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Dietary Compositions and Trophic Levels of *Chrysichthys nigrodigitatus* (Lacépède) and *Lates niloticus* (Linné) in Ikere Gorge Reservoir, Oyo State, Nigeria

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Abstract

Food compositions and trophic levels of Chrysichthys nigrodigitatus (Lacépède) and Lates niloticus (Linné) in Ikere gorge reservoir (reported to be underutilized) were studied in order to provide biological information for the effective management of the fisheries of these dominant and highly valued food fish. Samples of C. nigrodigitatus and L. niloticus were collected monthly between April and September, 2018 and stomach contents were examined. In addition, trophic indices including trophic levels were estimated and the overlap index. The dominant food items in the gut of C. nigrodigitatus were algae, insect and insect parts. In contrast L. niloticus showed more preference for animal components including insects and fish. The food spectrum of female individuals was more diverse in C. nigrodigitatus, while males had greater diversity in L. niloticus. In small size groups of C. nigrodigitatus, plant-based food items were encountered more frequently and large size individuals preferred animal derivatives. Insects were dominant in diet of small size L. niloticus while fish dominated in the large size individuals. The mean trophic level of C. nigrodigitatus and L. niloticus was 2.856 ± 0.675 and 3.217 ± 0.720, respectively. The mean diet overlap between C. nigrodigitatus and L. niloticus was 0.2, indicating a low overlap of resources between the species.

Keywords: ***Chrysichthys nigrodigitatus; Diet; Feeding habits; Lates niloticus; Trophic level.***

1. Introduction

Reservoir fisheries are of nutritional and economic importance with regards to the riparian communities and the nation as a whole [1]. Ikere gorge reservoir (a man – made lake on River Ogun) was impounded in 1992. The dam was meant to serve the people in the region in terms of water provision, irrigation farming, hydro power generation, fishery, recreation, navigation and other purposes. The dam was found to be grossly under- utilized considering the water storage capacity and purposes for which it was built [2]. For sustainable exploitation and management of reservoir fisheries, biological research of fish species is important. The study of the food and feeding habits of freshwater fish

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species is a subject of continuous research, because it plays a basic integral part in the development of a successful fisheries management programme on fish capture and culture [3]. The food and feeding habit of fish may be an important characteristic of the life-history strategy of a species to know the foremost necessary functional role of the fish inside their living ecosystems [4], [5]. The knowledge of species diet is important in ecological research as it reveals potential competition for the available food resources and predator-prey interactions which contribute to the understanding of the ecosystem's structure and the trophic dynamics in the food webs [6]. The study of feeding habits can also be used to assess changes in abundance and diversity of organisms caused by physical or human related changes, such as climatic or exploitation pressures, producing that way unexpected 'cascade effects' [7], [8].

Quantitative knowledge of diet and hence trophic level of species is a key piece of information in our understanding of functioning of aquatic ecosystems [9]. The position of an organism in the food web is depicted by its trophic level and has gained wide acceptance as an ecological indicator for ecosystem management. If fisheries are to be managed in the context of the ecosystem, a paramount input is the trophic level of the species involved [10]. The trophic role of a fish species in a food web is determined by its trophic level, what it eats (i.e., qualitative information) and in what proportions (i.e., quantitative information), essential information to understand energetic fluxes through ecosystems [11], [12].

Previous studies on fisheries of Ikere gorge reservoir include fish diversity and catch assessments [11], [12]; taxonomy and distribution of fishes [14]. They reported *Chrysichthys nigrodigitatus* as the most abundant species by weight and number, *L*ates *niloticus* was also abundant. Adeosun determined heavy metal contamination of *C. nigrodigitatus* and *L. niloticus* in the reservoir [15]. There are few reports on feeding habits of fishes in Ikere gorge reservoir, especially commercially important species including *L. niloticus* and *C. nigrodigitatus*, hence this study was designed to determine the food, feeding habits, trophic level and niche overlap index of *C.nigrodigitatus* and *L. niloticus* in Ikere gorge reservoir, Oyo State, Nigeria.

2. Materials and Methods

2.1 Description of Study Area

Ikere gorge dam is an earth-filled type of dam located in Ikere village in Iseyin local government (which lies on the geographical coordinates of 7° 50''N, and 3° 360" E). Ikere gorge is located on the intersect of latitude 3° 401" N and 3° 501" N of the equator and on longitude 8° 101" E and 8° 201" E of the Greenwich meridian. The climate is typical of tropical rainforest waters with a prolonged wet season (April to October) and a short dry season (November to March). The reservoir was formed by damming River Ogun - main source, River Owu and River Amaka which are minor tributaries and found in the southwestern zone of Nigeria, about 30km northeast of Iseyin in Oyo State and about 8 km from Ikere village. It is also surrounded by five villages namely Ikere village itself, Aba, Igborao, Abokede and Alobo. Toward the southern part of the reservoir were hills primarily made of rock and gravels. The rivers that run down to the dam have gravels and sand as their major substrate (Adebisi, 1981). The water bed comprised mainly of fine and coarse sand particles and gravels. Along the bank of the reservoir are distributed forest and savanna trees and aquatic grasses. Ikere gorge dam has a total capacity of 690 million m^3, surface area of 47 km^2, depth at intake tower of 35.599 meters and intake tower length of 50 meters [17].

2.3 Fish Sampling and Field Analysis

Fish specimens were collected monthly between April and September, 2018 at the landing centre from fishermen who employed gears such as gill nets, cast nets, traps, hooks and lines in the reservoir. Identification of fish species was done using fish identification guide by Idodo-Umeh [18]. The weight of each of the specimen was taken using a top loading mettler balance (AMW 2000 precision bench scale) to the nearest 0.1g after draining excess water with a pile of filter paper while their total and standard lengths were measured in centimeter using a calibrated measuring board. Thereafter, the fish were dissected and sex and degree of stomach fullness recorded. The sex was determined by examination of the gonads. The degree of stomach fullness was divided into five stages: empty, poor (¼ full), medium (½ full), good (¾ full), and heavy (full) guts [19], [20]. Feeding Intensity (FI) was calculated according to Kennedy and Fitzmaurice, [21]; as FI = 100 x numbers of guts containing food / number of total guts. Empty index = 100 – Feeding intensity. Then, the stomachs were weighed and preserved in a specimen bottle that contains 4% formalin and transported to the laboratory for subsequent examination.

2.3 Diet Analysis

The contents of each stomach with food was emptied into a petri dish and food items were identified to the lowest possible taxonomical level using a compound microscope at x40 magnification [22]. Numerical, occurrence, and points methods were used to quantify the food items and their variation with length groups, fish sex, and the season [April – June, Early Rainy Season (ERS); July – September, Late Rainy Season (LRS)] for *C. nigrodigitatus* and *L. niloticus* [23]. In the numerical method (N %), the total number of each food item was expressed as the percentage of the total number of all food items present. This method was not used for sand particles due to difficulties in their enumeration. In the frequency of occurrence method (F %), the occurrence of each food item was expressed as the percentage of the total number of stomachs containing food items. In point's methods (P %), each food item was allotted a rank number or points depending upon its size and abundance. Then, the total point of each food item was expressed as the percentage of the total points of stomach contents. The standardized Index of Relative Importance (IRI_i) of each prey was calculated for each prey type i as follows [24], [25].

$$IRI_i = (N_i\% + P_i\%) * F_i\%$$

The proportional form of the index (IRI_i %) was also estimated according to the following formula:

$$IRI_i\% = 100 * \frac{IRI_i}{\sum_{i=1}^{n} IRI_i}$$

where IRI_i represents the index of relative importance for prey type i and n is the total number of prey types at a given taxonomic level [24], [25].

The trophic levels (TL) were determined according to the equation TLi = 1+ Σj (TLj. DCij) [26], Where TLj is the "fractional" (i.e., non-integer) trophic level of the prey j (as listed in Pauly *et al*. [27]), and DCij represents the fraction of j in the diet of i. Variations in feeding habits (percentage of major food groups) and trophic levels of studied fish species in Ikere gorge reservoir with different sexes, sizes (*Chrysichthys nigrodigitatus*; Small <20 cm; Medium 20.1-25

cm and Large >25.1 cm, *Lates niloticus*: Small <20 cm; Medium 20.1-30 cm and Large >30.1 cm) , and seasons were statistically analysed using Student's T-test and one-way Analyses of Variance (ANOVA). All the statistical analyses were considered significant at the level of 5% ($p \leq 0.05$). Statistical analyses and figures were performed using MS Excel 2016. The niche overlap index was calculated according to Pianka [28] which is calculated as:

$$Ojk = \frac{\Sigma p_{ij} p_{ik}}{\Sigma p_{ij}^2 p_{ik}^2}$$

where Ojk is Pianka's measure of overlap between species j and species k, pij is the proportion that resource i is used by species j of the total resources, and pik is the proportion that resource i is of the total resources used by species k. This measure ranges from 0 (no resources used in common) to 1 (complete overlap). Diet overlap between species was considered as low (0 - 0.39), intermediate (0.4 - 0.6) or high (0.61 - 1) [29].

3. Results

3.1 Feeding Intensity

Seasonal variations in feeding intensity of *C. nigrodigitatus* and *L. niloticus* in Ikere gorge reservoir is shown on Table 1. The feeding intensity for *C. nigrodigitatus* (85.8%) and *L. niloticus* (77.8%) did not differ significantly (t=1.8797; p=0.0848). For *C. nigrodigitatus*, poor and medium guts were encountered more in the LRS (24.5%); however, good and heavy guts were encountered more frequently in ERS (30.2%). Poor and medium guts (16.6%), also good and heavy guts (30.6%) were more frequently encountered in ERS in *L. niloticus*. Empty guts occurred more in the LRS (10.4%) in *C. nigrodigitatus* while they were more in ERS in the *L. niloticus*. There is no significant difference between the feeding intensity of the ERS and LRS of both species (Table 1).

Table 1: Variation of Feeding Intensity of *Chrysichthys nigrodigitatus* and *Lates niloticus* With Season in Ikere Gorge Reservoir, Oyo State, Nigeria by Using the Number of Guts that Contained Food.

Species	Season	Gut Stages							Feeding Intensity [Fullness Index] %	Empty Index %	t stat	P
		Empty	Poor	Medium	Good	Heavy	Total Full	Total Gut				
C. nigrodigitatus	Early Rainy	4	12	7	8	24	51	55	92.73	7.27	0.2561	0.8022
	Late Rainy	11	18	8	4	10	40	51	78.43	21.57		
	Total	**15**	**30**	**15**	**12**	**34**	**91**	**106**	**85.8**	**14.2**		
L. niloticus	Early Rainy	5	3	3	2	9	17	22	77.27	22.73	0.8610	0.4094
	Late Rainy	3	2	3	3	3	11	14	78.57	21.43		
	Total	**8**	**5**	**6**	**5**	**12**	**28**	**36**	**77.8**	**22.2**		

3.2 Analysis of the Gut Contents

The food items found in the stomachs of *C. nigrodigitatus* were placed into fifteen categories with 41 specific food items. For *L. niloticus*, 20 specific food items placed in 12 categories were encountered in the gut contents as shown on Table 2. Phytoplanktonic organisms were encountered frequently in the stomach contents of *C. nigrodigitatus* and together contributed 44.48%, 34.49% and 14.61% by numerical, occurrence and point methods. Insect and insect parts also occurred often among the food items and formed 27.98%, 36.61% and 30.32% by numerical, occurrence and point

methods. Insects (IRI_i % = 35.33), other animal components together (IRI_i % = 28.26) of the gut contents contributed more than the plant components. A partly digested tadpole was recorded once. Sand grains occurred in the stomach contents and contributed 5.63% and 10.58% by frequency and points methods, respectively Fig. 1 A - D.

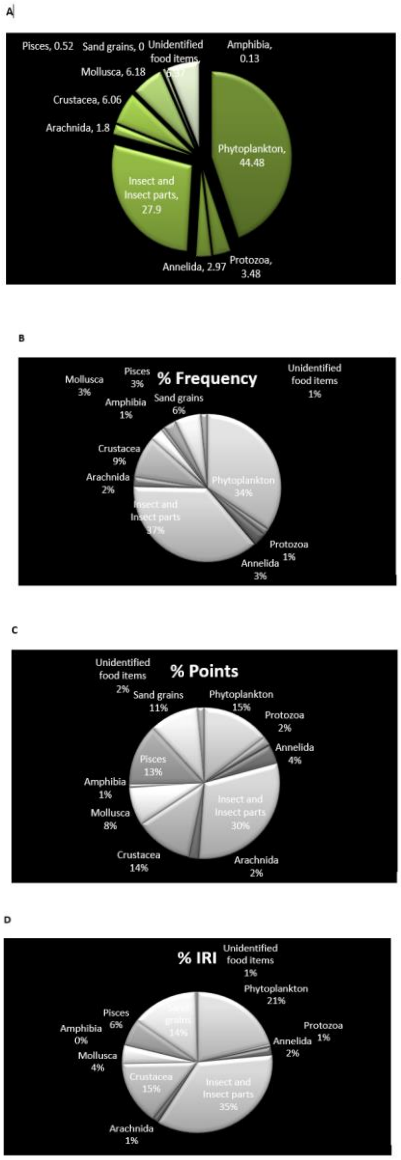


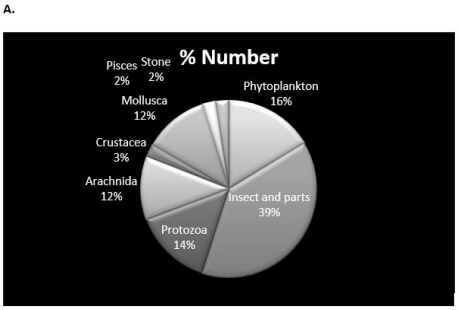
Fig. 1. Estimation of trophic indices A**.** Percentage number B. Frequency of occurrence C. Points and D. Index of relative importance of food items in *Chrysichthys nigrodigitatus* in Ikere Gorge Reservoir, Oyo State, Nigeria.

Table 2: List of Food Items Encountered in the Stomachs of *Chrysichthys Nigrodigitatus* and *Lates Niloticus* in Ikere Gorge Reservoir, Oyo State, Nigeria.

GROUP	ITEMS	*C. nigrodigitatus*	*L. niloticus*
Bacillariophyceae	*Nitzschia*Hassall, 1845	+	+
	*Synedra*Ehrenberg	+	-
	*Navicula*Bory de Saint-Vincent,1822	+	-
	Surirella Turpin	+	-
	Pediastrum duplex Meyen 1829	+	-
Chlorophyceae	*Cladophora*Kütz., 1843	+	-
	*Microspora*Thuret, 1850	+	-

	Pleurotaenium	+	-
	Genicularia De Bary, 1858	-	+
	*Tetrapedia*Reinsch, 1866	+	-
	Richterella	+	-
Cyanophyceae	*Microcystis aeruginosa* (Kützing) Kützing 1846	+	+
	Microcystis flosaquae (Wittrock) Kirchner 1898	+	-
	*Coelosphaerium*Nageli, 1849	+	-
	Nostoc Vaucher, 1888, ex Bornet and Flahaul	+	-
	*Oscillatoria*Vaucher ex Gomont,1822	+	+
	Cylindrospermopsis raciborskii (Wolosz.) Seena. and Subbar.	+	+
Desmidaceae	*Closterium*Nitzsch ex Ralfs	+	-
Dinophyceae	*Ceratium* Shrank,1793	+	+
Protozoa	*Spirostomum* Ehrenberg, 1833	+	+
	Euglena Ehrenberg, 1833	+	+
Annelida	Aquatic worms	+	+
	Leech	+	-
Insect and Insect Parts	Non-biting midge larva	+	+
	Immature dragonfly	+	-
	Caddisfly larva	+	-
	Adult midge	+	+
	Adult dragonfly	+	-
	Polyrhachis sokolova (fire ant)	+	+
	water beetle	+	-
	Riffle beetle	+	-
	Aquatic moth	+	+
	Head, wings, legs	+	+
Arachnida	Water mite	+	+
Crustacea	*Ceriodaphnia* Dana, 1853	+	+
	Macrobranchium Spence Bate, 1868	+	+
	Wood louse	+	-
Mollusca	Gastropod	+	+
Amphibia	Tadpole	+	-
Pisces	*Tilapia* Smith 1840	+	+
Sand grains	stone	+	+
Unidentified food items		+	-

For *L. niloticus,* insects and their parts were encountered more frequently in the stomach contents and constituted 38.48% by number, 35.11% by frequency and 12.32% by points Fig. 2 A - D. The animal components (IRI_i % = 96.1) together contributed more to the stomach contents than plant-based food items (IRI_i % =3.18). *Coptodon* sp. was the dominant food item by points (57.9%). More varieties of insects were found in *C. nigrodigitatus* (Diptera, Odonata, Coleoptera, Trichoptera, and Lepidoptera) than *L. niloticus* (Diptera and Lepidoptera).



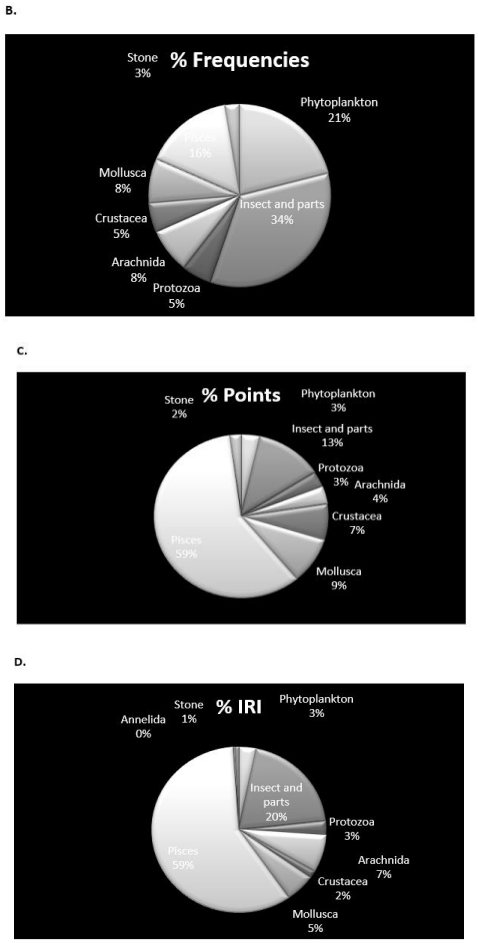


Fig. 2. Estimation of trophic indices A. Percentage number B. Frequency of occurrence C. Points and D. Index of relative importance of food items in *Lates niloticus* in Ikere Gorge Reservoir, Oyo State, Nigeria.

3.3 Variation in Feeding Habits with Sex

Frequency of occurrence analysis revealed that female *C. nigrodigitatus* fed more on insects and insect parts (36.92%), blue-green algae (16.93%) and crustaceans (10.77%). The gut contents of male individuals were also dominated by insects and insect parts (38%), blue-green algae (24%) and diatoms (10%). Annelids, protozoans and some crustaceans (*Ceriodaphnia* and water louse) encountered in females were not in found in males, thus greater diversity of food were encountered in females. The empty index of female (15.7%) and male (15.5%) were similar Table 3.

Table 3: Variation in Frequency of Occurrence of Major Groups of Food Items of *Chrysichthys nigrodigitatus* with size, sex and season in Ikere Gorge Reservoir, Oyo State, Nigeria.

	% Frequency						
Food Items	**<20 cm**	**20.1 – 25cm**	**>25.1 cm**	**Male**	**Female**	**ERS**	**LRS**
Bacillariophyceae	**0**	**13.46**	**9.1**	10	9.24	10.33	7.28
Chlorophyceae	**2.7**	**3.84**	**9.1**	6	1.54	5.2	1.82
Cyanophyceae	**10.8**	**23.08**	**9.1**	24	16.93	18.79	10.92
Desmidaceae	**0**	**1.92**	**0**	2	0	1.3	1.82
Dinophyceae	**10.8**	**5.77**	**0**	4	3.04	9	1.82

Protozoa	**2.7**	**0**	**0**	0	0	1.3	1.82
Annelida	**2.7**	**1.92**	**0**	0	4.62	3.9	1.82
Insecta and insect parts	**45.92**	**30.76**	**18.2**	38	36.92	32.18	45.6
Arachnida	**0**	**3.85**	**0**	0	3.08	1.3	3.64
Crustacea	**10.8**	**5.77**	**9.1**	6	10.77	6.4	9.14
Mollusca	2.7	1.92	9.1	2	3.08	1.3	3.64
Amphibia	0	1.92	0	0	1.54	1.3	0
Pisces	2.7	1.92	18.2	2	4.62	1.3	5.5
Sand grains	8.1	3.85	18.2	6	4.62	6.4	5.5

For *L. niloticus*, the analysis showed that the female individuals consumed more insects (46.77%), *Tilapia* sp. (17.65%) and water mite (11.77%) than other food items encountered in the stomachs. The males more frequently consumed insects (26.32%), gastropods (10.53%), *Tilapia* sp. (10.53%), protozoans (10.52%) and blue-green algae (10.52%). The food spectrum of male individuals was more diverse, and included some protozoans and crustaceans not found in female gut contents. The empty index of males (25%) was higher than female (20%) Table 4. Statistically, there were no significant differences in the food items of females and males for both *C. nigrodigitatus* (t=0.4800; P= 0.6352) and *L. niloticus* (t=0.2228; P=0.8257).

Table 4: Variation in Frequency of Occurrence of Major Groups of Food Items of *Lates Niloticus* with Size, Sex and Season in Ikere Gorge Reservoir, Oyo State, Nigeria.

	% Frequency								
Food Items	**<20 cm**	**20.1-30cm**	**30.1 – 40cm**	**40.1 - 50 cm**	**50.1 – 60 cm**	**Male**	**Female**	**ERS**	**LRS**
Bacillariophyceae	5.88	0	0	0	0	5.26	5.88	4.55	0
Cyanophyceae	5.88	20	0	0	0	10.52	0	9.03	7.7
Dinophyceae	5.88	0	0	25	0	5.26	5.88	0	7.7
Chlorophyceae	0	0	0	0	0	0	5.88	0	7.7
Protozoa	0	10	33.3	0	0	10.52	46.77	4.55	7.7
Annelida	5.88	0	0	0	0	5.26	11.77	4.55	0
Insecta and insect parts	35.3	40	33.3	0	50	26.32	0	40.93	23.1
Arachnida	5.88	10	0	25	0	5.26	5.88	4.55	15.4
Crustacea	11.77	0	0	0	0	5.26	17.65	9.1	0
Mollusca	11.77	0	0	25	0	10.53	0	4.55	15.4
Pisces	5.88	20	33.3	25	50	10.53	5.88	13.64	15.4
Sand grains	5.88	0	0	0	0	5.26	0	4.55	0

3.4 Variation in Feeding Habits With Size

C. nigrodigitatus

In the small size group, foods of animal origin (67.52%) were more frequently encountered, and insects (45.92%) were dominant followed by macrocrustaceans (10.8%). Blue-green algae (10.8%), dinoflagellates (8.1%) and stone (8.1%) were also frequently found among food items. In medium size fish, phytoplanktonic organisms together contributed 48.07% by occurrence. Animal derivatives together formed 48.06% and insects (30.76%) were dominant, followed by macrocrustaceans (7.69%). *Tilapia* sp. and sand particles (18.2% each) were dominant in the gut contents of large size fish Table 3. Crustacean (*Macrobrachium*), molluscans, insects and insect parts (9.1% each) were also encountered. Plant based food together formed 27.3%. The empty index was 19.1% for medium size > 18.2 % for large size >15.4%

for small size. There was no significant difference in the gut contents of *C. nigrodigitatus* with size (f-ratio value = 2.17003; p = 0.7766).

L. niloticus

In small size group, food items encountered were more diverse than other groups, and insects formed 35.29%; phytoplankton, 17.64%; gastropod,11.77; crustaceans, 11.76%; and other food items (fish, annelids and arachnids) being less than 10% each, Table 4. In medium size groups stomach contents, insects (40%) were more frequently encountered> fish (20%) = blue-green algae (20%)>protozoans (10%) and arachnids (10%). For large size groups (30.1 - 40cm and 50.1 – 60 cm), animal-based food items formed 100 % of the gut contents and 75% in the 40.1 – 50cm. The empty index was highest in small size (29.4%)> medium size (18.2%), while large size had no empty stomach. The gut contents of *L. niloticus* differed significantly with size groups (f=2.9488; P=0.027996)

3.5 Temporal Variation of Feeding Habits

Food of plant (44.62%) and animal origin (47.68%) were frequently encountered in the gut of *C. nigrodigitatus* during ERS. However, during the LRS, animal derivatives dominated contributing 71.16%, while plants formed 23.66%. Empty index was higher in the LRS (23.5%) than ERS (8.93%). Animal derivatives dominated the food items in both ERS and LRS for *L. niloticus*, however more diverse animal food items were consumed during ERS. Empty index for ERS and LRS was 23.8% and 21.4%, respectively Tables 3&4. The gut contents of both *C. nigrodigitatus* (t = 0.0022; P = 0.9982) and *L. niloticus* (t=0.1025; P= 0.9194) were not significantly different temporally.

3.6 Trophic Levels

For *C. nigrodigitatus*, the mean trophic level was 2.856 ± 0.675. Medium size group had the least trophic level and differed significantly (P> 0.05) from the other size groups, Table 5. Higher trophic level recorded in the female was non-significant. Also, the higher trophic level in the LRS was not significantly different from ERS Table 5.

The mean trophic level was 3.217 ± 0.720 for *L. niloticus* and trophic level increased with increase in size group. Males (3.08) had relatively lower trophic level compared to females (3.26). The trophic level of the species was lower in LRS (3.11) than ERS (3.29) Table 6. There were non-significant variations in the trophic levels among size groups, sex and period.

Table 5: Size, Sex and Seasonal Variations of the Trophic Level Based on the Diet of *Chrysichthys Nigrodigitatus* in Ikere Gorge Reservoir, Oyo State, Nigeria.

	<20 cm	**20.1-25 cm**	**>25 cm**	**Female**	**Male**	**ERP**	**LRP**
No. of guts	46	36	8	41	36	51	37
Minimum	2	2	2	2	2	2	2
Maximum	4.2	3.8	4.2	4.2	4.2	4.2	4.2
Mean	2.97	2.69	3.09	2.94	2.68	2.76	2.99
SD	0.567	0.677	0.961	0.677	0.680	0.673	0.664
SE	0.573	0.687	0.811	0.663	0.680	0.679	0.672
F ratio; P value	2.4470; 0.0925						
t stat; P value				1.3343; 0.1862		1.6347; 0.1058	

Table 6: Size, Sex and Seasonal Variations of the Trophic Level Based on the Diet of *Lates Niloticus* in Ikere Gorge Reservoir, Oyo State, Nigeria.

	<20 cm	**20.1-30 cm**	**30.1-40 cm**	**40.1 – 50 cm**	**50.1 – 60 cm**	**Female**	**Male**	**ERP**	**LRP**
No. of guts	12	8	3	3	2	12	14	17	11
Minimum	2	2	2	3.2	3.2	2	2	2	2
Maximum	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Mean	3.11	3.15	3.13	3.58	3.7	3.26	3.08	3.29	3.11
SD	0.643	0.833	1.102	0.539	0.707	0.730	0.719	0.678	0.801
SE	0.587	0.547	0.636	0.311	0.5	0.741	0.722	0.638	0.818
F ratio; P value	0.54565;0.58622								
t stat; P value						0.5617;0.5798		0.6299; 0.5342	

3.7 Trophic Overlap Index

Mean diet overlap between *C. nigrodigitatus* and *L. niloticus*, according to calculations from Pianka's index, was 0.23, indicating a low overlap between species.

4. Discussion

The results revealed that *Chrysichthys nigrodigitatus* is omnivorous, feeding on a variety of phytoplankton and benthic food organisms. Previous studies that obtained similar results for *C. nigrodigitatus* include Ugwumba and Kusemiju in Lekki Lagoon and Lawal in Epe Lagoon [30], [31]. Similar to the finding of Nkalubo *et al*., [31], in Lake Victoria and Adeosun [33], in Oyan Dam, *Lates niloticus* is a carnivore in Ikere gorge reservoir and fish was the dominant food item.

Many factors were considered to cause changes in the feeding habits of fish species including the size of the fish, sex, season, water temperature, habitat and competition [34]. The type and size of food items consumed by fish change with the age and size of the fish [35]. This phenomenon, known as an "ontogenic shift" has been observed for several fish species, including Nile perch, *Lates niloticus* [36] and Nile tilapia *Oreochromis niloticus* [37], [38]. The phenomenon helps reduce competition among the different age classes of the same species, and reduces niche overlap, especially with respect to feeding. Nile perch usually switches from invertebrates to fish when it grows, but the size at which it shifts its diet is variable [39].

In this study, the dominant food item in *L. niloticus* up to 20 cm were the invertebrate prey, insects and insect parts, while in the large size groups they were tilapia. This may indicate that the switch from insects to fish as dominant prey occurred at the size of about 30 cm in Ikere gorge reservoir. In upper Ogun River, it was reported that Nile Perch with mean length 71. 90 cm fed on *Macrobrachium* (2%) and various fin fishes (98%) (Adebisi, 1981). This corroborates the findings in this study and the difference in percentage occurrence of finfish could be due to the smaller size of the fish (largest size being 53.6 cm) in this study. In the northern and southern part of the Mwanza Gulf of Lake Victoria the switch from shrimps (invertebrate prey) to haplochromines as dominant prey of Nile Perch occurred already at the size of about 20 cm and 16.7 cm TL, respectively [35], [36], thus occurred earlier. In *C. nigrodigitatus*, variation occurred in the composition of the diet as the fish grows with tilapia being dominant, molluscs and shrimps also increased in

occurrence. Thus, the size of preys consumed increased with size and could be due to larger mouth gape and increased ability to digest the preys. Similar observations were recorded in cichlids [40], [20].

The seasonal variations in the composition and availability of the food items have a great effect on the diet composition [41]. Plants' (phytoplankton) being less encountered in the late rainy period in *C. nigrodigitatus* is probably due to the water being more turbid as a result of flooding/runoff, thus photosynthesis is reduced. This is corroborated by the poor and medium guts being encountered more during the late rainy season. Contrary to this observation, Yem *et al*., [42] reported that plant material dominated the diet of *C. nigrodigitatus* and *C. auratus longifilis* in both dry and rainy seaons in Lake Kainji, Nigeria. Dadebo *et al*. and Shalloff *et al*. [43], [20] also reported seasonal variations in food items of cichlids in Lake Ziway, Ethiopia and Lake Nasser, Egypt. The observed differences in the composition of the food items of males and females *of C. nigrodigitatus* and *L. niloticus* could be due to the recorded female sizes being higher than males. The change in food consumed with sex is also reported in *Schilbe mystus* in South-western Nigeria [44] and in *O. niloticus* and *Sarotherodon galilaeus* in Lake Nasser, Egypt [20]. They stated that this probably resulted from the difference in the feeding ground of both sexes.

Trophic level has gained wide acceptance as an ecological indicator for ecosystem management. Its strength as an ecological indicator lies in its efficiency in capturing/expressing fishing-induced effects at the community or ecosystem level [27]. The trophic levels of fishes generally range from 2 (e.g., the detritus feeding blue-barred parrotfish) to 4.7 (e.g., the piscivorous striped marlin)[45], [46]. The present results showed that the mean trophic level of *C. nigrodigitatus* and *L. niloticus* was 2.856 ± 0.675 and 3.217 ± 0.720, respectively. The lower trophic level of *C. nigrodigitatus* than *L. niloticus* in this study could be due to its feeding ecology that differs by consumption of a high level of primary producers (micro-algae). The higher trophic level of *L. niloticus* may be explained by the consumption of larger quantity of fish. According to study of Traore *et al.,* [47] in Lake Ayamé (Côte d'Ivoire), fish with trophic level 2 < TL > 3 are intermediate predator and TL > 3 are top predator, thus *C. nigrodigitatus* could be classified as an intermediate predator and *L. niloticus*, a top predator in this study site. The trophic level of *C. nigrodigitatus* estimated in this study almost equal the TL reported for the juvenile *C. nigrodigitatus* in FishBase (TL= 2.8) [48]. Higher trophic level of 4.5 was reported for *L. niloticus* in FishBase based on diet of species in the upper Ogun River [16]. The lower TL of *L niloticus* in this study is due to inclusion of plant materials in the diet and suggest gradual change in the feeding habit of this species in the lentic water/ reservoir. The trophic levels of *L. niloticus* agreed with that reported by Cornelissen *et al*., [36] in southern Lake Victoria. However, the trophic level of 3.03 reported for *C. nigrodigitatus* in Lake Ayamé (Côte d'Ivoire) is higher than the present study; the species is also reported to be a top predator in Cross River estuary [44]. The wide food spectrum of *C. nigrodigitatus* is an indication of flexibility in trophic level which gives the fish ecological advantage to feed effectively on different categories of diet based on the availability of the food items [49]. The trophic levels of *L. niloticus* increased with size groups and also the largest size group of *C. nigrodigitatus* that had highest trophic level suggests that a species can play different functions in the ecosystem and emphasizes the importance of considering size criteria in studies of trophic dynamics [50]. This agreed with Pasquaud *et al*. [51] that observed increase in trophic levels in parallel with an increase in the size of individuals for *Dicentrarchus labrax* and *Argyrosomus regius* (Asso, 1801). Higher trophic level of females of both species results from their larger sizes than males. The low dietary overlap between studied species suggests little completion for food resources.

5. Conclusion

Chrysichthys nigrodigitatus fed on more diverse food materials including plant and animals than *Lates niloticus*. *Chrysichthys nigrodigitatus* is an omnivore in the Ikere gorge reservoir, while *Lates niloticus* is a carnivore. Variation occurred in the feeding habits of both species with size, sex and season. The trophic level obtained for *Chrysichthys nigrodigitatus* and *Lates niloticus* suggests being intermediate predator and top predator, respectively in the reservoir. This could be utilized for effective management of fisheries in the Ikere gorge reservoir.

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