species in these months might have been due to size selection of diet by the species. Qin (1997) observed similar size selection in *Channa striatus* in South-east Asia as was similarly observed by Ng and Lim (1990) in the same area. Fish feeding success depends upon vision, its ability to pursue and catch prey, and the ability of prey to escape (Qin, 1997; Ajah *et al*., 2005).

Variations in the numerical abundance of the diet components consumed by *C. nigrodigitatus* were also observed in each of the months. There were 670 in July, 527 in August and 556 in September. The variations might have been caused by an increase in the quantity of a particular food item in one month and a reduction in one or another food item consumed by the species in the month during the study. This again agrees with the report of Onyia (1973) during his studies on a contribution to the food and feeding habits of the thread fin *Galeoides decadactylus* in Lagos, Nigeria who attributed the variations in the food consumed by *G. decadactylus* to food preference and availability; Costa and Wanninayake (1986), when working on food, feeding and fecundity of the giant freshwater prawn *Macrobrachium rosenbergii* from natural habitats in Srilanka; Okon (2002), when working on some aspects of the food and feeding

habits of *Ilisha africana* from Qua Iboe River estuary, Nigeria; Ajah *et al.,* (2005), when studying the food and feeding habits of five freshwater and brackish water fish species in Nigeria; Job and Udo (2002), when reporting on the food, and feeding and the condition factor of the estuarine catfish *chrysichthys nigrodigitatus* of the Cross River, Nigeria, George *et. al*., (2011), when studying the food and feeding habits of *Ophiocephalus obscura* (African Snakehead) in the Cross River Estuary, Cross River State, Nigeria; George and Akpan (2011), when reporting on the diet composition and condition Factor of *Ilisha africana* in the Cross River Estuary, Nigeria; George *et. al*., (2013), when studying the diet composition and condition factor of *Ethmalosa fimbriata* in the Cross River Estuary, Nigeria.

The mean condition factor showed an interesting variation pattern. This ranged between 1.38 and 1.57. In July, condition factor was 1.38, in August the condition factor increase to 1.44 and a further increase in September to a value of 1.57. These variations are indicative of the fact that in September, the species had good and varied diet components which might have been unconnected with favorable ecological conditions. These parameters might have continually undergone significant variations and changes resulting in the observed increase in condition factor of the species in the habitat with time. In July and August mean condition factor of the species were low with a value of 1.38 and 1.44 respectively, indicating either a period of unfavorable ecological conditions or a period which the species might have undergone stress from low food availability and/or reproductive processes. When an organism undergoes starvation or has become spent, it condition factor reduces even when every other ecological factors is optimum (Odum, 1971). This might have been the case during this study.

A further increase in mean condition factor was observed in September when a value of 1.57 was recorded. Condition factor is known to indicate the state of health of a particular species (Ricker, 1971). With a mean condition factor of 1.57 in September, These variations are indicative of the fact that in September, the species had good and varied diet components which might have been unconnected with favorable ecological conditions. Similar observations were made by Job and Udo (2002) during their studies on the food, feeding and the condition factor of the estuarine catfish *Chrysichthys nigrodigitatus* of the Cross River, Nigeria. Enin and Enidiok (2002) also reported monthly variations in the mean condition factor in *Cynoglossus senegalensis* in the Cross River Estuary, Nigeria which they attributed to environmental changes, state of growth and food

availability which support the results of the present study.

References
1. Ajah P. O., Georgewill M. N., Ajah M. O. (2005). The food and feeding habits of five freshwater and brackish-water fish species in Nigeria. *Afr. J. Aquat. Sci*., 31: 313-318.
2. Ajani, E. K. 2001. Effects of biotic and abiotic components of the habitat on fish productivity in Lagos Lagoon, Nigeria. Ph.D. Thesis, University of Ibadan, Ibadan, Nigeria.
3. Akpan, E. R. (1994). Seasonal Variation in Phytoplankton biomass in relation to physico-chemical factors in the Cross River Estuary of South Eastern Nigeria. . Ph.D Thesis, University of Calabar.
4. Costa, H. H., Wanninayake T. B. (1986). Food feeding and fecundity of the Giant Freshwater Prawn *M. rosenbergii* from natural habitat in Sri Lanka. The First Asian Fisheries Forum, Maclean, J.L., L.B. Dizon and L.V. Hostillos, (Eds.), Asian fisheries content analysis a review of methods and their application. *J. Fish Biol.*, 17: 411-429.
5. Enin, U. I., Enidiok S. E. (2002). Length-weight relationship, condition factor and feeding habits of *Cynoglossus senegalensis* (Kaup, 1850) (Pleurnectiformes, Cynoglossidae) in the Cross River Estuary, Nigeria. *Afr. J. Fish. Aquacult.*, 3: 31-42.
6. Etim, L. (1991). Growth, biochemical composition and reproduction cycle in Egeria radiate (Lamark, 1804) (Lamellibiancheia Tellinaceae; Dmacidea) from the Cross River Nigeria. Ph.D Thesis, University of Calabar.
7. Ezenwa, B., Kusemiju, K. (1986). Age and growth determination in the catfish, *Chrysichthys nigrodigitatus* (Lacepede) by the use of dorsal spine. *Journal of fish Biology*. 19(3):345-361.
8. Ezenwa, B., Alegbeleye, W. O., Anyanwu, P. E., Uzukwu, E. O. (1990). Cultural fish seeds in Nigeria Costal Water. A research survey and marine research. (National Institute of Oceanography and Marine Research) Technical paper. p. 66, 37.
9. George, U. U**.,** Ekanem, A. P., and George, E. (2011) Food and Feeding Habits of *Ophiocephalus obscura* (African Snakehead in the Cross River Estuary, Cross River State, Nigeria. *International Journal of Fisheries & Aquaculture* 3 (13):231-238.
10. George, U. U. and Akpan, E. R. (2011). Diet Composition and Condition Factor of *Ilisha africana* in the Cross River Estuary. *African*

Journal of Environmental Pollution and Health, 9(2):24-32.

11. George, U. U., Idung, J. U., Andem, A. B., Okorafor, K. A. and Mowang, D. (2013). Diet Composition and condition Factor of *Ethmalosa fimbriata* in the Cross River Estuary. *Greener Journal of Biological Science,* 3(6):244-252.

12. Haroon A. S. (1998). Diet and feeding ecology of two size of Barbodes gonionotus and Oreochromis species in rice field in Bangladesh. NAGA, the ICLARM Q., pp. 13 – 18

13. Hyslop, E. J. (1980). Stomach content analysis, a review of methods and their application. *Journal of Fish Biology.* 17. 4111-430.

14. Idodo-Umeh, G. 2003. Freshwater fishes of Nigeria (Taxonomy, ecological notes, diet and utilization). Idodo-Umeh, Benin City, Edo State, Nigeria.

15. Ikusemiju, K. (1975). A comparative racial study of *Chryschthys nigrodigitatus* (Lacepe) from Lagos and the Lekki lagoons, Nigeria. *Nig. J. Nat. Sci.* 4(1-2):144-149.

16. Ikusemiju, K. & Olaniyan, C. I. O. (1977). The food and feeding habits of the catfishes: *Chrysichthys walkeri* (Gunther), *Chrysichthys filamentosus* (Boulenger) and *Chrysichthys nigrodigitatus* (Lacépède) in the Lekki Lagoon, Nigeria. *J. Fish Biol.* 10: 105-112.

17. Job B. E., Udo P. J. (2002). Food, feeding and condition factor of estuarine catfish *Chrysichthys nigrodigitatus* (Lacepede) of the Cross River Estuary, Nigeria. *Afr. J. Fish. Aquacult.*, 3: 43-45.

18. Job B. E., Nyong E. A. (2005). Diet composition and condition factor of the African River Prawn (*Macrobrachium vollenhovenii*) (Herklots, 1857) (Crustacea, Decapoda, Palaemonidae) of the Cross River Estuary, Nigeria. *Afr. J. Fish. Aquacult.* 4:9-17.

19. Lagler, K. F., Bardach, Miller J. E., May R. R., Passino, D. R. (1977). Ichthyology. 2nd Edition. Wiley and Sons Inc. printed in USA, pp.129-16.

20. Marioghae, I. E. (1982). Notes on the biology and distribution of *M. vollenhovenii*, *M. macrobrachion* in the Lagos Lagoon. *Rev. Zool. Afr.*, 96(3): 493 – 508.

21. Ng, P. K. L., Lim K. K. P. (1990). The Black Snakehead, *Channa melasoma* (Channidae): First Record from Singapore. *Raffles Bull. Zool.*, 38(1): 21-24.

22. Odum E. P. (1971) Fundamentals of Ecology. WB Saunders Company, Philadelphia.

23. Offem, B O., Akegbejo-Samsons, Y., & Omoniyi I. T., (2008). Diet, size and reproductive biology of the silver catfish, *Chrysichthys nigrodigitatus* (Siluriformes: Bagridae) in the Cross River, Nigeria. *Rev. Biol. Trop.* 56: 1785-1799.

24. Okon A. M. O. (2002). Some effects of the food and feeding habits of *Ilisha africana* (Bloch) Picesi clupeidae) in Qua Iboe Estuary, Nigeria. *Afr. J. Fish. Aquacult.*, 2: 1-9.

25. Olansebikan, B. and Raji, A. (1998). Field guide to Nigerian freshwater. Federal College of Fresh water Fishes (FCFF), New Bussa, Niger State. Nigeria. 106pp.

26. Onyia A. D. (1973). A contribution to the food and feeding habit of the threadfins *Galeoides decadactylus. Springer-verlag. Mar. Biol.*, 22: 371 – 372.

27. Oronsaye, C.G. & Nakpodia, F. A., (2005). A comparative study of the food and feeding habits of *Chrysichthys nigrodigitatus* and *Brycinus nurse* in a tropical river. *Pakistan J. Sci. Indust. Res.* 48: 118-121.

28. Qin, Fost (1997). *A* bioenergetics model for Juvenile snakehead (*Channa striatus*): *Environ. Biol. Fish*, 50: 308-318.

29. Reed, W., Burchard, J., Hopson A. J., Jenness, J. & Yaro, I. (1967). Fish and fisheries of Northern Nigeria. Ministry of Agricultures, Northern Nigeria, Kaduna. 226pp.

30. Ricker, W. E. (1971). Computation and interpretation of biological statistics of fish populations. *Bull. Fish. Res. Bd. Can.* 191: 382.

31. Schineider, W. (1990). Field Guide to the Commerical Marine Resources of the Gulf of Guinea. FAO identification sheets for Fishery purposes. Rome, p. 268.

32. Smith, L. S. (1982). *Introduction to fish physiology,* T. F. H. Publications Incorporated, 211 West Sylvania Avenue, Neptune New Jersey Pp. 352.

33. Windell, J. T. (1978). Estimating food consumption rates of fish populations. In: Methods for Assessment of fish production in fresh water (Ed. Bagenal, T), . 227-253. Blackwell scientific publications. Third Edition, London.

34. Yem, I.Y., N.O. Bankole, O. Ogunfowora & B. Ibrahim. 2009. Food habit of the catfish *Chrysichthys nigrodigitatus* (Geoffrey Saint Hilaire, 1808) in Kainji Lake, Nigeria. *Nat. Sci.* 7: 17-22.

11/10/2015