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Research Article

Physico-Chemical Parameters and Ichthyofauna Composition of Oyan Dam Area, Ogun State, Nigeria

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ABSTRACT

The surface water physico-chemical characteristics and ichthyofaunal composition of Oyan Dam and its environment were investigated monthly between December, 2017 and August, 2018. The surface water temperature, pH, Total Dissolved Solids (TDS) were measured in-situ with a portable Hanna TDS/pH meter - (HI9813-6). The Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Phosphate, Nitrate, and Nitrite were determined in the laboratory using standard methods. The monthly total rainfall, relative humidity, and air temperatures were obtained from world weather online/Abeokuta weather. Fish abundance (ichthyofaunal composition) was determined by monitoring and recording the catch from fishermen. The pH ranged between 6.9-8.2, 7.2-8.3, and 7.0-8.2 in Apojola, Dam site, and Ibaro respectively. Highest DO 7.86 mgL^{-1} and lowest 4.2 mgL^{-1} were recorded in the Dam site in April and July. Eighteen fish species belonging to ten families were encountered in the study. The family Cichlidae contains more fish species than any other family. Ichthyofauna species recorded were *Oreochromis niloticus, Tilapia guineensis, Sarotherondon galilaeus, Tilapia mariae, Tilapia zillii, Chrysichthys nigrodigitatus, Sarotherondon melanotheron*. *Chrysichthys nigrodigitatus* was the most abundant (16%) and occurred throughout the sampling period. The least abundant species (0.05%) *Parachanna obscura*, occurred only in December and January. The study revealed that Bagridae represented by *Chrysichthys nigrodigitatus* contributed to the highest number of fish. The physico-chemical parameters are within the range for culturable species. Nigeria can derive a substantial proportion of its fish demand from the Oyan Dam, if private and public sectors were allowed to culture fish in the dam.

Keywords: Cichlidae, Fishing activities, Ichthyofauna, Oyan Dam, Water quality
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INTRODUCTION

Nigeria is a country that can boast of 230 billion cubic meters of water, making it one of the richest countries for fish and aquaculture development, fish markets, and fish consumption (Bolarinwa, 2017). Fish makes up around 40 per cent of Nigeria's intake (Iheke & Nwagbara, 2014) while about 1,477,651 people work as fishermen (FAO, 2018).

Nigeria with an estimated population of about 190 million people requires about 3.2 million metric tonnes of fish and fisheries product for good health at the recommended 19 kg/caput/year by Food and Agriculture Organization (FAO, 2018). However, the national production is about 1.1 million metric tonnes from all sources, including aquaculture, artisanal and industrial fishing sectors, leading to a supply shortfall of about 2.1 million metric tonnes (FAO, 2018).

Nigeria imported over 2 million metric tonnes of fish, however, the Federal government restricted food importation and directed that fish importers should embrace backward integration through commercial aquaculture and this made fish production doubled by 600,000 MT. The deficit in fish supply has led to policy formulation by the Federal government that will enhance more fish production for the nation's increasing human population. Therefore, existing dams will be potential fisheries resources to the Nigerian economy (FAO, 2018). Nigeria can derive a substantial proportion of its fish demand from the Oyan Dam of Ogun State with the adoption of some proffered strategies which include combined efforts of the

private and public sectors in the rational management of the fisheries resources of the dam.

Dam construction alters fish communities both up and downstream of the barrier (Jellyman & Harding, 2012) while Yem *et al*. (2011) reported that changes in water qualities as a result of human activities are also known to affect fish communities. Due to anthropogenic activities and climatic conditions that may have taken place in the dam (UNEP, 2001), obtaining new information about natural production, species composition, distribution and genetic information of fish species within the impoundment, would make it possible to know species of fish that are still thriving and the species that can be farmed successfully. This information will be of benefit to the Fisheries and Aquaculture Value Chain of the Agricultural Transformation Agenda (ATA). It can create an enabling environment for increased and sustainable development of over one million metric tons of farmed table fish. And also, be useful for employment generation for the teeming unemployed Nigerians and a platform towards poverty alleviation.

Ichthyofauna diversity of some lakes in Nigeria (Akinyemi, 1985; Ita *et al.,* 1985; Bankole, 1988; Omotoso, 1998; Ufodike & Zakari,1992; Inyang, 1995) and the fisheries of Oyan Dam (Ikenweiwe *et al*., 2006; Olopade, 2013; Olopade & Rufai, 2014) have been reported in literature. The objectives of this study were to examine the current abundance of the ichthyofauna of Oyan Dam in relation to the physical and chemical parameters of the dam and its environment.

MATERIALS AND METHODS

Description of Study Area

Oyan Dam (Figure 1) is owned and operated by the Ogun-Osun River Basin Development Authority (O-ORBDA) and has a surface area of 4,000 hectares and a catchment area of 9,000 km^2. It is located 7°15' North latitude and 3°16'East longitude at an elevation of 43.3m above sea level on the confluence of Oyan and Ofiki Rivers, both tributaries of Ogun River some 20 km north-west of Abeokuta, close to Badagry-Sokoto Highway (Ofoezie *et al*., 1991; O-ORBDA, 1998). The dam has a crest length of 1044 m, height 30.4 m and gross storage capacity of 270 million m^3 (Ofoezie & Ashaolu,1997).

The dam was commissioned on 29 March, 1983 to supply raw water to Lagos and Abeokuta, for use in irrigation purposes and power generation of 9 megawatts of hydroelectric power which never materialized. The dam also provides fishing ground for adjoining communities, Apojola and Ibaro which are two major fishing villages located in close proximity to the bank of the Oyan Dam. The main occupation of the people living around the dam area is fishing (Olopade & Rufai 2014). Some engaged in farming, trading and sales of sand (Otuneme *et al*., 2014).

Determination of the Physical and Chemical Characteristics of Oyan Dam and its Environment

Physico-chemical parameters were determined monthly from December 2017 to August 2018 at the study areas. The surface water temperature, pH, Total Dissolved Solids (TDS) were measured *in-situ* with a portable Hanna TDS/pH meter - (HI9813-6). The Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Phosphate, Nitrate, and Nitrite were determined in the laboratory from the water samples collected in sample bottles from the three studied sites. The monthly mean minimum and maximum total rainfall, relative humidity and air temperatures were obtained from world weather online/Abeokuta weather from December 2017 to August 2018.

Collection and Identification of Fishes

Fish samples were collected between December 2017 to August 2018 from the catches of artisanal fishermen using cast and gill nets of different mesh sizes ranging from 30 mm to 120 mm in Apojola, Oyan Dam site, and Ibaro. Species of the different catches were counted to obtain the number of individual species from the fishermen. The collected species were kept in sterile polythene bags, stored in an ice chest and transported to the Department of Marine Sciences Laboratory, University of Lagos for identification using Idodo-Umen (2003), Daget (1991) and Holden & Reed (1991).

Statistical Analysis

The data obtained were statistically evaluated using the one-way analysis of variance (ANOVA).The data included means and standard deviations of the values obtained from the three (3) sampled sites. A comparison of means was done using Duncan's Multiple Range Test (DMRT) to test the level of significant.

RESULTS

Results of the monthly Physico-chemical parameters of the Oyan Dam are shown in Table 1. The pH of the water ranged between 6.9 and 8.2 in Apojola, 7.2 and 8.3 in the Dam site, 7.0-8.2 in Ibaro.

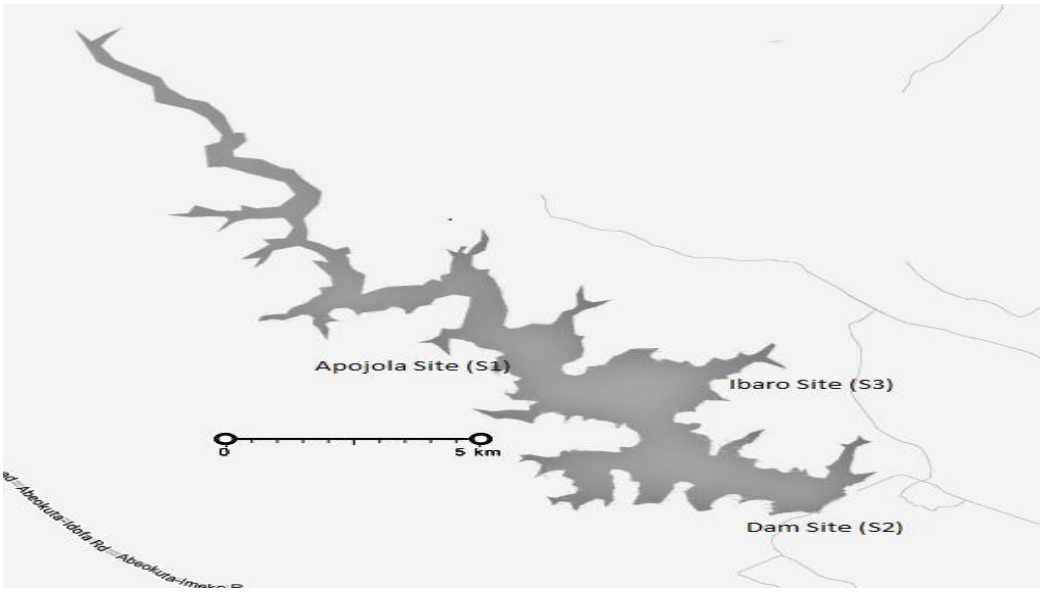

Figure 1: Oyan Dam, Ogun State, Nigeria showing study sites

Table 1: The monthly physico-chemical parameters of the Oyan dam and its environment

Month	Location/Site	pH	DO mg/l	TEMP (^oC)	Salinity (ppt)	TDS-mg/mL	BOD-mg/l	COD-mg/l	PO_4^- mg/l	NO_3^- mg/l	NO_2^- mg/l
17-Dec	Apojola	8.2	6.84	31.6	0.05	81.7	8.2	11.3	0.59	2	0.02
	Dam Site	8.1	7	31.6	0.05	81.3	8.1	11.7	0.62	1.7	0.08
	Ibaro	8.2	7.3	31.7	0.05	81.7	8.2	11.3	0.67	1.2	0.01
18-Jan	Apojola	7.9	6.81	31.6	0.04	62	3.3	12.7	0.89	2.3	0.01
	Dam Site	8.3	6.8	31.6	0.06	124.3	2.7	11.7	0.33	2	0.00
	Ibaro	7.7	6.78	32	0.07	122	4.1	12	0.09	1.3	0.00
18-Feb	Apojola	7.4	6.6	32.2	0.04	64.3	4.4	11	0.83	1.1	0.12
	Dam Site	7.5	6.5	32.1	0.04	64.3	3.5	10.7	0.84	1.1	0.14
	Ibaro	7.3	6.53	32.3	0.06	78.3	3.3	8	0.43	0.5	0.01
18-Mar	Apojola	8	7.27	33.5	0.05	71	3.9	9.7	0.47	2.4	0.01
	Dam Site	7.6	7.1	34.1	0.04	60.8	3.5	9.3	0.33	2.9	0.01
	Ibaro	7.7	6.95	32.3	0.05	65.6	3.9	9.7	0.3	2.0	0.01
18-Apr	Apojola	6.9	7.84	33.2	0.06	76.3	3.3	11.7	0.89	1.2	0.10
	Dam Site	7.2	7.86	32.7	0.06	82.3	3.5	17.3	0.73	1	0.11
	Ibaro	7	7.84	32.7	0.06	76.7	3.2	9.3	0.46	0.7	0.06
18-May	Apojola	8.1	7.84	32.5	0.05	80.7	6.7	12.7	0.54	1.3	0.12
	Dam Site	8.1	8	32.2	0.04	86.7	3.6	16.3	0.5	1.2	0.12
	Ibaro	8.1	6.95	24.5	0.04	71.3	4.1	11	0.47	1.2	0.12
18-Jun	Apojola	8	5.5	33.9	0.05	78.7	4.6	11.7	0.5	1.2	0.09
	Dam Site	7.6	5.81	32.6	0.05	81.3	3.3	12.7	0.53	1.2	0.02
	Ibaro	7.7	5.3	32.4	0.05	67.3	4.5	14.7	0.51	1.1	0.09
18-Jul	Apojola	7.8	4.33	27.8	0.06	79.3	3.8	12.3	0.56	1.2	0.15
	Dam Site	7.9	4.2	27.8	0.05	80.7	3.5	14.3	0.5	1.3	0.05
	Ibaro	7.7	4.88	27.3	0.05	87.3	4.7	12	0.5	1.4	0.01
18-Aug	Apojola	7	5.72	27.8	0.05	75.7	4.3	11	0.51	1.5	0.01
	Dam Site	7.1	6.1	27.7	0.05	67.3	3.4	15.7	0.49	1.4	0.01
	Ibaro	7.3	5.1	28.1	0.06	69.3	4.4	12	0.54	1.3	0.00

The highest DO of 7.86mgL^{-1} and lowest of 4.2mgL^{-1} were recorded in the Dam site in April and July of the sampling period respectively. The mean Physico-chemical parameters of the three sampling stations are shown in Table 2. There was no significance difference P>0.05 in the mean values of pH, Dissolved Oxygen (DO), water temperature, salinity, Total Dissolved Solid (TDS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and nitrite recorded in the three sites, Apojola, Dam site and Ibaro during the period of study. However, there was a significant difference (p<0.05) in the mean values of phosphate in the three sampling sites. The mean nitrate values obtained in Apojola and Dam site showed no significant difference (p>0.05) but there was a significant difference (p<0.05) in the mean value obtained in the Ibaro sampling site compared to Apojola and Dam site.

The monthly variation in total rainfall and relative humidity of Oyan Dam and its environment is presented in Table 3. The data showed that a low amount of rainfall was recorded in January (0.7 mm) and rained for 2 days during the month. The highest rainfall recorded was in July (362.9 mm). It was observed that there was rainfall throughout the sampling period. The range of the relative humidity around the Oyan Dam and its environment was 50% in January to 86 % in July of the sampling period. During the sampling periods of December 2017 to August 2018, the minimum and maximum air temperature ranged from 21 ^{o}C to 26^{o}C (Mean = 24.44 ^{o}C) and 29-39 ^{o}C (Mean = 34.67 ^{o}C) respectively. The average low temperature was observed in June, July, and August (Table 4).

The fish species identified in the Oyan Dam and its environment are presented in Table 5. Ten (10) families comprising of eighteen (18) species were recorded. The family with the most abundant fish species was the Cichlidae (Table 6). Seven species recorded throughout the sampling period were *Oreochromis niloticus, Tilapia guineensis, Sarotherondon galilaeus, Tilapia mariae, Tilapia zillii, Chrytsichthys nigrodigitatus* and *Sarotherondon melanotheron.* The remaining eleven species were recorded in some of the sampling months, while *Oreochromis aureus* was observed in the samples collected in March, April and August. *Heterotis niloticus* was collected in all the sampling periods except in February. *Clarias gariepinus* was not observed in February, May, June, and July. *Hemichromis fasciatus* was not recorded in February, March, and July. *Mormyrus rume, Mormyrus tapirus*, and *Parachanna obscura* were recorded in December and January. *Mormyrus rume* was also observed in samples collected in August. *Lates niloticus* was observed in the samples collected in December, January, April, and May. *Alestus macrolepidotus, Eutropius niloticus, Synodontis nigrita* were observed in samples collected only in February.

The most abundant species recorded during the studied period was *C. nigrodigitatus* (Table 7) this species had the highest number and occurred in all the samples collected from the fishermen throughout the sampling period. The least abundant species was *P. obscura*, this species occurred only in December and January. There was a significant difference (p<0.05) in the Physico-chemical parameters and *C. nigrodigitatus*. Significance difference (p<0.05) was also observed between the BOD and *P. obscura*.

Table 2: Mean physico-chemical parameters of water samples from the Oyan dam and its environment.

Parameters	Apojola	Dam site	Ibaro
pH	7.69 ± 0.09^{a}	7.64 ± 0.08^{a}	7.69 ± 0.08^{a}
DO	6.53 ± 0.21 ^{a}	6.58 ± 0.22 ^{a}	6.41 ± 0.20 ^{a}
Temp	31.57 ± 0.42^{a}	31.40 ± 0.41 ^{a}	30.36 ± 0.55 ^{a}
Salinity	0.05 ± 0.01 ^{a}	0.05 ± 0.01 ^{a}	0.05 ± 0.01 ^{a}
TDS-mg/L	74.41 ± 1.43 ^{a}	81.02 ± 3.47 ^{a}	79.96 ± 3.28^{a}
BOD-mg/L	4.77 ± 0.31 ^{a}	3.90 ± 0. 31 ^{a}	4.50 ± 0.28 ^{a}
COD-mg/L	11.44 ± 0.35 ^{a}	13.30 ± 0.57^{b}	11.11 ± 0.45 ^{a}
Phosphate	0.64 ± 0.07 ^{b}	0.54 ± 0.06 ^{ab}	0.43 ± 0.04 ^{a}
Nitrate-mg/L	1.58 ± 0.11 ^{b}	1.53 ± 0.12 ^{b}	1.19 ± 0.09 ^{a}
Nitrite-mg/L	0.07 ± 0.01 ^{a}	0.06 ± 0.01 ^{a}	0.04 ± 0.01 ^{a}

Table 3: monthly variation in total rainfall and relative humidity (%) of Oyan dam and its environment

Month	Rain Days	Rain (mm)	Relative Humidity (%)
December '17	11	17.2	57
January'18	2	0.7	50
February'18	15	108.8	61
March'18	25	25.0	65
April'18	24	51.0	68
May'18	25	173.8	73
June'18	27	216.5	78
July'18	30	362.9	86
August'18	31	314.8	85

Table 4: The monthly air temperature (^{o}C) in the Oyan dam and its environment

Month	Minimum	Maximum	Mean
December'17	25	38	33
January'18	24	39	33
February'18	26	38	33
March'18	26	36	32
April'18	26	36	32
May'18	25	35	31
June'18	24	32	29
July'18	23	29	27
August'18	21	29	26

Table 5: Fish species identified in Oyan dam and its environment

	Fish Species																	
Sampling months	*Oreochromis niloticus*	*Tilapia guineensis*	*Sarotherondon galilaeus*	*Oreochromis aureus*	*Tilapia mariae*	*Tilapia zillii*	*Heterotis niloticus*	*Chrysichthys nigrodigitatus*	*Clarias gariepinus*	*Sarotherondon melanotheron*	*Hemichromis fasciatus*	*Mormyrus rume*	*Mormyrus tapirus*	*Lates niloticus*	*Parachanna obscura*	*Alestes macrolepidotus*	*Eutropius niloticus*	*Synodontis nigrita*
17-Dec	√	√	√	x	√	√	√	√	√	√	√	√	√	√	√	x	x	x
18-Jan	√	√	√	x	√	√	√	√	√	√	√	√	√	√	√	x	x	x
18-Feb	√	√	√	x	√	√	x	√	x	√	x	x	x	x	x	√	√	√
18-Mar	√	√	√	√	√	√	√	√	√	√	x	x	x	x	x	x	x	x
18-Apr	√	√	√	√	√	√	√	√	√	√	√	x	x	√	x	x	x	x
18-May	√	√	√	x	√	√	√	√	x	√	√	x	x	√	x	x	x	x
18-Jun	√	√	√	x	√	√	√	√	x	√	√	x	x	x	x	x	x	x
18-Jul	√	√	√	x	√	√	√	√	x	√	x	x	x	x	x	x	x	x
18-Aug	√	√	√	√	√	√	√	√	√	√	√	√	x	x	x	x	x	x

√ = Present; X = Absent

Table 6: Frequency of occurrence of fish species family obtained in the Oyan Dam and its environment

Family	Occurrence	Percentage frequency
Cichlidae	8	44.44
Mormridae	2	11.11
Arapaimidae	1	5.55
Claroteidae	1	5.55
Clariidae	1	5.55
Latidae	1	5.55
Channidae	1	5.55
Alestidae	1	5.55
Schilbeidae	1	5.55
Moichokidae	1	5.55
Total	18	99.99

Table 7: Relative fish species abundance (%) obtained in the Oyan dam

Fish species	Total collected	Percentage (%)
Oreochromis niloticus	2895	10.36
Tilapia guineensis	3827	13.69
Sarotherondon galilaeus	2438	8.72
Oreochromis aureus	1331	4.76
Tilapia mariae	3379	12.09
Tilapia zillii	2945	10.54
Heterotis niloticus	1492	5.34
Chrtsichthys nigrodigitatus	4472	16
Clarias gariepinus	281	1.01
Sarotherondon melanotheron	3252	11.64
Hemichromis fasciatus	434	1.55
Mormyrus rume	23	0.08
Mormyrus tapirus	51	0.18
Lates niloticus	58	0.21
Parachanna obscura	13	0.05
Alestes macrolepidotus	308	1.1
Eutropius niloticus	550	1.97
Synodontis nigrita	200	0.72
Total	27949	100

DISCUSSION

The pH 6.9 and 8.2 (7.67± 0.05) of the water samples obtained in this study was almost similar to that (6.6 to 8.3) (mean 7.4 ± 0.43) reported by Ayoade *et al*. (2006) on the same dam. Throughout the sampling period, the water was not acidic at the three sites, Apojola, Dam site, and Ibaro. The pH of the three sites was not significantly different ($p>0.05$) from each other and during the sampling period. The pH value also falls within the WHO permissible standard of 7.0 to 8.50 (WHO, 2005). The pH obtained in this study showed that the water in the Oyan Dam and its environment is suitable for fish farming and other aquatic organisms.

The dissolved oxygen (DO) values of the three sampling sites in Oyan Dams and its environment did not show any significant difference ($p>0.05$). There was no seasonal variation observed in the DO values. The DO obtained during the sampling period was suitable for the growth of aquatic organisms and is slightly lower (6.51 ± 0.12) mgL^{-1} than the value (7.1±

0.96) mgL^{-1} reported by Ayoade (2006). The values reported in this study could be due to nutrient enrichment of the water body because of the various culturing of fish in cages taken place in the Dam site, which could consequently encourage growth of algae.

The temperature of the sites where samples were collected showed no significant difference ($p>0.05$). The surface water temperature of the dam and its environment ranged between 26-33 ^oC. This value was higher than the range of 24-31.5 ^oC reported by (Ayoade, 2006). This may be due to the high air temperature of the surrounding of the dam, which can be as a result of global warming that is observed worldwide. The temperature recorded in this study falls within the value of optimum temperature of about 28^oC required for fish growth.

The lowest relative humidity was recorded in January. Ayoade (2006) also recorded low relative humidity in the dry season and attributed this to the thicker cloud cover during the raining season. Heavy rainfall was observed in May, June, July, and August during the sampling periods. In these months, rain fell every day, though there was variation in the amount of rain. Ayoade (2006) further stated that rainfall also influences the amount of discharge into river and consequently into dam and that due to the effects of rainfall on water level and physico-chemical parameters of dams, the differences observed in amount and duration of rainfall may cause differences in physico-chemical parameters which will affect fish growth and production.

There were no significant differences ($p>0.05$) in the mean values of pH, DO, water temperature, salinity, TDS, BOD, COD, and nitrite recorded in the three sampling sites, Apojola, Dam site, and Ibaro during the period of study. There was, however, a significant difference ($p<0.05$) in the mean values of phosphate in the three sampling sites. The mean nitrate values obtained in Apojola and Dam site showed no significant difference ($p>0.05$) but there was a significant difference ($p<0.05$) in the mean value obtained in Ibaro compared to Apojola and Dam site. At the Dam site, there were private fish farmers that rear fish in cages, the fish were fed with compounded feeds. The feeds may contain nitrates and phosphates, these elements may also be added to the water to fertilize the dam. These elements are plant nutrients and can cause plant life and algae to grow quickly in a body of water. The plants and algae can act as natural feeds for the farmed fish in the dam. The results of this study showed that the family Cichlidae are more abundant in the dam.

The number obtained in this study was higher than the number reported by Olopade (2013) and Ikenweiwe *et al*. (2007). Olopade (2013) stated that the number of species will vary depending upon differences in the sampling methods and sampling effort, as well as fish abundance. Among the cichlids, the most abundant is *T. guineensis*, other species that were also abundant include, *Oreochromis niloticus, Sarotherondon galilaeus, Tilapia mariae, Tilapia zillii*. They were said to be particularly known to evolve rapidly into a large number of closely related but morphologically diverse species within large lakes (Meyer, 2005). Tilapia generally differs greatly in size and taxonomic group (Olojo *et al*., 2003) and are widely distributed throughout natural (Fagade & Olaniyan, 1973) and artificial water reservoirs in tropical and temperate regions of the country (Morales, 1991). The group consists of three important genera namely *Oreochromis, Sarotherodon* and *Tilapia*.

A total of 29 mormyrid species have been described in the Nigerian freshwaters (Adesulu & Sydenham, 2007). In this study only 2 species were recorded, Olopade (2013) reported 6 species belonging to the family Mormyridae, while Ita (1993) reported 8 species in the same water body. The difference in the species and the quantities of the catch obtained may be as a result of the sampling periods, fishing gear and the catches obtained from the fishermen. Olopade (2013) attributed the limited number to factors related to the fishing gear deployment. Holden and Reed (1991) however, stated that the majority of the species have slender bodies and spines and they are difficult to catch with most normal types of fishing gears and therefore, they make up only a small part of the commercial catches.

In this study, *Mormyrus tapirus* had a higher number than *Mormyrus rume*, while Olopade (2013) reported *M. rume* as the most abundant species of the family Mormyridae in Oyan Dam, the difference could be due to different sampling sites. A decline in Mormyrids was noted for the Niger River after the creation of Kainji Lake in Nigeria (Blake, 1977). The most abundant species in terms of number was *Chrysichthys nigrodigitatus*, this species also occurred throughout the sampling period. This could be due to many factors such as habitat variation, substrate nature, dam site and whether the dam is open or closed.

The Physico-chemical parameters of the Oyan Dam and its environment fall within the range that can support aquaculture and the species recorded can survive in the water body. Therefore, Nigeria can derive a substantial proportion of its fish demand from

the Oyan Dam of Ogun State by allowing culturing of the species recorded in this study to increase fisheries resources of the dam.

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