ANALYSIS OF FOOD ITEMS AND DIET PREFERENCE IN THE STOMACH OF*Synodontisobesus*(BOULENGER, 1898: SILURIFORMES, MOCHOKIDAE) IN THE LOWER CROSS RIVER, NIGERIA

Abstract

Analysis of stomach contents of *Synodontisobesus*(BOULENGER, 1898: SILURIFORMES, MOCHOKIDAE) in the Lower Cross River, Nigeria was carried out with standard methods to assess the food items and diet preference of the species. A total of 160 individuals of *Synodontisobesus* (Mochokidae)were collected from October 2022 to January, 2023 at Akan ObioUraun fishing port in Itu Local Government Area, Lower Cross River, Nigeria from local fishers and used for the study. Analysis of the fullness of stomach showed that 84.4 % had food contents while 15.60 % were empty stomachs. Samples with one quarter (25%) stomach fullness had the highest value of 28.13% while samples with 100% stomach fullness (18.75%) weremore than those with half (50%) stomach fullness (17.52%). Twelve food itemswere found in the digestive tubes of the species, indicating that the fish has a high level of food selectivity and rich nutritionregime. The percentage frequency of occurrence of the food items with respect to whole sample indicated that plants part accounted for 36.98 %, fish (animal items) 21.93%,and palm fruits 16.05%, detritus 9.49%, sand grains 7.30%, insect /insect appendages 6.80%, and unidentified items 1.45 %. The wider food spectrum exhibited by the species revealed trophic flexibility. Food items increased as the fish grows in size but declined at old age indicating transitional diet shift as the fish grows bigger. The fish species is omnivore,feeding on a wide variety of food items including detritus.The results of this study are useful in determining the relationships between food availability, diet favorite and growth of the species in freshwater ecosystem.

Key words: Synodonthisobesus, lower cross river; Diet preference, stomach fullness, trophic flexibility.

1.0 Introduction

The genus *Synodontis*is commonly known as the up-side down catfish and belongs to the family, Mochokidae. The species, *Synodontisobesus*has whisker-like organs on their head called barbels which relate to touch. It can also be identified by the colour of their skin, the skull bone and the number and length of the teeth and those structures also help it to gnaw at any hard plant tissues which form part of its rich diet (Welcome, 1979). The speciesisof great ecological and commercial importance in the inland waters of Nigeria and West Africa (Reed *et al.,* 1967; Araoye*etal.,* 2002; Lalèyè*et al.,* 2006).Local fishermen consider the species as a nuisance because often it is entangled in their gill nets and very difficult to remove from the nets since it has long and serrated spines.

The diet of the fish is a subject of continued research. Various studies had been conducted on feeding regimes, food preference, dietof the species(Offem*et al.*, 2008; Adeyemi*et al.*, 2009; and

Ekpo*et al*., 2014a). Studies of the food and feeding habit are useful in determining the population level since the number of individuals in the population depends on the amount of food available (Okey*et al*., 2017). Gut content analysis gives information on seasonal and life history changes of the fish because the types and magnitude of food available as well as the season it occurs plays an important role in the life history of the fish (Ekpo*et al*., 2015 and Okey*et al*., 2017).

Besides, food availability is one of the critical factors that influenced the survival of fish and it is the basis of development of a successful capture and culture fisheries management (Lanzanne, 1983.). Information on the feeding habits of fish will aid the study of intra-inter trophic relationships (Baijot, and Moreau, 1997). The quality of the available natural food influences feeding habit of fish (Orihbabhor*et al.*, 2019). The adaptive significance of a broad trophic spectrum (high diet diversity) ensures a constant energy source. These facilitate adequate utilization of available food resource and enable the fish to move easily from one source to another in response to natural pulses in their relative abundance (King, 1993).

Investigating the feeding regime of commercial fish in the Lower Cross River may help to identify habitats or sites and season of higher fish abundance for successful commercial capture thus increasing catch per unit effort. Consequently, the study was conducted to analyze to assess the food items and diet preference of *Synodontisobesus,* Mochokidae in the lower Cross River South-Eastern, Nigeria.This would serve conservation purposes for the relevant fisheries agencies in putting appropriate measures in place for the conservation of fish species.

2.0 Materials and Methods

2.1 Description of the study area

The lower Cross River at Akan ObioUraun fishing port is located in Itu Local Government Area, AkwaIbom State within the Niger Delta region, Nigeria (Map.1). It lies between latitude 5º 10′N and longitude 8° 03′ E. It is bounded in the North by Cross River State, West by IbionoIbom Local Government Area, East by Uruan Local Government Area, and South by Uyo Local government Area. The lower Cross River has an area of 1500 km2 of the tidal floodplains (Ekpo and Udoh, 2013) as it empties into the Atlantic Ocean. The main channel of the river has a total surface area of 70,000 km^2 of which 50,000 km^2 is at the lower reaches. The lower Cross River isapproximately 7 m deep and inundates an area ofapproximately 800 km^2 (Offem*et al.*, 2013). Thefloodplain contains numerous swamps, pools andlagoons which are often isolated from the main river,sometimes in dry season (Etim, 1993). It is subjected toseasonal flooding between

July and October (Etim and Akpan,1992); with the wet (April – October) and dry (November–March) seasons.

2.2 Climate

The lower Cross River shares the climatic conditions that prevail in the rain forest zone of southern Nigeria where the weather is permanently wet with an annual rainfall of up to 4000m. The mean annual temperature for the area is about 27^0C with mean maximum of approximately 30^0C recorded in the month of January, with a narrow range of about 3^0C. The narrow range is attributed to the nearness of the area of the sea, which tends to prevent extreme fluctuation of temperature. The main factor influencing the climate is movement of inter – tropical front which gives rise to two seasons, the wet and dry season. The wet season is characterized by high rainfall, relative humidity and heavy clouds from April to mid - November. The dry season during which harmattan occurs begins in mid-November and ends in March.

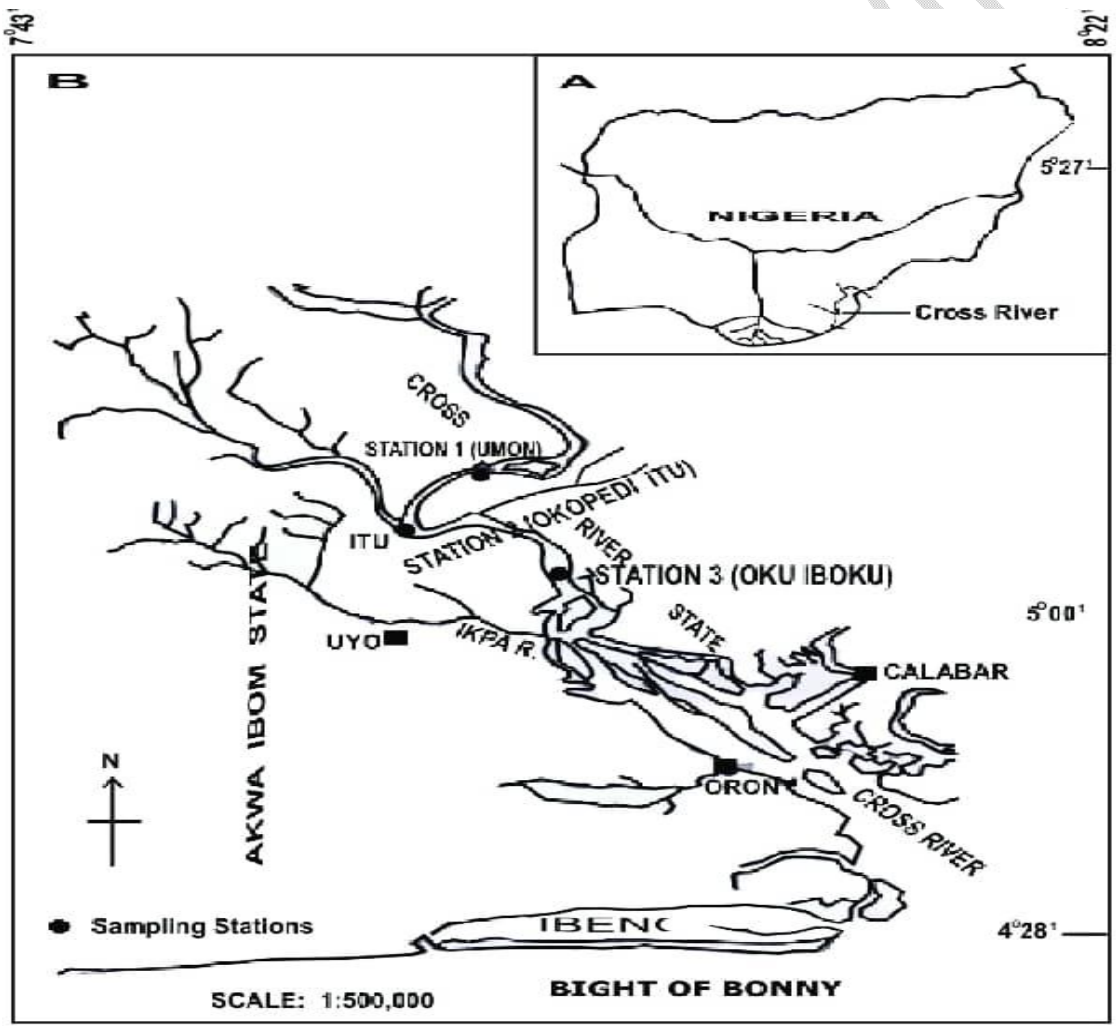

Fig 1. Map of Lower Cross River showing the sampling stations

2.3 Collection to Fish Samples

The fishes were caught by the local fishers using wooden canoes and speed boats. They Samples were collected bimonthly for the period of four months (October 2021- January 2022) from the local fishers using wooden canoes and speed boats. Fish samples were randomly collected from selected artisanal fishers' landings whose fishing gear were mainly gillnet (22-76 mm), stretched seine net (10-34 mm stretched mesh size) and traps. The samples were gotten directly from the fishermen on early arrival at cheaper prices or most times bought from the market women around the landing sites.

2.4 Preservation and Measurement of the Samples

Fish samples collected were preserved in 10% formalin prior to laboratory examination in well labeled containers to reduce microbial digestion to the minimum (Ekpo, 2013c). The preserved samples were soaked in water prior to analysis to remove the formalin. Laboratory gadgets were worn at all times. The samples were placed on a dissecting board to be examined.

The total length was taken by the measuring distance from the tip of the snout to the end of the caudal fin. The standard length was obtained by measuring the length of the fish from the tip of snout to the end of the caudal peduncle using a measuring board. The weight was measured with the use of a weighing balance. The samples were after preserved in 10% formalin.

2.5 Stomach Content Analysis

The fish stomachs were exposed by cutting the body ventrally from the anal opening towards the head; this was done by the use of a small dissecting scissors. The stomachs of each specimen were then removed and preserved in a bottle containing 4% formalin for thereafter examination of the food items. Each stomach slit was assigned a number of points proportional to its degree of fullness thus, 0, 25, 50, 75, 100 points were scored, for (0) empty, 1/4 full, ½ full, ¾ full and full distended stomachs respectively (Hyslop, 1980). Later, the gut was removed from the bottle and placed on a filter paper to drain out the fluid, each stomach of the fish sampled were opened and the content were placed in a petri-dish and aggregates dispersed with a few drops of water prior to microscopic (X10, X40 and X100), and macroscopic (using the naked eyes) examinations.

The food materials were identified with the aid of keys provided by Needham and Needham (1962),Mellanby (1975) and Welcome (1979). The stomach contents were analyzed by frequency of occurrence method as described by Hynes (1950). Each food item was identified and number of stomachs in which each food occurred was counted and expressed as a percentage of stomach containing food. The method showed the proportion of individuals eating a particular food item in a species. The occurrence of each food item was expressed as a percentage of all stomach with food. That is, $P = (b/a) \times 100$, where, a = total number of fish examined with food in the stomach; b = Number of fish containing a particular food item; p = percentage of occurrence of each food item. The Gut Repletion Index (GRI) was calculated using the formula

according to Ekpo et al. (2014b):GRI=(number of non-empty guts)/(total number of specimens examined) x 100

3. Results

3.1 Numerical Abundance and Length Frequency Distribution of *Synodontisobesus*

A total of 160 individuals of *Synodontisobesus* (Mochokidae) were collected at Lower Cross River at Akan ObioUraun fishing port in Itu Local Government Area, AkwaIbom State, Nigeria from local fishers and analyzed for size composition and diet preference. Numerical abundance showed high size variability within months with a peak in January (Table 1). The maximum total length ($L_{max)}$ was 20.30 cm while the minimum total length was 6.50cmTL with a mean value of 15.77± 0.22 cmTL. Total weight raged from 7.60-239.69g with the mean value of 102.81 ±3.56 and total biomass of 16450.13g (16.45Kg).

Table 1. Monthly Size structures of *Synodontisobesus* (October, 2022 – January, 2023)

		October			**November**	
Parameters	**N**	**Range**	**Mean±SR**	**N**	**Range**	**Mean±SR**
Total Length (cm)	40	9.80-20.30	16.1775±0.410	37	6.50-19.50	13.051±0.60
Total Weight (g)		23.05-239.69	105.46±7.94		7.60-188.00	67.56±7.92
		December			**January**	
	N	**Range**	**Mean±SD**	**N**	**Range**	**Mean±SD**
Total Length (cm)	41	13.80-20.00	16.80±0.22	42	13.80-20.00	15.77±0.224
Total		73.60-193.20	116.89±4.84		73.60-	117.59±4.81

Weight (g)					193.20	
		Overall				
Total Length (cm)	160	6.50-20.30	15.775±0.224			
Total Weight (g)		7.60-239.69	102.813±3.56			
Total biomass (wet season)			16.45Kg			

N = Number of specimen, SR = standard error, Range (Minimum-Maximum values), Total biomass = 16.45Kg

3.2 Stomach Content Analysis

Categorization and levels of stomach fullness of *S. obesus* are presented in Table 2 and Fig 2. Analysis of the fullness of stomach showed that 84.4 % had food contents while 15.60 % were empty stomachs. Samples with one quarter (25%) stomach fullness had the highest value of 28.13% while samples with 100% stomach fullness (18.75%) weremore than those with half (50%) stomach fullness (17.52%).

Table 2 Categorization of stomach fullness of *S. obesus*

	Oct		Nov		Dec		Jan		Overall	
Stomach fullness (%)	**No. of samples**	**%**	**No. of samples**	**%**	**No. of samples**	**%**	**No. of samples**	**%**	**No. of samples**	**%**
0 (empty)	13	32.5	3	8.10	5	12.20	4	9.52	25	15.60
25 (one quarter)	5	12.5	13	35.13	15	36.58	12	28.57	45	28.13
50 (half)	6	15.0	7	18.91	6	14.63	9	21.42	28	17.52
75(three quarter)	7	17.5	8	21.62	7	17.07	10	23.83	32	20.0
100 (full)	9	22.5	6	16.24	8	19.52	7	16.66	30	18.75
Total	**40**	**100**	**37**	**100**	**41**	**100**	**42**	**100**	**160**	**100**

Gut Repletion Index (GRI): (number of non-empty guts)/(total number of specimens examined) x 100 = 84.4%

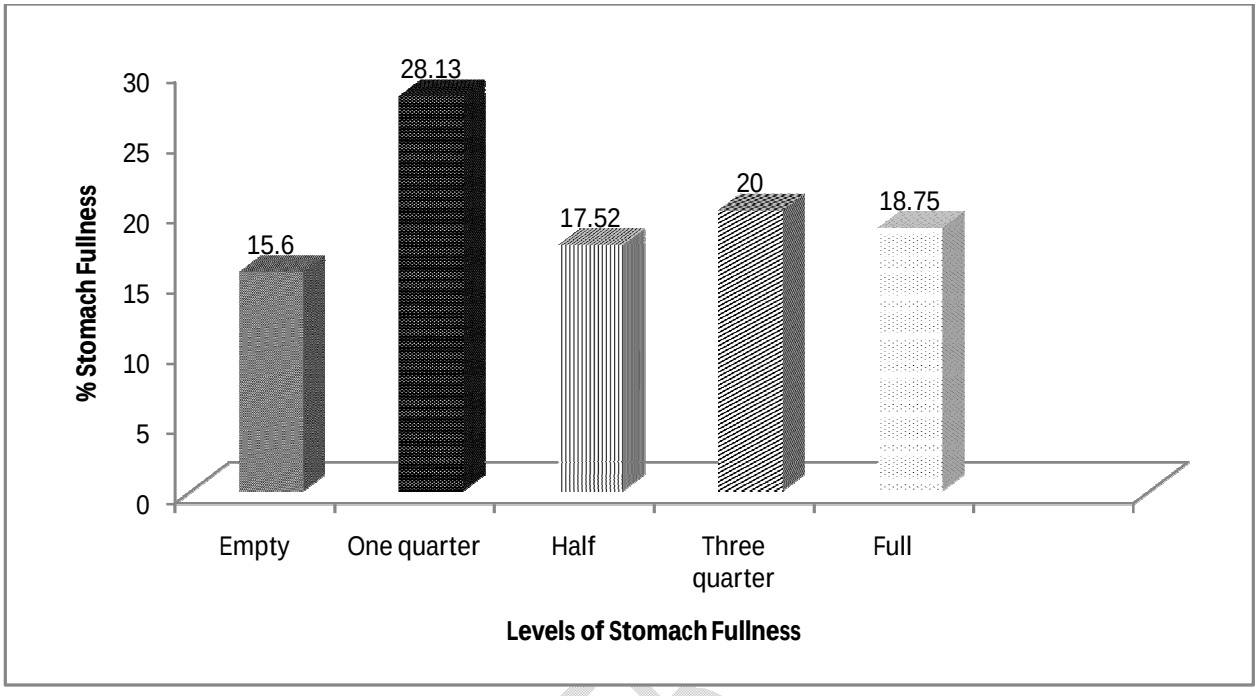

Fig 2 Level of Stomach Fullnessin *S. obesus*

3.3 Feeding intensity

Table 3: Frequency of occurrence of food items in the stomach of *S. obesus*from Lower Cross River

SN	Food items		OCT a=27	NOV a=34	DEC a=36	JAN a=38	a-Total = 135	P= % occurrence of each food item
	Plants							
1	Plant matter	b	10	7	21	20	58	14.11
2	Decomposed plant matter	b	20	25	29	20	94	22.87
								36.98
	Fruit items							
3	Palm fruits	b	13	18	19	16	66	**16.05**
	Animal items (fish)							
4	Decomposed animal matter	b	13	21	20	17	71	17.31
5	Animal matter	b	3	6	7	3	19	4.62
								21.93

	Bottom Items							
6	Sand	b	3	3	9	10	25	6.08
7	Stone	b	1	-	3	1	5	1.22
								7.30
	Insects							
8	Insect parts	b	-	10	7	9	26	6.32
9	Insect parts matter	b	-	1	-	-	1	0.24
10	Insect matter	b	-	-	-	1	1	0.24
								6.80
	Other items							
11	Detritus	b	3	10	13	13	39	**9.49**
12	Un-identified food	b	4	1	1	-	6	**1.45**
	b-Total		70	102	129	110	**411**	100
	% occurrence of total food items		17.03	24.82	31.38	26.77		

P = (b/a)x100: P= % occurrence of each food item; b = number of fish containing a particular food item; a= total number of fish examined with food in the stomach

Frequency of occurrence of food items in the stomach of *S. obesus*from Lower Cross Riverare shown on Table 3. Twelve food items including detritus and un-identified food were found in the digestive tubes of the species, indicating that the fish has a high level of food selectivity and diet sensitivity. The percentage frequency of occurrence of the food items with respect to whole sample indicated that plants part accounted for 36.98 %, fish (animal items) 21.93%, palm fruits 16.05 %, detritus 9.49%, sand grains 7.30%, insect /insect appendages 6.80 %, and unidentified items 1.45 %. In all ,plants component was the highest food item, algae were the most preferred food items followed by fish (animal items), palm fruits, detritus, sand grains, and unidentified items(Table 3). Thus, the fish species, S. *obesus* are versatile omnivores feeding on a wide variety of food items including detritus. The percentage of the stomach with food items was highest in December and January but lowest in October and November.

3.4 Percentage frequency of occurrence of the food items in *Synodontisobesus* in respect to size composition

Table 4: Percentage frequency of occurrence of the food items in *Synodontisobesus* in respect to size composition

		Juvenile (7.5-13cmTL)	**Sub-Adult (14-16cmTL)**	**Adult (16.2-18cmTL)**	**Old fish (18.2-23.2cmTL)**	**Overall**	**%**
SN	FOOD ITEMS						
	Plants						
2	Plant matter	5	22	23	8	58	22.87
1	Decomposed plant matter	13	34	36	11	94	14.11
							36.98
	Fruits						
3	Palm fruits	11	20	28	7	66	**16.05**
	Animal items (fish parts)						
4	Decomposed animal matter	10	21	28	13	71	17.31
5	Animal matter	2	6	10	1	19	4.62
							21.93
	Bottom items						
7	Sand	2	5	15	4	25	6.08
6	Stone	-	-	3	2	5	1.22
							7.30
	Insects						
8	Insect parts	1	6	16	5	26	6.32
9	Insect parts matter	-	1	-	-	1	0.24
10	Insect matter	-	-	1	-	1	0.24
							6.80
11	**Detritus**	**16**	**14**	**7**	**2**	**39**	**9.49**
12	**Un-identified food items**	**3**	**1**	**1**	**1**	**6**	**1.45**
	b-Total	**63**	**130**	**168**	**54**	**411**	**100**
	% occurrence of total food items	**15.32**	**31.63**	**40.87**	**13.13**		

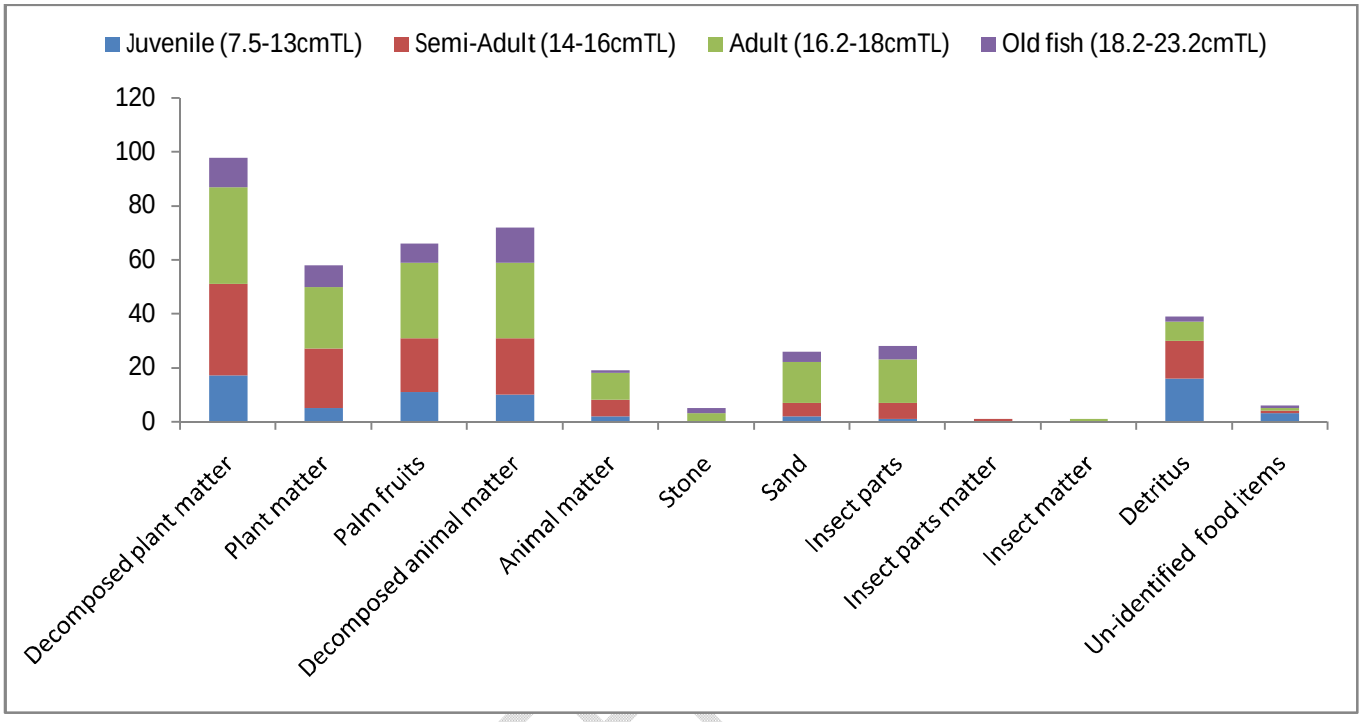

Fig3: Percentage contribution of different food items consumed at different size classes of *S. obesus*

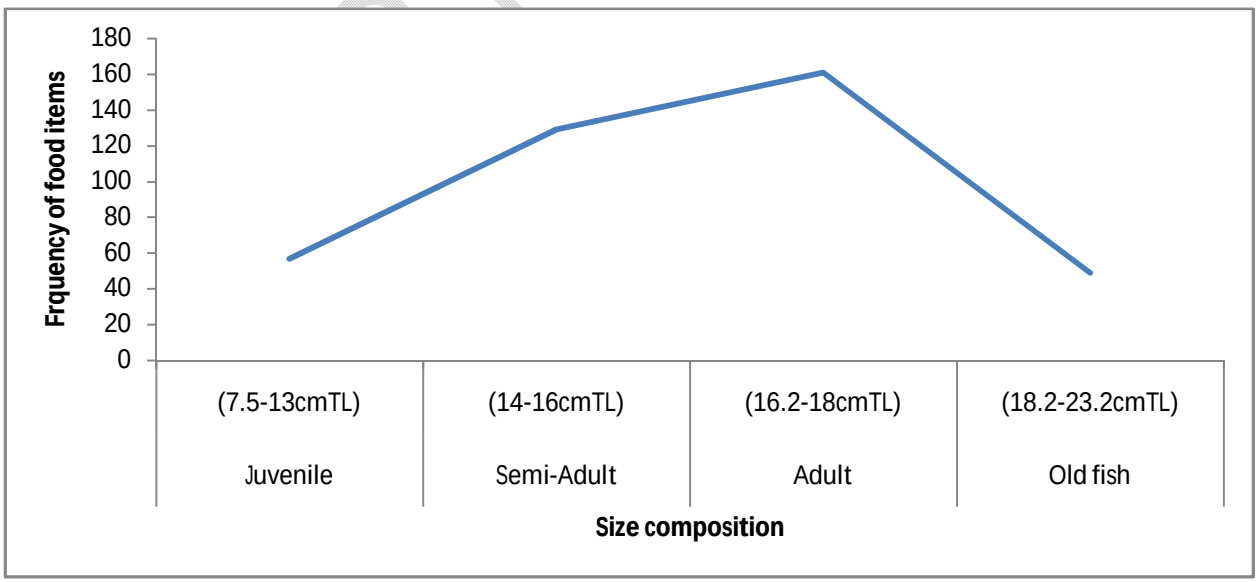

Fig 4. Frequency of different food items in respect to size composition

The frequency of occurrence of food items in stomachs of S. *obesus*in respect to sizeare summarized in Table 4, Fig. 3 and Fig 4.Food items in the stomach of *S.obsesus* increase with the size of fish. The percentage occurrence of food items in stomachs of the fishrevealed 15.32% for (juvenile, 7.5-13.0cmTL), 31.63% for (sub-adult, 14-16cmTL), 40.87% for adult (16.2-18.0cmTL) and 13.13% for (old fish, 18.2-23.2cmTL). The active population (sub-adult and adult fish) consumed 72.5% of the food items found within the fish habitat. Plant items were the major food ingredients in the diet of the fish and increased with increase in size. The sub-adult and adult fish (14-18 cm TL) were found to be predominantly planktotrophic. The results showed a progression from detritivorous diets in fish below 14 cm TL through a transitional planktivorous diets in fish class 14-16cm TL to a predominantly insectivorous diets in fish above 16 cm TL. Insects' diet progressed from juvenile to a peak in the adult class and declined as the size of fish increased with age. The food and feeding regime of the fish confirmed that species is an omnivore. Frequency of different food items in respect to size composition showed normal curve with food items increased as the fish grows in size but declined at old age indicating transitional diet shift as the fish grows bigger.

4. Discussion

Feeding Behaviour of *Synodontis*Species

The results of this study revealed that the fish, *Synodontisobesus* feeds on a wide range of food items including macrophytes, all types of phytoplankton, palm fruits, detritus, insects (gastropods), bottom items (sand and stone), animal matter (fauna species)and the feeding behavior publicized the fish as versatile omnivores with encyclopedic diet disposition. Friel and Vigliotta (2006) had earlier reported that the species are omnivorous fish feeding on a wide spectrum of different foods. The results of this study is similar to the findings of Edwine*et al.* (2019) on *Synodontis*species from different African freshwaters that the species are omnivorous feeders and feed on a wide spectrum of food ranging from various types of plankton to invertebrates, plant parts and small fish (animal matter).The species exhibits opportunistic and resourceful feeding bahaviour due to richness and abundance of food items in the study area. This flexibility in the choice of food items is a survival strategy of the fish to live successfully in adverse environmental condition. The high diversity of the food composition in the stomach of *S.obesus* indicates a wide adaptability to the available food items in the Lower Cross River. The observed results support the findings of Araoye, (2004) in Ase Lake, Lalèyè*et al.*, (2006) in Ouémé River and Akombo*et al.*, (2016) in Lower Benue River, where the most frequent food items inthe stomachs of *S. nigrita*and *S. schall*were macrophytes and algae. The presence of sand grains and stone in the stomachs indicates that these species cruise on benthic deposits in compliance with its unscrupulous feeding habits.Reed (1967) had confirmed that *Synodontis*species are mainly bottom dwellers, feeding on mud, detritus and debris.The results of this study support the finding of Owolabi, (2008) that similar species*S.membranaceus*fed on plant materials, plant seeds, insects, copepods, detritus, and gastropods.The food items in the stomachs of Mochokidae (Essien – Iboke*t al.*, 2015) suggest that they are euryphagous. Although a euryphagous fish are not necessarily omnivorous, they may be carnivorous fish feeding on a wide variety of other fishes. Wanyanga*et al.* (2016) equally reported that the diet of *S. victoriae*primarily comprise of molluscs, crustaceans, insects, detritus and fish scales.

Percentage frequency of occurrence of the food items in *Synodontisobesus* in respect to size composition

The percentage of occurrence of food substances varied with month, age and size class of the fish. This is similar to the report of (Adeyemi, 2010). Thus, time, season, age and size of fish are factors responsible to changes in the feeding habit of the fish. The results revealed 9.49% detritus in the stomach of the species. The presence of detritus in the stomachs indicated bottom feeding. This disagrees with observation by Bard *et al* (1976) in River Kaduna where the same species do not feed on detritus. The 7.30% of sand and stone in the stomach of the species also confirms bottom feeding behavior. The results also showed a progression from detritivorous diets in juvenile fish through a transitional planktivorous diets in sub-adult class to a predominantly insectivorous and carnivorous diets in adult fish. This implies that the fishare decomposers at juvenile stage, bottom grazers at sub-adult stage and benthopelogicorganisms at adult level with preferences for aquatic insects, and animal matter (fry and fingerlings). Similar diet progression was reported byOlufemi, (2007) on *S. membranaceus*from Jebba Lake in Nigeria, though with higher class range of juvenile and adult fish. The planktotrophic feeding pattern predominantly found within the sub-adult and adult fish is similar to the findings of Ajah*et al.* (2006) who also found adults of S. *nigrita*from Cross River Estuary to be predominantly planktotrophic.

Importance of Food and Feeding Habits

The study of feeding habit of fish species in their natural habitat has been shown to promote useful information on positioning of the fish in the food web (Shinkafi*et al.,* 2010), provide information about the niche of the particular fish in its ecosystem and contributes a better understanding of the trophic dynamics and food webs which is essential for appropriate fisheries management (Offem*et al.,* 2009). It also gives information on seasonal changes of fish because the type and magnitude of food available as well as season of occurrence plays an important role in the history of the fish (Akpan and Isangedighi, 2005). Therefore, the information about the feed habits of fishes is useful in defining predatory-prey relationship (Sa-a *et al.,* 1997). Food and feeding habits based on stomach content analysis, is widely used in fish biology as an important means of investigating trophic relationship in the aquatic communities (Ekwu, 2006

and Arendt *et al.,* 2001) and in the creation of trophic models as a tool to understanding complex ecosystem (Lopez-Peralta and Arcila, 2002). The study of the food and feeding habits of fish species is a subject of continuous research because it constitutes the basis for the development of a successful fisheries management programmed on fish capture and culture (Oronsaye and Nakpodia, 2005) and because the aquatic ecosystem is dynamic. The gut content is a reflection of the water quality, all other factors being constant (Ekpo*et al.*,2014a).

Stomach Contents: (% food contents and empty stomach)

Analysis of the fullness of stomach showed that 84.4 % had food contents while 15.60 % were empty stomachs. The percentage of stomach fullness (> 80%) is similar to the findings of Adeyemi,2010 that revealed that the analysis of the fullness of the stomachof *Synodontisresupinatus*at Idah Area of River Niger, Kogi State, Nigeria showed that 89.6 % , while 10.3 % had empty stomach and also closer to the findings of Shinkafi, *et al;* (2010) that the fullness of stomach of *Synodontisnigrita*in River Rima, Sokoto, Nigeria showed that 81.6% had food contents while 18.4% were empty stomachs. The presence of 15.60 % empty stomachs is within the range (10.3%- 18.4%) reported by Adeyemi, 2010 and Shinkafi, *et al;* (2010). The presence of 15.60 % empty stomachs could be attributable to two behavioural factors: post-harvest digestion and multiple-dealing feeding habit.

The percentage frequency of occurrence of the food items

The percentage frequency of occurrence of the food items with respect to size and whole sample indicated that plants component was the highest food item, algae were the most preferred food items followed by fish (animal items), palm fruits, detritus, sand grains, and unidentified items. The wider food spectrum exhibited by the species revealed trophic flexibility. The wider food spectrum exhibited by the species revealed trophic flexibility. The switching from one category of food to another in response to fluctuation in their abundance ensures survival strategy in the midst of food scarcity. The deviation from feeding item to the next available food element reduces inter and intraspecific competition for food resources and encourage the sustainability ofthe population of the fish species in the Lower Cross River inland wetlands. The present information on wider range of food spectrum by the species is in unison with reports of heterogeneity in the trophic biology of the *synodontisnigrita* in River Rima, Sokoto, Nigeria

(Shinkafi*et al;* 2010) and *synodontisresupinatus* at idah Area of River Niger, Kogi State, Nigeria (Adeyemi, 2010). The feeding versatility of *Synodothisobesus*, Mochokidae enables this species to overcome food scarcity, habitat modifications and environmental perturbations. Thus, there is a compelling need to evolve adequate strategy for comprehensive conservation and wide-ranging sustainabilityof the rarely studied but commercially important species in the Lower Cross River, Nigeria.

5. Conclusion

- Twelve food items including detritus were found in the digestive tubes of *Synodontisobesus*in the Lower Cross River, Nigeria.
- The species areversatile omnivores with wide-ranging diet disposition.
- The speciesshowed a progression from detritivorous diets in juvenile fish through a transitional planktivorous diets in sub-adult class to a predominantly insectivorous and carnivorous diets in adult fish.
- The species exhibits transitional diet shift as the fish grows bigger
- The species exhibits opportunistic and resourceful feeding bahaviour due to richness and abundance of food items in the study area.
- The fish are decomposers at juvenile stage, bottom grazers at sub-adult stage and benthopelogic organisms at adult level with preferences for aquatic insects, and animal matter (fry and fingerlings).
- The wider food spectrum exhibited by the species revealed trophic flexibility.
- The percentage of stomach fullness is (> 80%)
- Time, season, age and size of fish are factors responsible to changes in the feeding habit of the fish and these factors need to be monitored in order to conserve the species in the Lower Cross River, Nigeria.

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