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Seasonal Fish Abundance and Fishing Gear Efficiency in River Orogodo, Niger Delta, Nigeria

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Abstract: Seasonal fish abundance and fishing efficiency of various gears were investigated in River Orogodo, Nigeria for 24 months. Fishing gears employed included; dragnets, (mesh size 1.5 cm), gillnets (mesh size 0.5 -10.2 cm), rod and single line hook (Nos. 1-4), hand nets and a combination of traditional basket traps. 4339 individuals (or 47.01%) accounting for a biomass of 191371.0g were caught in the dry season while rainy season recorded a total of 4890 individual (52.99%) with a total biomass of 224415.6 g. Significantly higher catch ($p<0.05$) in the rainy season than dry season was recorded for most species. Thirty-five out of the 37 fish species recorded occurred in the river during both seasons. *Auchenoglanis occidentalis* (6.75%), *Hemichromis fasciatus* (6.6%). *Clarias macromystax* (6.24%) and *C. gariepinus* (6.34%) were the prominent rainy season catch. Prominent dry season catch were; *Erpetoichthys calabaricus* (7.14%), *Malapterurus electricus* (6.71%), *Chromidtilapia guentheri* (5.39%) and *H. fasciatus* (6,65%). Gear efficiency showed that dragnets caught 3734 or 40.46% of the total catch and had 33 species recorded, while gillnets had 3441 individuals or 37.28% of the catch, comprising 24 out of 37 species. Traditional basket traps had the least catch of 319 or 3.46% and 17 species. Distinct seasonal pattern in the fish composition of the river was observed and multiple gear sampling techniques recommended for the area.

Key words: Fishing % Gillnet % Dragnet % Basket Traps

INTRODUCTION

The effect of season and climatic regimes in the composition, distribution and abundance of fish species in tropical rivers cannot be over-emphasized. This is because the biology and ecology of fishes in these rivers are strongly linked to the annual hydrological regime in the main channel and regular flooding of the associated flood plains [1, 2]. Therefore, studies on the fish community structure of tropical rivers must of necessity consider not only the spatial but also the temporal distribution of species.

Most regions of the tropics experience strong seasonality in precipitation that produces seasonal patterns of river discharge. A variety of physico-chemical variables vary in relation to the seasonal hydrologic variations in these rivers [3]. In addition, the annual flooding associated with the rains brings fishes in contact with a greater abundance and diversity of allochthonous food resources, especially within the forested watersheds [4, 5]. On the other hand, the gradual drying up of the rivers' flood plains in the dry season months causes fish densities (per unit surface area) to increase and species interaction to intensify as habitat and resource availability decline. As a result, some fishes become stranded in isolated pools where they compete for limited resources and are often exposed to deteriorating water quality and risk of being preyed upon by piscivorous fishes, birds and other vertebrates [6]. The regular changes in tropical rivers and their associated flood plain habitat implies that fishes inhabiting these waters are challenged to respond in an adaptive manner. Future management of tropical fish stocks and the aquatic ecosystems that support them will therefore require greater knowledge of the fish community response to these seasonal alterations [7].

In Nigeria, most studies on seasonal/temporal distribution of fish species have been centered on River Niger and Lake Kainji [8-11] to the neglect of smaller rivers and lakes [12, 13]. Herein lies the need and prompting for the study reported in this communication.

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River Orogodo is a first order (1^0) stream flowing through Agbor town, where it is seriously inundated with flood water from inland drainage particularly during the rainy season. Fishing activities in this river like most other rivers in the Niger Delta is intense all year round with the fishermen using all kinds of fishing gears to increase their catch [14]. In most cases, their efforts are not commensurate with their catches. Worse still, catch effort data on which fisheries management regulations are sometimes based are not readily available in Nigeria. However, failure to regulate fishing gears and methods has been a major cause of collapse of fisheries in the country. Fisheries have been damaged by destructive and non-selective fishing gears and methods [15]. For a better management of the fisheries of the study area and in order to improve the catch per unit effort of the subsistence fisher folks, a knowledge of the rainy days, water levels, extent of flood in each season as well as the relative efficiency of the different fishing gears being used in the area is a *sine qua non*. In addition, an understanding of the seasonal fluctuations in the composition, distribution and abundance of the fish species in the area can never be neglected. This study therefore investigates the seasonality in the fish fauna to provide the much needed baseline data for improved and sustainable exploitation and management of the fisheries resources of River Orogodo.

MATERIALS AND METHODS

Study Area: River Orogodo (5°10[1]-6°20[1]N and 6°101 - 6°6[1]E) (Fig.1) is located in the mid-western area of Nigeria. It is an oligotrophic freshwater river with its source at Mbiri, (6°21[1] N and 6°16[1]E) where it arises from an aquifer outcrop and fed secondarily from precipitation, municipal and surface run-off from the riparian communities. It flows south-westerly for about 45 km through Agbor and Abavo, both in Ika South Local Government Area to Obazagbon-Nugu and Evboesi both in Orhionmwon Local Government Area, Edo State and finally empties into a swamp near Abraka in Delta state. During the dry season months, this lower course dries up.

In the study area, two climatic seasons prevail, namely: the rainy season (May-October) and the dry season (November-April). Some key physico-chemical variables of the river studied during both seasons were: water temperature (20.1-32.7°C), dissolved oxygen (3.8-9.4 mglG^1), conductivity (18-200.3 mscmG^1), transparency (40.0-124.1 cm) and BOD_5 (1.4-14.4 mglG^1) [16]. The river (Fig.1) was demarcated into three sampling stations

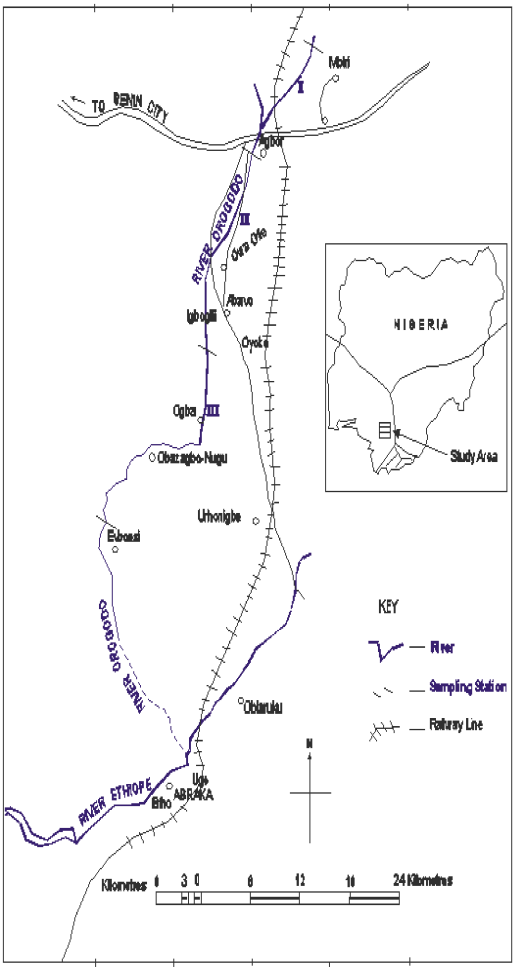

Fig. 1: The Study Area = -(A) Nigeria Showing the Location of Agbor (B) study Stretch the Location of the Sampling Stiation
Source: Directorate of Lands and Surveys, Govemors Office, Asaba (2000).

namely; Station I (upstream), Station II (midstream) and Station III (downstream). A detailed description of the study stations is as given by Meye and Ikomi [17].

Relevant human activities in the river included fishing, cow slaughtering and commercial sand dredging.

Fish Sampling: Routine sampling of fish from the study stations was conducted on a monthly basis from January 2006 to December 2007. Sampling was conducted at both day and night with the assistance of hired local fisher folks in the area. Five fishing gears were regularly used: drag nets (1.5 - 2.5 cm stretch mesh size) gill nets (0.5-10.2 cm stretch mesh size) and the traditional basket traps (25 cm in diameter and 80 cm deep), hook and line (nos. 1-4)

and hand nets. The fish specimens caught by each fishing gears were separately transported to the laboratory in 10% formalin, sorted and identified. The fish were identified using the keys provided by Teugels, *et al*. [18] and Idodo-Umeh,[12]. Each fish was weighed to the nearest 0.1g and the total length determined to the nearest 0.1mm.

The samples collected were qualitative. To enable a valid comparison of the seasonal abundance and fishing gear efficiency, attempts were made to standardize the fishing efforts in both seasons and in all stations. The sampling duration, the length of gill and drag-nets used the mesh size of nets and the numbers of hook and line and traditional basket traps were approximately the same throughout the period.

Statistical Analysis: The seasonal variation in abundance of the fish taxa was tested using the Chi-square (X^2) with the formula:

$$X^2 = \frac{(Fi\text{-}fi)^2}{Fi}$$

Where,
fi = Observed frequency
Fi = Expected frequency

Catch per unit effort was calculated by dividing the total monthly catch by the effort (number of each type of fishing gear) and dividing by the number of hours of fishing as shown below:

CPUE = Total catch/ Number of a fishing gear/ fishing hours

CPUE= Kg/man/h [19].

RESULTS

Table 1 shows the variations in number of individuals and the biomass of fishes captured during dry and rainy seasons of the two years of sampling based on the same fishing effort. A total of 2,348 individuals (48.90%) accounting for a biomass of 102581.5g were caught during the dry season in 2006, while 1,991 individuals (44.99%) accounting for a biomass of 88,789.5g were caught during the dry season in 2007. The rainy season of 2006 recorded 2,454 (51.10%) individuals and a biomass of 112,701.6g as against 2,435 individuals (55.0%) and a biomass of 11174.0g in the rainy season of 2007.

Table 2 shows the seasonal variations in the number of individuals of the various species caught in River Orogodo. A general trend of higher catch in the rainy season (52.99%) than the dry season (47.01%) was observed. The Chi-square test showed significant difference ($X^2 = 32.896$, $P<0.05$) between the dry season and rainy season catch in the river. The prominent rainy season catches include the Bagrid, *Auchenoglanis occidentalis* (6.75%), Cichlid, *Hemichromis fasciatus* (6.63%) and the Clariids; *Clarias gariepinus* (6.34%) and *C. macromystax* (6.24%). In the dry season, the Clariid, *Clarias gariepinus* (11.25%) also maintained a predominant status, closely followed by the polyppterids, *Erpetoichthys calabaricus* (7.14%) and the electric catfish, *Malapterurus electricus* (6.71%). Also of prominent status in the dry season were the two Cichlids, *Chromidotilapia guentheri* (5.39%) and *Hemichromis fasciatus* (5.65%). The least catch during both seasons was shown by *Tilapia dageti* (0.74% dry and 0.29% rainy season), *Hepsetus odoe* (0.58% dry and 0.80% rainy season), *Mastacembellus leonbergii* (0.02% dry and 0.04% rainy season), *Gnathonemus petersii* (0.07% dry and 0.08% rainy season),

Papyrocranus afer (0.35% dry and 0.51% rainy season) and *Schilbe intermedius* (0.55% dry and 0.63% rainy season).The two species which were recorded during the rainy season only were *Gymnarchus niloticus* (0.04%) and *Ilisha africana* (0.10%).

Monthly Variation: Figure 2 presents the monthly variations in number of species, biomass and individuals caught during the sampling period. The highest number of individuals was caught in October 2006 and May 2007. In 2006, there was low number in dry months of January and February, a gradual rise in March and a peak in April. There was a sudden drop in May and then another rise to a peak in October. In 2007, there was only one peak between April and May. The numbers caught during the remaining months showed uneven fluctuations. The number of species caught was not always correlated to the number of individuals caught as relatively fewer numbers of species were caught between October and December of both years when higher number of individuals were recorded. However, in 2007, the high number of species caught in May, June and July corresponded to the high number of individuals caught. The lowest numbers of individuals were captured in January 2006 and February 2007. The biomass of fish caught in these months was equally the lowest. The monthly variations in the biomass during the sampling period had an identical trend like that of the number of individuals caught.

Table 1: Variations in number of individuals and biomass during the dry and rainy seasons of the two sampling years in River Orogodo

	2006			2007		
Sampling Period/ Season	Number	%	Biomass (g)	Number	%	Biomass (g)
Dry season	2348	48.90	102581.5	1991	44.99	88789.5
Rainy season	2454	51.10	112701.6	2435	55.00	111714.0
X^2	2.339		475.74	44.540		2620.99
P	>0.05		<0.05	<0.05		<0.05

Table 2: Seasonal variation in the number of individuals of fish caught in River Orogodo for the two sampling years combined. (*R.A is the relative abundance in %)

S/N	Species	Total Abundance	Dry Season	*R.A (%)	Rainy Season	*R.A (%)
1	*Ctenopoma kingsleyae*	272	150	3.46	122	2.50
2	*C. petherici*	175	104	2.40	71	1.45
3	*Auchenoglanis biscutatus*	521	246	5.67	275	5.62
4	*A. occidentalis*	544	214	4.93	330	6.75
5	*Parachanna obscura*	177	73	1.68	104	2.13
6	*P. Africana*	364	205	4.72	159	3.25
7	*Brycinus longipinnis*	135	55	1.27	80	1.64
8	*Chromidotilapia guentheri*	509	234	5.39	275	5.62
9	*Hemichromis fasciaatus*	569	245	5.65	324	6.63
10	*H. bimaculatus*	134	33	0.76	101	2.07
11	*Tilapia zillii*	253	68	1.57	185	3.78
12	*T. mariae*	250	92	2.12	158	3.23
13	*T. dageti*	46	32	0.74	14	0.29
14	*Oreochromis aureus*	128	51	1.18	77	1.57
15	*O. niloticus*	11	6	0.14	5	0.10
16	*Sarotherodon macrocephala*	13	10	0.23	3	0.06
17	*Clarias gariepinus*	798	488	11.25	310	6.34
18	*C. macromystax*	605	300	6.91	305	6.24
19	*C. anguillaris*	324	146	3.36	178	3.64
20	*Barbus callipterus*	217	65	1.49	152	3.11
21	*Epiplatys sexfasciatus*	131	50	1.15	81	1.66
22	*Gymnarchus niloticus*	2	-	-	2	0.04
23	*Hepsetus odoe*	64	25	0.58	39	0.80
24	*Malapterurus electricus*	519	291	6.71	228	4.66
25	*Mastacembellus leonbergii*	3	1	0.02	2	0.04
26	*Hyperopisus bebe occidentalis*	223	79	1.82	144	2.94
27	*Brienomyrus branchistius*	244	127	2.93	117	2.39
28	*Isichthys henryii*	78	26	0.60	52	1.06
29	*Gnathonemus petersii*	7	3	0.07	4	0.08
30	*Polycentropsis abbreviate*	282	109	2.51	173	3.54
31	*Xenomystus nigri*	291	163	3.76	128	2.62
32	*Papyrocranus afer*	40	15	0.35	25	0.51
33	*Pantodon bucholzi*	225	106	2.44	119	2.43
34	*Phractolaemus ansorgei*	421	193	4.45	228	4.66
35	*Erpetoichthys calabaricus*	593	310	7.14	283	5.79
36	*Ilisha Africana*	5	-	-	5	0.10
37	*Schilbe intermedius*	55	24	0.55	31	0.63
	Total	9229	4339	100	4890	100
	Percentage		47.01		52.99	
	X^2		32.896			
	P		<0.05			

Table 3: Variations in the number of individuals caught during the dry and rainy seasons for the various fish families in River Orogodo

	2006		2007		
Family/Species	Dry Season	Rainy Season	Dry Season	Rainy Season	Total
Cichlidae					
Chromidotilapia guentheri	133	147	101	128	509
Hemichromis fasciatus	142	191	103	133	569
H. bimaculatus	8	42	25	59	134
Tilapia zillii	21	86	47	99	253
T. mariae	35	78	57	80	250
T. dageti	18	-	14	14	46
Oreochromis aureus	49	50	2	27	128
O. niloticus	4	-	2	5	11
Sarotherodon macrocephala	5	-	5	3	13
Total	415	594	356	548	1913
Clariidae					
Clarias gariepinus	269	166	219	144	798
C. macromystax	182	141	118	164	605
C. anguillaris	68	82	78	96	324
Total	519	389	415	404	1727
Bagridae					
Auchenoglanis biscutatus	143	161	103	114	521
A. occidentalis	151	227	63	103	544
Total	294	388	166	217	1065
Polypteridae					
Erpetoichthys calabaricus	112	100	198	183	593
Mormyridae					
Hyperopisus bebe occidentalis	35	61	44	83	223
Brienomyrus branchistius	58	23	69	94	244
Isichthys henryii	11	29	15	23	78
Gnathonemus petersii	-	-	3	4	7
Total	104	113	131	204	552
Anabantidae					
Ctenopoma kingsleyae	74	51	76	71	292
B. petherici	48	27	56	44	175
Total	122	78	132	115	467
Phractolaemidae					
Phractolaemus ansorgei	121	131	72	97	421
Notopteridae					
Xenomystus nigri	79	38	84	90	291
Papyrocranus afer	7	19	8	6	40
Total	86	57	92	96	331
Channidae					
Parachanna africana	162	94	43	65	364
P. obscura	56	71	17	33	177
Total	218	165	60	98	541
Malapteruridae					
Malapterurus electricus	152	128	139	100	519
Nandidae					
Polycentropsis abbreviate	41	54	68	119	282
Pantodontidae					
Pantodon bucholzi	45	46	61	73	225
Cyprinidae					
Barbus callipterus	31	64	34	88	217
Characidae					
Brycinus longipinnis	35	40	20	40	135
Cyprinodontidae					
Epiplatys sexfasciatus	23	52	27	29	131
Total	2918	2399	1971	2353	9641
Percentage	30.27	24.88	20.44	24.41	100

Table 4: Fishing gear efficiency in River Orogodo

Fish Species	Gil Net	Drag Net	Traditional Traps	Hook and Line	Hand Net
1Erpetoichthys calabaricus	11	570	12	-	-
Pantodon bucholzi	75	150	-	-	-
Papyrocranus afer	20	12	2	6	-
Xenomystus nigiri	121	90	8	72	-
Brienomyrus branchistius	-	155	5	68	21
Hyperopisus bebe occidentalis	-	163	-	46	14
Isichthys henryii	-	70	-	8	-
Gnathonemus petersii	-	7	-	-	-
Phractolaemus ansorgei	178	140	57	46	-
Brycinus longipinnis	40	65	-	19	11
Hepsetus odoe	44	-	20	-	-
Barbus callipterus	-	178	-	-	39
Auchenoglanis biscutatus	380	95	30	16	-
A. occidentalis	395	86	32	31	-
Schilbe intermedius	20	25	5	5	-
Clarias gariepinus	502	190	44	62	-
C. anguillaris	210	80	19	15	-
C. macromystax	425	142	20	18	-
Epiplatys sexfasciatus	-	86	-	-	45
Parachanna Africana	236	-	20	57	51
P. obscura	47	-	16	54	60
Malapterurus electricus	-	280	-	239	-
Polycentropsis abbreviate	60	187	-	-	35
Chromidotilapia guentheri	116	192	10	30	161
Hemichromis fasciatus	171	155	14	30	200
H. bimaculatus	16	74	-	20	24
Oreochromis aureus	-	60	-	-	68
O. niloticus	-	10	-	-	1
Sarotherodon macrocephala	-	8	-	5	-
Tilapia dageti	20	16	-	10	-
T. mariae	71	150	-	29	-
T. zillii	-	171	5	51	26
Mastacembellus leonbegii	-	3	-	-	-
Ctenopoma kingsleyae	182	70	-	20	-
C. petherici	100	55	-	20	-
Gymnarchus niloticus	-	-	-	2	-
Ilisha Africana	1	4	-	-	-
Total	3441	3734	319	979	756
% catch	37.28	40.46	3.46	10.61	8.19
Number of species	24	33	17	26	14

Table 5: Catch per unit effort (CPUE) of the different fishing gears at River Orogodo.

Fish gears	Catch per unit effort (CPUE)
Drag nets	2.42
Gillnets	3.12
Traditional traps	0.72
Hook and line	1.13
Hand nets	0.21

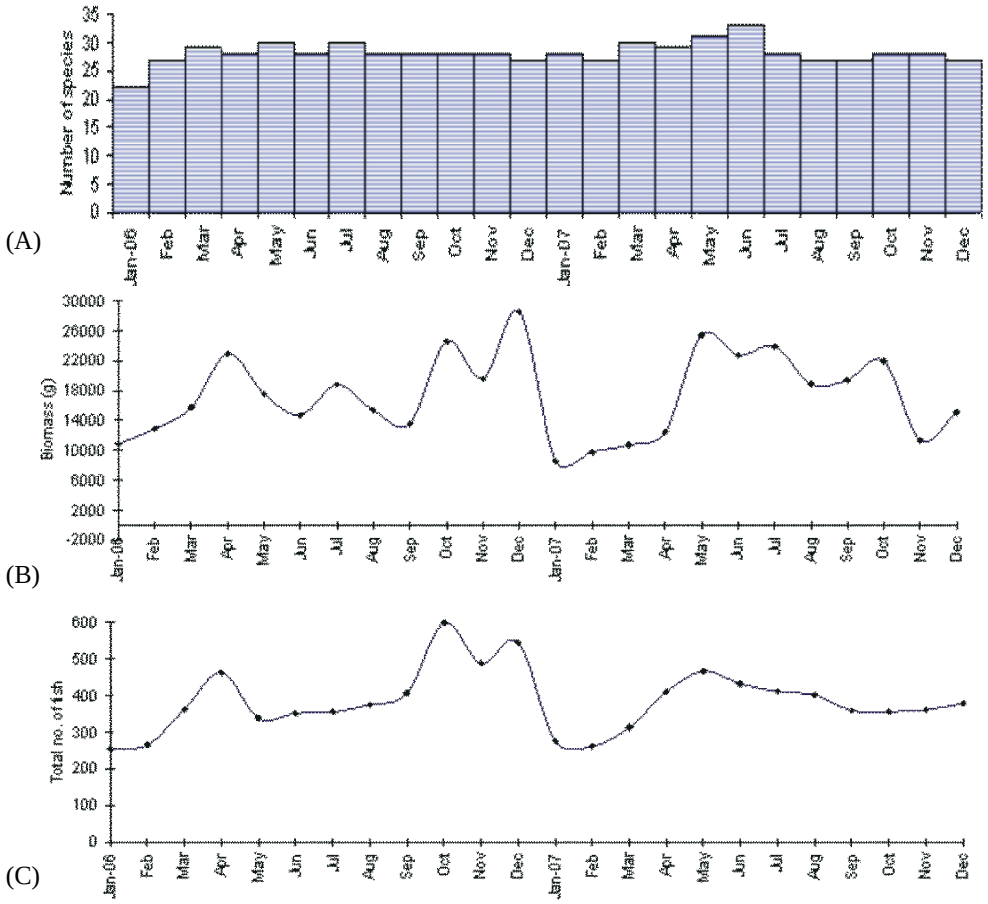

Fig. 2: Monthly variation in (A) number of species, (B) biomass and (C) number of fish caught in River Orogodo, Jan 2006 - Dec 2007.

Seasonal Variations in Abundance among the Fish Families: Table 3 presents the seasonal variations in the numerical abundance of the dominant and subdominant families. Among the dominant families (Cichlidae, Clariidae and Bagridae), the family Cichlidae showed the highest abundance during the rainy seasons of both years. It was closely followed by the family Clariidae, which showed its peak abundance during the dry season of both sampling years. The bagrids had their peak abundance like the cichlids, in the rainy seasons of the two years. The thirty species accounting for 9,641 individuals were caught in both dry and rainy seasons. For all the species, 4,889 (50.7%) individuals were caught during the dry season of both years while 4,752 (49.29%) individuals were caught during the rainy season of both years. Five species, (*Chromidotilapia guentheri, Hemichromis fasciatus, H. bimaculatus, T. zillii, T. mariae*) of the family Cichlidae were caught more during the rainy season than during the dry season. The other species, *T. dageti, Oreochromis aureus, O. niloticus* and *Sarotherodon macrocephala* had varying numerical abundance. The three members of the family Clariidae showed higher abundance during the dry season than the rainy season. Similar trend was also shown by the two species of the family Bagridae.

Fishing Gear Efficiency: Fishing gear efficiency in River Orogodo is shown in Table 4. Drag net caught 40.46% of the total catch and had the highest diversity of 33 out of the 37 species. Quality catches consisted of the Polypterid, *Erpetoichthys calabaricus* (15.01%), the electric catfish, *Malapterurus electricus* (7.22%), the Cichlid, *Chromidotilapia guentheri* (5.21%) and the Clariid, *Clarias gariepinus* (5.15%). Such species as *Hepsetus odoe, Parachanna africana, P. obscura* and *Gymnarchus niloticus* were not caught with drag net. A total of 3,441 individuals or 37.28% comprising 24 out of the 37 species came from the gill net. The best catches of this gear consisted of the family Bagridae, Clariidae and

Channidae. The thirteen species not caught by the gill net were *Brienomyrus branchistius, Hyperopisus bebe occidentalis, Isichthys henryii, Gnathonemus petersii, Barbus callipterus* and *Epiplatys sexfasciatus*. Others include the Cichlids: *Oreochromis aureus, O. niloticus, Sarotherodon macrocephala, Gymnarchus niloticus, Malapterurus electricus, T. zillii* and *Mastacembellus leonbergii*. The hook and line recorded only 998 or 10.81% of the total catch and 26 out of the 37 species.

Table 5 also showed the fish gear efficiency using the catch per unit effort (CPUE) of the various fishing gears used in the study. Gill nets recorded the highest catch per unit effort (3.12), followed by the drag nets with a CPUE value of 2.42. The least CPUE values was recorded by the hand net (0.21) and Traditional traps (0.72).

The best catch from this gear was the electric catfish, *Malapterurus electricus*, which accounted for 239 individuals or 23.95%.

The traditional basket traps caught 319 or 3.46% of the individuals and 17 out of the 37 species in the study area. The catch from this gear consisted mostly of the catfishes (Bagridae and Clariidae) and *Phractolaemus ansorgei* (blood fish). The hand net caught 756 or 8.19% and 14 out of the 37 species recorded in this study. The best catch of this gear include juveniles of the family Cichlidae and Channidae.

DISCUSSION

The fish community of River Orogodo has distinct seasonal variations. The number of individuals and their biomass caught in rainy seasons were more than those obtained in dry seasons. This is to be expected since the high water period is the main feeding and growing time for nearly all species in the seasonal flood plain rivers of the tropics [20, 21, 22 23]. On the other hand, Allison *et al.* [24] observed higher fish abundance in the dry season than the rainy season in Elechi Creek. This was attributed to greater and easier accessibility into the water body for the fishermen during the dry season due to reduced water volume. Out of 37 species of fish caught in River Orogodo, 2 were restricted to the rainy season, while none was restricted to the dry season. However, the contribution of these species to the fish abundance in the river was low.

The remaining 35 species which occurred in River Orogodo both during the rainy and dry seasons seem to be responsible for the observed seasonal variations in abundance. The seasonal variations in the abundance of various species of River Orogodo showed that significantly more individuals were caught in rainy seasons than in dry seasons.

Generally, the fish abundance in River Orogodo increased in the rainy season resulting in high fishing intensity in the river by most full or part time fishermen. A similar trend of high fishing intensity in the rainy season was observed by Idodo-Umeh [25] in River Ase. The high fishing intensity in the river during the rainy season indicates that there is an increase in fish population density and therefore most species could effectively be captured using all types of fishing gears. During this period, many fish species migrate up river as the water rises [20] and it is possible that extensive fish migrations take place between the bigger adjacent Ethiope River and River Orogodo during rainy season hence the presence of such deep water and fast swimming species as *Gymnarchus niloticus* and *Ilisha africana* during this period.

Members of the three dominant families (Cichlidae, Clariidae and Bagridae) were ubiquitous in River Orogodo. Among the family, Cichlidae; *Chromidotilapia guentheri, Hemichromis fasciatus* and *Tilapia mariae* were recorded throughout the study period. These species showed peak abundance in the rainy season. Idodo-Umeh [25] similarly observed an increase in number of the Cichlid, *Tilapia zillii* in River Ase at the onset of the rainy season (May) and affirmed that such increase was associated with the development of marginal vegetation among which it breeds, since this species prefer shallow marginal habitats [26]. During dry season months, the nutrients are depleted, the vegetation dies back and the water level falls at the end of the rainy season causing many fish to move back to the main river [20, 25, 27]. Araoye [13] similarly observed an inverse correlation between water level and fish abundance in Asa dam, Ilorin, Nigeria. The family cichlidae were on the contrary reported to show higher abundance during the dry season in Elechi Creek [24]. The 3 species of Clariidae also occurred more in the dry season than rainy season, while the bagrid catfishes similarly showed higher abundance in the rainy season. Generally, the catfishes particularly the family bagridae have been known to breed during the rainy season from June to October [11] in Lake Kainji. It is possible that the seasonality observed for members of this family in River Orogodo is related to the migratory behaviour associated with breeding and feeding activities. Similarly, Idodo-Umeh [25] caught more of *Chrysichthys nigrodigitatus*, a bagrid, during the rainy season and the high numbers seem to be correlated to high water levels.

Fishing efficiency (or effectiveness) is commonly expressed in terms of numbers or mass of fish captured by a fishing gear in a unit of time. It is also used to express the percentage removal of fish from a stock [28]. There was varying fishing efficiency of the fishing gears used in River Orogodo. The variation in mesh size and gears used may have greatly influenced species diversity and abundance in this study. Backiel [29] attributed size and gear efficiency to the behaviour and distribution of samples. Ufodike *et al.* [15] opined that gear technology and catch period or techniques are essential in maximizing fish catches. Both gill nets and drag nets constituted about 80% of the catch in this study and were dominated mainly by the bagrid, clariid and cichlid species. Similar higher efficiency of gill nets and drag nets was reported by Ikomi and Sikoki [30]. The gill net's high efficiency in terms of number of individuals as well as its catch per unit effort may be connected with the morphoteric projections and presence of scales on most of the fish species which make them easy catch for this gear. Efficiency of gill net is affected by several factors that can influence the catchability of the gear directly and indirectly. Brandt [31] listed some of these factors as the mesh size of the net, visibility, hanging ratio, twine size and exposed net area. In the case of drag net, its very high efficiency may be connected with the heterogeneous mesh sizes of the different panels used in this study; hence fishes with body projections and scales are easily caught. Similarly, the low efficiency of traditional traps, hook and line and hand net agrees with the earlier findings of Ikomi and Sikoki [30] in River Jamieson and Alfred-Ockiya [32] in Kolo Creek. These gears are mostly used by fisherman in the area particularly during the wet season.

CONCLUSION

The seasonal pattern observed in the fish fauna of River Orogodo reflects the response of the different fish species to hydrological changes in the habitat which ultimately influences the entire ecosystem as have been reported in other tropical rivers. Though the different fishing gears showed varying efficiency, the use of multiple gear sampling approach is however recommended as the best way to obtain a comprehensive ichthyofauna samples in the study area.

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