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Dietaries and diet dispersity of some perciform species of Ikpa River, Southeast Nigeria

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Abstract
The trophic structure of the perciform fish fauna in Ikpa River were assessed from March, 2009 to February, 2010. The aim was to determine the feeding patterns and interspecific interactions of the nine species examined. Twenty-three dietaries were identified; with fish and crustaceans being the most important food resources exploited. Cluster and principal component analyses (Euclidean Distance) identified three main trophic guilds (carnivores, detritivores and omnivores). The interspecific diet breadth and similarity values were low suggesting wide partitioning of the food resource with a tendency toward trophic specialization. The two specialist guilds (detritivores and carnivores) displayed low to moderate breadth niche (B = 0.01 - 0.37 and B = 0.05, respectively). The omnivores also showed low breadth niche, B = 0.16. Trophic levels (T_L) were 2.09 - 2.91, 4.05-4.5 and 2.88 - 3.25 for the three trophic guilds, respectively; higher (> 4) in piscivorous carnivores which preferred items of higher trophic value like fish. The fish samples exhibit excellent body condition and well-being.

Keywords: Dietaries, Feeding Performances, Trophic Segregation, Trophic Levels

1. Introduction

Food is an important limiting factor in fish and fisheries biology for they govern their abundance and distribution, growth, maturity, development, reproduction and migratory patterns. Diets also represent an integration of many important ecological components such as behaviour, condition, energy intake, habitat use, inter/intra specific interactions [1]. Hence accurate description of diets and feeding habits of fish based on stomach content analysis provide the basis for understanding trophic interactions in aquatic food webs and fish communities. Such studies afford recognition and delineation of distinctive trophic guilds, allowing inferential deductions about their structure, the degree of importance of the different trophic levels, the relationships among their components and are an important aspect of fisheries management. In tropical waters, a large number of fish species are able to coexist in the same community employing certain ecological mechanisms that allow for resource sharing [2-6]. One such ecological mechanism is trophic segregation [5, 6], which may vary according to physicochemical conditions and seasonality [7] and spatial distribution [6], age and locality, among others. Fishes feed on a wide spectrum of materials ranging from microscopic to macroscopic organisms and/or detritus matter depending on individual species choices. Habitat quality could also influence food consumption, rate of digestion and also quality and quantity of available food organisms.

This study seeks to elucidate the potential qualitative and quantitative patterns of diet among perciform fish species of the Ikpa River in southeast Nigeria; to examine the feeding performances in addition to diet breadth, and estimate the potential for trophic interactions and inter-relationships, and trophic segregation or interspecific diet overlap among the species. The results of this study would further increase understanding of trophic ecology of the Ikpa River for proper management of the resource and its contribution as a major feeder draining the Cross River system in Nigeria.

2. Materials and Method

2.1 Study area

The Ikpa River is a small perennial tributary located west of the lower reaches of the Cross River system in the rainforest zone of southeast Nigeria (Fig. 1). It drains a catchment area of 516.5 km^2 with about 14.8% (76.5 km^2) prone to annual flooding.

The main channel of the stream is in Ikono from where it travels 53.5 km till it discharges into the Cross River Creek close to Nwaniba beach [8]. The non-flooded zones of the upper reaches have a basin area of 440 km^2 (85.2%) and mean depth and width of 2.0 m and 12.5 m, respectively [8]. Three stations were established along this course for sample collection; namely Ikot Ebom (station 1, 379437.913mE, 572840.203mN) in Ibiono Ibom, Ntak Inyang (station 2; 380881.32mE, 561822.998mN) in Itu and Nwaniba (station 3; 394252.669mE, 558778.199mN) in Uruan. The choice/section of these sites was as a result of the various human anthropogenic activities. Its annual rainfall of 255.8 cm renders the lower reaches susceptible to annual flooding during the rainy season; while the substrate is sand, mud/sand organic debris; depth ranges from 1-6 m ± 3.5 m and maximum transparency varies from 1.0-1.3 m ±1.15 m[8].

2.2 Sample collection and laboratory analysis

Samples of perciform species: *Bostrychus africanus* Eleotridae (Steindachner, 1880), *Caranx hippos* Carangidae (Linnaeus, 1766), *Galeoides decadactylus* Polynemidae (Bloch, 1795), *Lates niloticus* Latidae (Linnaeus, 1758), *Liza falcipinnis* Mugilidae (Valenciennes, 1836), *Parachanna obscura* Channidae (Günther, 1861), *Pomodasy peroteti* Pomodasyidae (Cuvier, 1830), *Pomadasys rogeri* Haemulidae (Cuvier, 1830), and *Trachinotus teraia* Carangidae (Cuvier, 1830) were obtained fortnightly from artisanal fishers for 12 consecutive months (March 2009 to February, 2010) from the three (3) sampling stations and pooled into one sample for analysis. Fishers employed gears such as cast net, gill net and traps baited with palm fruits. Specimens were identified using identification keys of Idodo-Umeh [9] and fixed in 10% formalin after collection prior to analysis. Total length and weight of the specimens

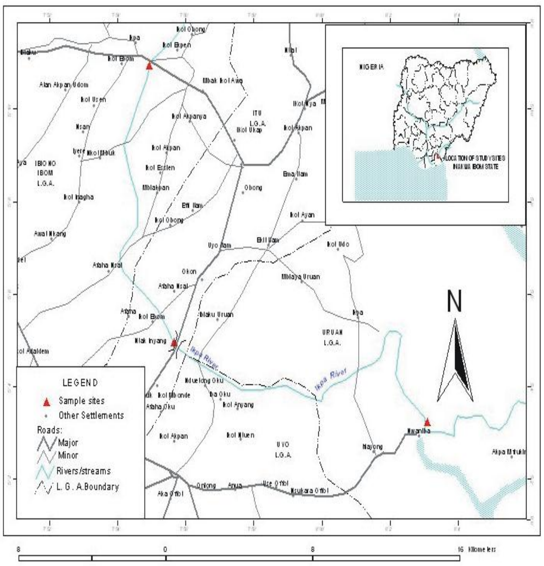

Fig 1: Map of study area showing sampling points

were taken and the specimens were eviscerated. The stomachs of the specimens were excised and the contents weighed. The stomach contents were examined macroscopically and microscopically and the alimentary items identified. Diet composition was assessed using the point and frequency of occurrence methods [10]. The stomachs were sorted out visually and allocated points of 0, 5, 10, 15 and 20 corresponding to empty, 25% full, 50% full, 75% full and fully distended stomachs. These points were shared among the various contents, taking into account their relative proportion by volume. The percentage point (*PP*) was evaluated by expressing the point scored by each food item as a percentage of the total points scored by all stomach contents. The percentage relative frequency (*RF*) was calculated by expressing the number of each prey item in all non-empty stomach as a percentage of the total number of food items in all non-empty stomachs [10]. The percentage points (*PP*) and percentage relative frequency (*RF*) calculated were used to estimate the relative importance of food items (excluding unidentified food items) while the overall importance was expressed by the index of food dominance (*IFD*) [11]. This index is scaled between 0 and 100%: items with *IFD* ≥ 10% were considered as primary dietaries; those with *IFD* of 1-9.9% were considered as secondary dietaries and those with *IFD* < 1.0% as incidental dietaries. Trophic levels (T_L) values and their standard errors, SE, were estimated from quantitative diet composition data using *TrophLab*, a stand-alone application ([12]; with *IFP* of food categories classified into of four trophic levels – nekton, detritus, plants, and zoobenthos as input values. T_L values vary between 2.0, for herbivorous/detrivorous, and 5.0, for piscivorous/carnivorous organisms [13, 14].

2.3 Data analysis

Ecological biotic indices of Shannon-Weiner Diversity, *H′* [15], Simpson Dominance, *D*; Diversity, *1-D*; Evenness, e^H/S, and Equitability, *J*, indices [16] and Margalef index, *d* [15] were used to describe the trophic structure and compare the sampling stations, based on the percentage proportion (*IFD*) of dietaries**.**

The average gut fullness (*AGF*) and the gastrosomatic ratio (*GSR*) calculated as the number of stomachs containing food expressed as a percentage of the total sample, were determined and used to evaluate the pattern of feeding activity. The wideness of dispersion of food items among the species was determined using the index of biotal dispersity (IBD) as given by Koch [18]:

$$\mathbf{IBD} = \frac{(\mathbf{T}-\mathbf{S}) \times 100}{\mathbf{S}(\mathbf{n}-1)}$$

where *T* = arithmetical sum of dietaries in each of the n compared locations; *S* = Total list of dietaries in the n compared location. *IBD* ranges from 0 (for completely different set of dietaries in both locations) to 100% (for identical set of dietary in both locations).

Levins' was used to integrate the number of prey categories present and their relative proportion in the diet, thereby determine diet specialisation of the fish species sampled. Diet breadth ranges from 0 – 1.0, where values close to 0 indicates specialisation (when no resource state is shared by species from the two locations) while values close to 1.0 indicate generalisation (when perciform species from the river utilize each resource state in proportion to its abundance); and a value >1.0 if the species utilizes certain resource states more intensively than others and the utilization functions of the species at both locations tend to coincide [19]. The standardized diet breadth was calculated as [19]:

$$\mathbf{B} = \left[\left(\sum_{i=1}^{n} \mathbf{P_i}^2\right)^{-1} - 1\right] \Big/ \mathbf{n} - 1$$

where B = diet breadth; P_i = proportion of the diet comprised by resource type i; n = number of food types eaten. Breath niche values were arbitrarily assess relatively as high (> 0.6), intermediate (0.4 - 0.6) or low (<0.4).

Dietary overlap or similarity in diet composition of the fish species was assessed using percentage similarity coefficient (S)[20] to determine the intensity of the interaction between specie's pairs:

$$S = \sum_{i-1}^{n} \min(X_i Y_i)$$

where X_i and Y_i = proportions of the components of the nth item comprising the diets of X and Y. This index ranges from 0 (totally dissimilar dietary components) to 100% (identical diets). A value of 60% was used as threshold to delineate similar (> 60%) from distinct feeding niches (< 60%) for both index of biotal dispersity, *IBD* and dietary overlap or similarity, *S*.

Data set of the dietary composition (%*IFD*) of the nine perciform species sampled were used for cluster analysis (CA) and principal components analysis (PCA) based on assumption that the most important components are correlated with other underlying variables. Cluster analysis was by Ward's method to minimize within-group variance [21] and yield dendrograms identifying hierarchies of association and natural groupings among species sampled and among dietaries. PCA was by var-covar for dietary variables since they were measured in the same units, % IFD while correlation (normalized var-covar) was used in analyzing interspecies differences since the variables are measured in different units. Correlation matrix (Pearson's method) was performed to know the inter-relationship between dietaries and the species sampled.

Length-weight relationships were calculated using the equation $W=aL^b$ [22] otherwise expressed as Log W= Log a + bLogL, where W is the weight of fish (g), L is total length of fish (cm), b is regression coefficient and ***a*** is the intercept of regression line. The general well-being of the crabs was evaluated using Foulton's condition factor, K [23];

$$K = (W \times 100)/L^3$$

where W = Weight (g) and L = carapace length (cm). The SPSS version 17 and PAST® [24] statistical packages were used in data analysis.

3. Result

3.1 Length weight relationship and morphometrics of species sampled

Table 1 is a summary of length-weight relationships of the species sampled excluding species with one sample (n = 2-50) while Table 2 outlines the morphometrics, feeding indices and diet breadth of sampled fish specimens. The b values fall within the range, b = 2.74-7.16), higher in *T. teraia*. The average gut fullness (*AGF*) ranged from 10.08 in *B. africanus* to 16.14 in *P. peroteti* while the gastrosomatic ratio was highest for *B. africanus* (4.48). The condition factor (K) ranged from 2.095 in *B. africanus* to 0.887 in *L. falcipinnis*, probably owing to its slender shape.

3.2 Diet Composition

The overall stomach contents of perciform species sampled in Ikpa River, Nigeria revealed a high dietary complexity involving the utilization of a wide variety of food resources. Crustaceans and fish were the most exploited resources by the majority (five) of the fish species sampled. A composite spectrum of 23 food items was observed (Tables 3); primarily composed of crustaceans, worms, molluscs, oil droplets, detritus, mud and sand grains, with IFD ≥ 10% and grouped into four trophic levels ranging from 2.09±0.05 to 4.50±0.80 (Fig. 2). Similar trends occurred in the rank order of *IFD* in samples of food items of each species (Table 3). The dietaries of the specimens sampled comprise one to 12 food items with diversity indices ranging from 0.0 (Oligodiverse) for *C. hippos*, 0.5 (Mesodiverse) for *L. niloticus* and *G. decadactylus*, and > 0.5 (Polydiverse) for *B. africanus*, among others (Table 4).

3.3 Diet Overlaps and relationships

The low index of biotal dispersity (*IBD* = 14.5%) and pair wise interspecific dietary overlap or similarity (S = 44.42% < 60%; Table 5) indicate the diets were dissimilar. Also B < 1 (Table 2), widest (B = 0.37) in *B. africanus* followed by *L. falcipinnis* (B = 0.18) and least in *P. obscura* (B = 0.01), indicating quantitative dissimilarities in dietaries among the species; and suggesting trophic flexibility and partitioning of food resource. Linear correlation (Table 6) and multivariate analysis using PCA and CA (Fig. 3, 4) confirm some interrelationships.

Table 1: Length Weight Relationship of Species Sampled

Species	*N*	*a*	*b*	*r*	*K*
B. africanus	50	-1.55	2.74	0.896	2.095
L. falcipinnis	2	-2.31	3.19	1.000	0.887
L. niloticus	2	-4.21	4.79	1.000	1.827
P. obscura	25	-2.04	2.96	0.867	1.041
P. peroteti	22	-2.05	3.14	0.895	1.413
T. teraia	2	-7.07	7.16	1.000	1.154

Table 2: The morphometrics and indices of feeding activities and diet breadth of perciform species sampled along Ikpa River, Nigeria

Species	*N*	Mean *TL* cm ± SD (min-max)	Mean *TW*, g ± SD (min-max)	Condition Factor (K)	*AGF*	*GSR*	*B*
B. africanus	50	10.38±3.57 (6.5-21)	25.81±23.44 (3.93-131.42)	2.09	10.08	4.48	0.37
L. falcipinnis	2	15.5±2.27 (13.4-17.63)	33.02±19.15 (19.48-46.56	0.88	11.00	3.86	0.18
L. niloticus	2	23.25±2.49 (21.5-25.0)	229.64±112.45 (150.12-309.15)	1.82	20.00	0.73	0.05
P. obscura	25	17.52±4.67 (8.5-26.8)	55.99±54.29 (5.21-210.95)	1.04	14.84	2.42	0.01
P. peroteti	22	14.8± 1.95 (11.0-20.5)	45.81±17.32 (22.0-120.06)	1.41	16.14	3.19	0.16
T. teraia	2	16.85±1.48 (15.8–17.9)	55.19±32.71 (32.06-78.32)	1.15	12.5	2.78	0.03

AGF = Average gut fullness; GSR = Gastrosomatic ratio (%) B = Diet breadth index

Table 3: Dietary composition and index of food dominance (%*IFD*) of nine perciform species sampled in Ikpa River, southeast Nigeria

S/N	*Dietaries*	*BA*	*CH*	*GD*	*LF*	*LN*	*PO*	*PP*	*PR*	*TT*
1	Detritus	10.9			21.1		12.4			8.3
2	Algae				5.3					

3	Mud	12.4			21.1		25.2	9.0		
4	Sand grains	7.7			21.1		14.7	12.5		
5	Oil droplets	3.5			21.1		5.4	14.6		
6	Fish scales	8.5								
7	Aq. insects						12.9	1.0		8.3
8	Crustaceans	12.3		50.0				36.4	33.3	3.9
9	Worms						2.8	18.1	33.3	
10	Prawns	8.8				53.3	7.1			
11	Insect larvae					40.0				
12	Nymphs					6.7				
13	Gastropods	4.8								
14	Fish bones						5.2			
15	Fish flesh						0.4			
16	Bivalves	6.5								
17	Molluscs							8.4	33.3	77.6
18	Tilapia						5.7			
19	Ants						4.7			
20	Diatom				2.6					
21	Zooplankton				7.9					
22	Fish	8.9	100.0	50.0			3.5			1.9
23	Plankton	15.6								
	Total	100	100	100	100	100	100	100	100	100
Trophic Level ± SE		2.91±0.46	4.5±0.80	4.05±0.70	2.09±0.05	3.43±0.51	2.74±0.40	2.88±0.39	3.25±0.41	3.17±0.54
Trophic Guild		*DET*	*PCN*	*PCN*	*DET*	*NPC*	*DET*	*OMN*	*OMN*	*NPC*

BA = *Bostrychus africanus* CH =*Caranx hippo* GD = *Gadeoides decadatylus* LF = *Liza falcipinnis* LN = *Lates niloticus* PO = *Parachanna obscura* PP = *Pomadasy peroteti* PR = *Pomadasy rogeri* TT = *Trachinotus teraia* PCN = Piscivorous carnivore NPC = Nonpiscivorous carnivore DET = Detritivore OMN - Omnivore

Table 4: Ecological indices of percentage proportion of dietaries of perciform species sampled in Ikpa River, southeast Nigeria

Indices	BA	CH	GD	LF	LN	PO	PP	PR	TT
Food items, *n*	11	1	2	7	3	12	7	3	5
Dominance, *D*	0.104	1.00	0.500	0.187	0.449	0.135	0.218	0.333	0.618
Equitability, *J*	0.970	0.00	1.000	0.906	0.804	0.885	0.868	1.000	0.504
Evenness, e^H/S	0.931	1.00	1.000	0.833	0.806	0.751	0.773	1.000	0.450
Margalef, *d*	2.172	0.00	0.217	1.302	0.434	2.389	1.303	0.434	0.869
Shannon, *H*	2.326	0.00	0.693	1.763	0.883	2.198	1.689	1.099	0.812
Simpson, *1-D*	0.897	0.00	0.500	0.813	0.551	0.865	0.783	0.667	0.382
Remark	PLD	OLD	MSD	PLD	MSD	PLD	PLD	PLD	PLD

OLD = Oligodiverse MSD = Mesodiverse PLD = Polydiverse

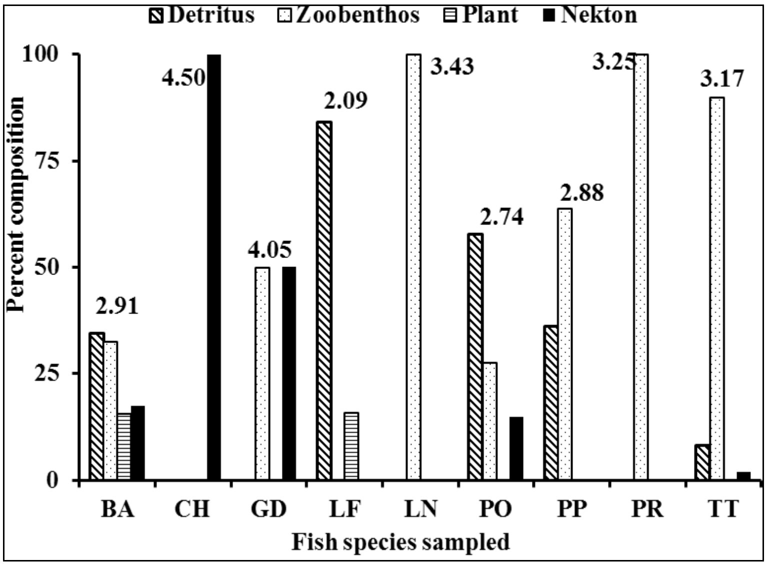

Fig 2: Major dietaries in the diet of perciform species in Ikpa River, Nigeria with trophic level indicated

Table 5. Interspecific similarity and diet overlap among perciform species in Ikpa River, Nigeria

Species	***PR***	***LN***	***GD***	***TT***	***PP***	***BA***	***PO***	***CH***	***LF***
PR	-	-	-	-	-	-	-	-	-
LN	-	-	-	-	-	-	-	-	-
GD	-	-	-	53.88	-	-	-	-	-
TT	-	-	-	-	9.22	-	-	-	-
PP	-	-	-	-	-	20.61	-	-	-
BA	-	-	-	-	-	-	35.26	-	-
PO	-	-	-	-	-	-	-	103.13	-
CH	-	-	-	-	-	-	-	-	-
LF	-	-	-	-	-	-	-	-	-

Similarity/diet overlap = 222.12/5 = 44.42%

Table 6: Linear correlation matrix of perciform species in Ikpa River, Nigeria

Species	**BA**	**CH**	**GD**	**LF**	**LN**	**PO**	**PP**	**PR**	**TT**
BA	0	0.384	0.075	0.143	0.920	0.134	0.219	0.933	0.493
CH	0.190	0	0.000^{**}	0.594	0.751	0.897	0.628	0.708	0.881
GD	0.378	0.691^{**}	0	0.439	0.646	0.564	0.017^{*}	0.114	0.898
LF	0.315	-0.117	-0.170	0	0.410	0.000^{**}	0.346	0.329	0.681
LN	0.022	-0.070	-0.101	-0.180	0	0.895	0.455	0.564	0.683
PO	0.322	-0.029	-0.127	0.680^{**}	-0.029	0	0.671	0.338	0.666
PP	0.267	-0.107	0.492^{*}	0.206	-0.164	0.094	0	0.000^{**}	0.598
PR	-0.018	-0.083	0.339	-0.213	-0.127	-0.209	0.740^{**}	0	0.006^{*}
TT	-0.150	-0.033	-0.028	-0.091	-0.090	-0.095	0.116	0.559	0

Correlation, *r* values under the diagonal and probability, *p* values over the diagonal * Significant pair at $p < 0.05$)

Linear correlation analysis (Table 6) establishes significant relationships ($p < 0.05$) in five pairs of species belonging to the same trophic guild. Cluster analysis (Fig. 3) identified and isolated three main trophic guilds among the perciform species of Ikpa River ecosystem in Nigeria, i.e., two groups of species with specialized feeding habits – detritivores and carnivores, and one generalist feeders - the omnivores. CA grouped together the detritivores (such as *B. africanus*, *P. obscura* and *L. falcipinnis* feeding mainly on detritus, mud, sand grains and aquatic insects showing low to moderate breadth niche, B = 0.01 - 0.37; T_L ± SE = 2.91 ± 0.46, 2.09 ± 0.05 and 2.74 ± 0.40, respectively) and carnivores (including piscivorous carnivores like *C. hippos* and *G. decadactylus* which feed mainly on fish and crustaceans (T_L ± SE = 4.5 ± 0.80 and 4.05 ± 0.70, respectively) while non-piscivorous carnivore like *T. teraia* and *L. niloticus* feed mainly on molluscs and prawns showing low breadth niche, B = 0.05; T_L ± SE = 3.17 ± 0.54 and 3.43 ± 0.51, respectively). The omnivores such as *P. peroteti* and *P. rogeri* showed preference for animal materials, feeding mainly on crustacean, worms and molluscs showing low breadth niche, B = 0.16 with T_L ± SE = 2.88±0.39 and 3.25±0.41, respectively (Fig. 3a). The cluster analysis further confirm the perciform species feed on three main food sources: mostly nekton, zoobenthos, and detritus; lesser on plants (Fig. 3b).

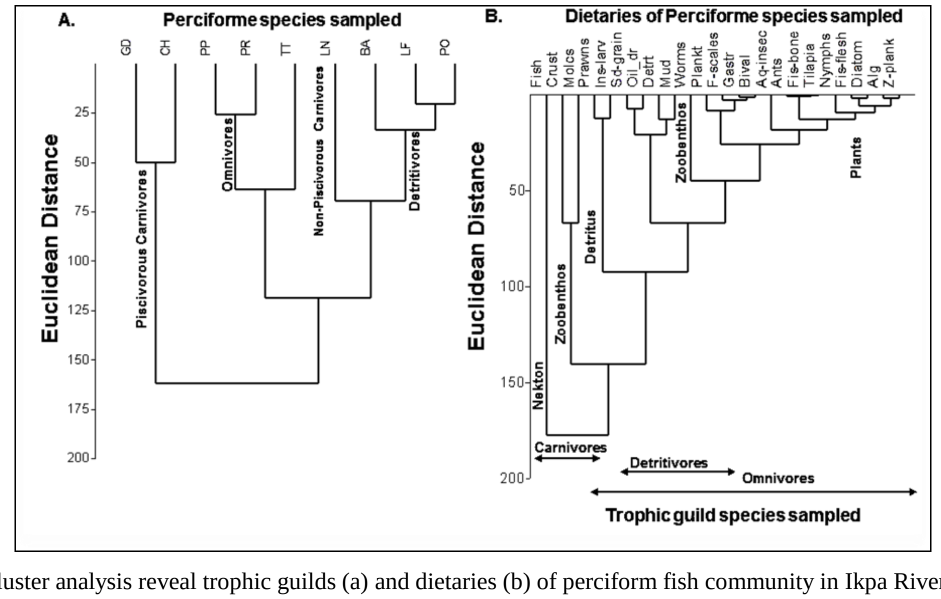

Fig 3: Cluster analysis reveal trophic guilds (a) and dietaries (b) of perciform fish community in Ikpa River, Nigeria

The PCA shows interactions and interrelationships among dietaries and perciform species in the Ikpa River ecosystem (Fig. 4). Generally an axis was named after the variable with the highest eigenvalue in a quadrat and variables lying close to each other indicate a positive correlation or relationship with each other. The first four of the PCA axes are the most important factors which cumulatively explained 86.49% of the variation in the diet preferences of the perciform species; with axis 1 having the highest proportion of the variance, 35.19%, and axes 2-4 accounting for 22.61, 18.06 and 10.63% variance, respectively. The ordination diagrams of the biplot of axis 1 identified detritus, mud, sand grains and crustaceans; 2: crustaceans, molluscs, fish and worms; 3: fish; 4: prawns and insect larvae and 5: molluscs and fish, as the major diets associated with perciform species in the study area. Hence, *P. rogeri* (*PR*), *P. peroteti* (*PP*) and *G. decadactylus* (*GD*) prefer crustaceans and worms (Fig. 4a,d) while *T. teraia* (*TT*), molluscs (Fig. 4b,d). *L. niloticus* (*LN*) prefer insect larvae and prawns (Fig. 4c); while the other four species utilize other sources of food available, exhibiting some level of convergence and similarity in diet preference. The PCA result agrees with that of CA which identified zoobenthos (crustaceans, worms and molluscs) as the main food preferences of perciform species in the study area.

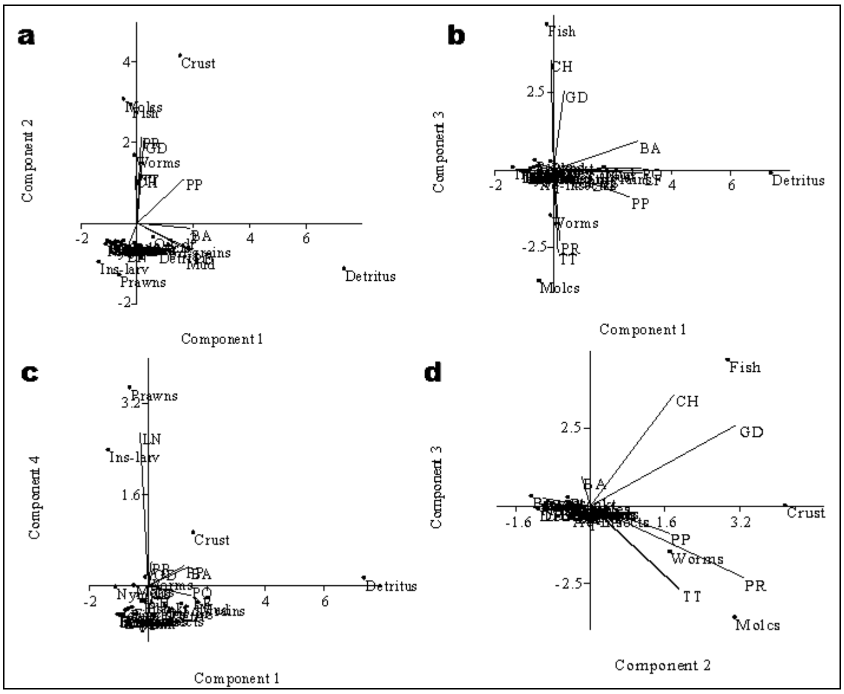

Fig. 4. Principal component analysis showing ordination of the main dietaries and convergence among perciform species in the Ikpa River ecosystem in Nigeria that show similarity in diet preference

4. Discussion

The variety of items occurring in the stomachs of the perciform species indicate that each species is capable of utilizing many sources of food, while some are selective feeding on 1-3 food items; others exploit over 8-11 of the food resources evaluated. However, at the community level, the most of the energy supporting the fish fauna was derived from fish and crustaceans, since individual species widely consumed both food resources. Novakowski *et al.* [7] suggested that although the fish species included more than one kind of food in its diet, the highest dominance by a single food item suggests their abundance in the environment, and may indicate food active selection.

The analysis of the stomach contents of the various species suggests categorization of the fishes into three broad trophic groups: those feeding mainly on nekton – carnivores; those feeding on bottom deposits or detritus (detritivore) and those feeding on generality of food sources – omnivores. The trophic guilds, in general, were composed of few species, indicating a more or less uniform distribution of food resource exploitation among the fishes in agreement with the observation of Novakowski *et al.* [7]; suggesting that these fish species are avoiding trophic competition [25], or optimized the food resources available, as described by Jacksic [26] and Hahn and Fugi [27]. Data analysis showed a low overall feeding overlap (44%) indicating a defined resource partitioning owing to the fact that most combination pairs belonged to species of different trophic guilds. Interspecific diet overlaps obtained were generally low to intermediate (9-54) among species whether belonging to the same or different trophic guilds, whereas the highest value of diet overlap was obtained in the pair of the piscivore, *C. hippos* (*CH*) with narrow diet with *P. obscura* (with very low diet breadth, $B = 0.01$). Linear correlation matrix (Table 6) establishes significant relationships in species pairs belonging to the same trophic guild.

The Ikpa River ecosystem provide a wide diversity of food resources exploited by the perciform species organized into three trophic guilds, with low individual niche breadth values, a small number of omnivorous species and low interspecific overlaps, suggesting a tendency toward trophic specialization as against the expectation in tropical freshwater fish assemblages, where most fishes are generalist feeders [3, 28-30]. This observation is probably owing to feeding specificity of the majority of the species examined and the taxonomic composition of the resident species [7]. It was observed that within each trophic guild diets were unspecialized, with species exploiting many different types of preys

The carnivorous or predatory fishes include the piscivorous species, i.e., those feeding principally on fish and those having dominantly crustaceans in their diet (non-piscivorous species). The piscivorous species like *C. hippos* derive their high index of food dominance from consuming chunks of fish flesh while non-piscivorous species like *T. teraia* and *L. niloticus* feed mainly on molluscs and prawns. The piscivores which preferred items of higher trophic value like fish exhibited higher trophic level (> 4; Fig. 2).

The fish species examined display trophic flexibility, switching from one food category to another in response to fluctuations in food abundance or availability. For instance, Fagade and Olaniyan [31] reported on the feeding habits of *T. teraia, P. peroteti* and *P. rogeri, L. falcipinnis, T. teraia* and *P. obscura* in the Lagos lagoon. They described *T. teraia* as piscivorous and non-piscivorous feeding on whole fish, adult crustaceans mainly shrimps and crabs) and molluscs (bivalves and gastropods) while *P. peroteti* and *P. rogeri* were omnivorous ingesting large quantities of crustaceans, molluscs, worms and browsed sand grains/detritus attached to them. *L. falcipinnis, T. teraia* and *P. obscura* were described as bottom feeders feeding mainly on bottom deposits by stirring up the bottom and filtering the particles brought into suspension with their gill rakers. King [32] also described *L. falcipinnis* as a *'detritivore- algivore-deposit feeder'.* These fish species displayed feeding patterns in this study area rather different from the descriptions of Fagade and Olaniyan [31 confirming trophic flexibility.

A higher gastrosomatic ratio indicates greater foraging activity hence wider diet breadth and higher condition factor as observed in *B. africanus* (*GSR* = 4.48; *B* = 0.37; *K* = 2.095). Condition factor (*K*) estimates the general well-being of an organism [33] assuming heavier individuals of a given length are in better condition than lighter ones [34]. Variations in *K* values may be indicative of food abundance, adaptation to environment and gonadal development of the organism [35]. In multi-species fisheries $b < > 3$ is typical but the expected range is $2.5 < b < 3.5$ [22] indicating a tendency towards slightly positive-allometric growth (increase in relative body thickness or plumpness) in most fishes. In this study, b = 2.74-7.16, fall within the expected range except for b > 3.5 (b = 7.16) obtained for *T. teraia* probably owing to low number of samples.

5. Conclusion

In summary, the food and feeding habits of the commonly occurring perciform fishes in the Ikpa River show some levels of similarity, distinction and overlaps in pattern to ensure reduced competition among the fish species and enhances their coexistence. Three trophic groups (carnivore, detritivore and omnivore) were identified within the food webs of the river for proper management of the fishery. The carnivores are sub-divided into piscivorous and non-piscivorous species while the detrivores are deposit feeders feeding on the bottom sediment and detritus. The fishes depended mainly on autochthonous food items comprising crustaceans, worms, molluscs, oil droplets, detritus, mud and sand grains, with IFD ≥ 10%. The study established the trophic relationships and contributes to understanding of the biology of perciform species in the Ikpa River. The fish samples in the Ikpa River exhibit excellent body condition and could provide excellent brood stock for aquaculture elsewhere. The economic and commercial importance of these fishes demands that the fish stocks be prevented from over-exploitation and ecosystem protected through enforcement of relevant fisheries and environmental laws and regulations.

6. References

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