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POLLUTION STATUS AND FISH ASSEMBLAGE OF EKOLE RIVER, BAYELSA STATE, NIGERIA

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ABSTRACT

Nigeria's aquatic ecosystems are currently under threat of localized or widespread physical, organic, and biological pollution. Therefore, the relationship between pollution status of water bodies and fish assemblage was investigated for Ekole river in the Niger Delta, Nigeria. This was done to gauge the seasonality of the pollution status of this important rivers and the effect it has on fish assemblage patterns. This is critical to forestall further pollution and safeguard food security. Sampling was done monthly for one year for physicochemical parameters from three sampling points on Ekole river. Physicochemical samples were analyzed for Dissolved oxygen (DO), Biochemical oxygen demand (BOD_5), Temperature, Alkalinity, Electrical conductivity (EC) and pH using standard procedures. Fish samples were also collected monthly from fish landing points from fishers, counted and identified using standard keys. Data were analyzed for means and standard deviations. T-test was employed to check for similarities and variations between seasonal physicochemical parameters in the river system. Analysis was aided by the use of SPSS® version 20.0 software tool kit. Result show that there are no significant seasonal differences ($P>0.05$) in, BOD_5. However, there are significant differences ($P<0.05$) in pH, DO, Temperature, Alkalinity and EC in the river. All physicochemical parameters of the river were within the international permissible limit. Fish data show that Ekole river has 20 families (29 species) with 12,406 individuals. The distribution and abundance of fish in Ekole river show that the wet season (6,740) has a greater species abundance than the dry (5,666) season. The families Cichlidae, Claridae, and Cyprinidae were the most dominant family in the river body. Based on the findings of this study, the water body is not under any immediate threat of pollution. It can be concluded that river system has acceptable water quality characteristics and healthy fish assemblage patterns.

1.0. INTRODUCTION

Water quality plays a critical role in determining the sustainability and productivity of aquatic ecosystems, especially in relation to fish production. The physicochemical parameters of water such as temperature, pH, dissolved oxygen (DO), turbidity, conductivity, and nutrient levels directly influence fish distribution, growth, reproduction, and survival. Globally, the increasing degradation of water quality due to anthropogenic activities, including industrial discharge, agricultural runoff, and urbanization, has heightened concerns about its implications for fisheries. This is particularly evident in developing countries like Nigeria, where inland water bodies serve as critical resources for livelihoods and food security.

In the Niger Delta region, where rivers and estuaries serve as important fishing grounds, the interplay between water quality and fish catch is particularly pronounced. Rivers such as the Bonny and Warri have been subjected to significant anthropogenic pressure, resulting in deteriorating water quality and declining fisheries productivity ([1], [2]). Such trends threaten not only the livelihoods of artisanal fishers but also the overall ecological balance of these water bodies. There is verifiable evidence that pollution of water bodies results in Regime shift in fish catch assemblage. Regime shift in fish catch assemblage from most polluted water bodies in the Niger Delta is a direct consequence of aquatic pollution.

As most water bodies in the Niger Delta are exposed to the risk of pollution, there is an acute societal need to investigate the fish assemblage of threatened water bodies such as the Ekole river exposed perennially to pollution.

This study aims to address this research gap by investigating the effect of water quality parameters on fish landing in Ekole river which has received little research attention, when compared to other rivers, lakes and reservoir in Nigeria. This research therefore, becomes necessary because, it seeks to provide preliminary data on the fishers' catch composition and relative abundance of the species for an effective management and sustainable utilization of the fishery resources in the study area.

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Plate 1: Landing Canoes Conveying Fish in Ekole river

2.0. MATERIALS AND METHODS

2.1. Study Area: The study area is at Ekole river spanning and extending from Swali axis to Agbura area. Three stations were identified and used for collection of samples for the study. The coordinates of the stations of the rivers are represented in Tables 1.

Table 1: Coordinates of Sample Stations in Ekole River, Bayelsa State

S/N	STATIONS	LATITUDE	LONGITUDE	ALTITUDE(M)
1	Station 1	$N4^{0}55'46.165''$	$E6^{0}14'14.46''$	1.5
2	Station 2	$N4^{0}55'36.287''$	$E6^{0}6'22.56''$	1.0
3	Station 3	$N4^{0}55'41.41''$	$E6^{0}6'22.53''$	1.5

2.2 Collection of Physicochemical Samples

Triplicate sub-surface water samples were collected monthly for 12 months from three (3) sampling points from Ekole river using empty plastic bottles. Sample bottles were dipped into the water to a depth of 20 – 30cm below the water surface and held to fill gradually before being removed and corked.

Collected samples were then marked/coded to represent the specific sampling point and then sent to the Department of Chemical Sciences, Laboratory, Niger Delta University, Wilberforce Island for analysis.

2.2.1 Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (D0)

Dark labeled reagent bottles were used to collect water samples from the sampling stations. BOD and DO samples were collected by completely immersing the bottles into the water and then allowed to fill. 2mls each of Winkler I and Winkler II reagents were added to the DO sample bottles and then shaken to mix properly and then corked. BOD samples were stored in dark containers and then transported to the laboratory and kept for five days before fixing with Winkler I and Winkler II reagents.

2.3 Collection of Fish Samples

Fish samples were obtained (procured) monthly for 12 months from fishers at the landing points or jetties early in the morning from Ekole river.

Fish landing points at Swali and Agbura axis in the Ekole river served as the major collection points for the river system.

2.4 Analysis of Samples

2.4.1 Physicochemical Analysis

Analysis for Dissolved oxygen (DO), Electrical conductivity (EC), pH, Alkalinity, Turbidity and Temperature were done in the laboratory using standard procedures [3].

2.4.2 Identification and Enumeration of Fish Samples

Identification of fish species was done using standard keys provided by Olaosebikan & Raji, [4]. Enumeration of the fish was done by manual counting from the stock of landed fish obtained from fishers arriving from their fishing expedition.

2.5 Statistical Analyses

Means and standard deviations were calculated for all physicochemical parameters in all sample stations. T-test was

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employed to check for similarities and variations between seasonal physicochemical parameters in the river systems. Analysis was aided by the use of SPSS® version 20.0 software tool kit.

3.0 RESULT

Table 2 shows the seasonal physicochemical parameters,

Table 2: Mean seasonal physicochemical parameters of Ekole River.

Parameters	Dry Season	Wet Season
Ph	$5.62^{a} \pm 0.24$	$5.87^{b} \pm 0.34$
DO (mg/l)	$5.55^{a} \pm 0.23$	$6.27^{b} \pm 0.50$
Temperature (^{0}C)	$27.93^{a} \pm 0.64$	$26.66^{b} \pm 0.80$
BOD_5 (mg/l)	$2.65^{a} \pm 0.28$	$2.31^{a} \pm 0.26$
Alkalinity (mg/l)	$53.38^{a} \pm 1.34$	$50.04^{b} \pm 2.59$
EC (ms/m)	$52.45^{a} \pm 2.23$	$49.14^{b} \pm 1.29$

Data represents Means± Standard deviation. Means with the same letter superscript (a,b) of the same parameter are not significantly different.

Table 3 shows the Diversity, Distribution &Abundance of fish in Ekole River.

Table 3: Diversity, Distribution &Abundance of fish in Ekole River.

S/N	FAMILY	SCIENTIFIC NAME	EKOLE RIVER
1	Claridae	*Clarias gariepinus*	2567
2	Claridae	*Clarias anguillaris*	678
3	Claridae	*Herterobranchus bidorsalis*	1002
4	Cyprinidae	*Labeo rosae*	223
5	Cyprinidae	*Hampala macrolepidata*	450
6	Cyprinidae	*Barbus enema*	231
7	Cichlidae	*Oreochromis niloticus*	2678
8	Cichlidae	*Pseudotolithus senegalensis*	1222
9	Cichlidae	*Pelvicachronis pulcher*	300
10	Synodontidae	*Synodontis nigritta*	345
11	Synodontidae	*Synodontis gobroni*	123
12	Lutjanidae	*Trachinotus teraia*	248
13	Lutjanidae	*Lutjanus dentatus*	87
14	Gymnacidae	*Gymnarchus niloticus*	289
15	Claroteidae	*Chryscththes nigrodigitatus*	344
16	Protopteridae	*Protopterus annectens*	56
17	Ariidae	*Synodontis schall*	34
18	Carangidae	*Parachanna Africana*	567
19	Carangidae	*Paranchanna obscura*	43
20	Eleotridae	*Eleotris vitata*	56
21	Polynemidae	*Liza falcipinnis*	43
22	Mugilidae	*Mugil curema*	90
23	Soleidae	*Mastacembelus docorsei*	6
24	Tetradontidae	*Tetraodon lineatus*	44
25	Anabantidae	*Ctenopoma petherici*	12
26	Gobiidae	*Polydactylus quadrifilis*	43
27	Monodactylidae	*Monodactylus sabae*	212
28	Mormyridae	*Marcusenius greshoffi*	324
29	Citharinidae	*Citharinus gibbosus*	89
	TOTAL		12,406

Table 4 show the Seasonal Diversity, Distribution &Abundance of fish in Ekole River

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Table 4: Seasonal Diversity, Distribution &Abundance of fish in Ekole River

S/N	FAMILY	SCIENTIFIC NAME	WET SEASON	DRY SEASON
1	Claridae	*Clarias gariepinus*	1367	1200
2	Claridae	*Clarias anguillaris*	392	286
3	Claridae	*Herterobranchus bidorsalis*	522	480
4	Cyprinidae	*Labeo rosae*	123	100
5	Cyprinidae	*Hampala macrolepidata*	240	210
6	Cyprinidae	*Barbus enema*	131	100
7	Cichlidae	*Oreochromis niloticus*	1357	1321
8	Cichlidae	*Pseudotolithus senegalensis*	622	600
9	Cichlidae	*Pelvicachronis pulcher*	160	140
10	Synodontidae	*Synodontis nigritta*	225	120
11	Synodontidae	*Synodontis gobroni*	63	60
12	Lutjanidae	*Trachinotus teraia*	128	120
13	Lutjanidae	*Lutjanus dentatus*	47	40
14	Gymnacidae	*Gymnarchus niloticus*	159	130
15	Claroteidae	*Chryscththes nigrodigitatus*	222	122
16	Protopteridae	*Protopterus annectens*	36	20
17	Ariidae	*Synodontis schall*	20	14
18	Carangidae	*Parachanna Africana*	367	200
19	Carangidae	*Paranchanna obscura*	30	13
20	Eleotridae	*Eleotris vitata*	26	30
21	Polynemidae	*Liza falcipinnis*	23	20
22	Mugilidae	*Mugil curema*	60	30
23	Soleidae	*Mastacembelus docorsei*	6	0
24	Tetradontidae	*Tetraodon lineatus*	22	22
25	Anabantidae	*Ctenopoma petherici*	7	5
26	Gobiidae	*Polydactylus quadrifilis*	23	20
27	Monodactylidae	*Monodactylus sabae*	112	100
28	Mormyridae	*Marcusenius greshoffi*	200	124
29	Citharinidae	*Citharinus gibbosus*	50	39
	TOTAL		**6,740**	**5,666**

Table 5 below show the species richness of fish in Ekole River. The percentage of species richness show that the family Cichlidae (10.34%), Claridae (10.34%), Cyprinidae (10.34%) > Carangidae (6.89%), Lutjanidae (6.89%), Synodontidae (6.89%) > Mormyridae (3.44%), Citharinidae (3.44%), Monodactylidae (3.44%), Gymnacidae (3.44%), Claroteidae (3.44%), Protopteridae (3.44%), Ariidae (3.44%), Eleotridae (3.44%), Polynemidae (3.44%), Mugilidae (3.44%), Soleidae (3.44%), Tetradontidae (3.44%), Gobiidae (3.44%).

Table 5: Percentage Species richness in Ekole River

S/N	Family	No. of Species	Percentage Occurrence (%)
1	Cichlidae	3	10.34
2	Claridae	3	10.34
3	Carangidae	2	6.89
4	Lutjanidae	2	6.89
5	Cyprinidae	3	10.34
6	Synodontidae	2	6.89
7	Mormyridae	1	3.44
8	Citharinidae	1	3.44
9	Monodactylidae	1	3.44
10	Gymnacidae	1	3.44
11	Claroteidae	1	3.44
12	Protopteridae	1	3.44
13	Ariidae	1	3.44
14	Eleotridae	1	3.44
15	Polynemidae	1	3.44

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16	Mugilidae	1	3.44
17	Soleidae	1	3.44
18	Tetradontidae	1	3.44
19	Anabantidae	1	3.44
20	Gobiidae	1	3.44
	TOTAL	29	100

Table 6: International Permissible Limits of Physicochemical Parameters of Water

PARAMETERS	WHO	SON	EPA
pH	6.5 – 7.5	6.5-8.5	6.5-8.5
TEMPERATURE (^{0}C)	25	Ambient	NS
EC (ms/m)	1500	1000	4.7-5.8
ALKALINITY (mg/l)	600	-	-
DO (mg/l)	15	NS	NS
BOD (mg/l)	10	NS	NS
SO_4 (mg/l)	200	100	250
PO_4 (mg/l)	0.5	0.01-0.03	NS

Adapted from WHO [5], SON [6] and USEPA [7].

3.2 Discussion of Result

The study investigated the connect between the physicochemical parameters of surface water of Ekole river and the fish assemblage over a period of one year. The physicochemical variables evaluated are temperature, pH, dissolved oxygen (DO), electrical conductivity, alkalinity and biochemical oxygen demand (BOD_5). The result of the study demonstrates variations among the physicochemical attributes between seasons of the water body. Some of the results obtained are in conformity with the works of previous scholars [8], [9] and [10]. while others are in disagreement with the works of other scholars done even on the same river at an earlier time and other rivers in the Niger Delta and diaspora.

In Ekole river, pH values range from 5.62 to 5.87 in the dry to wet season. Wet season values are greater than dry season values This finding is in disagreement with the findings of Alagoa and Wokoma [11] who observed greater acidity and lower pH values in the wet season compared to the dry season of Taylor creek, Bayelsa State.

On fish assemblage, this study recorded that Ekole river has 29 species with 12,406 individuals. The result of this study showed reduced fish diversity when compared to the amount recorded in the Nun river as observed by Alagoa et al [12]. This reduction may be as a result of changes in flood patterns and anthropogenic inputs over time. Changes in species composition are commonly observed during flooding which affects fish landings through movement and changes in fish migration [13]. Also, rapid freshwater inflow can carry organisms from upstream reaches into estuaries and creeks, up to several kilometers offshore [14]. Bayelsa state where these water bodies are situated have been epicenter of the recent national annual floods experienced in Nigeria since 2012. The decline in fish landings or catch is a major global problem leading to a collapse of the fishing industry and loss of livelihood in most affected countries [15].

However, the result of this study is significantly higher than those obtained by Onuoha et al [16] which recorded 26 fish species belonging to 7 families during the study of Ntakinyang stream. Also, Ita and Mohammed [17] reported low fish densities and diversity in twelve reservoirs in Kano state and also the dominance of Tilapia and Clarias species resulting from advanced stages of environmental degradation in these reservoirs.

In addition, the result of fish catch recorded in this study is still significantly higher that the diversity of 9 families and 7 fish species in Imo River at Owerri-Nta in artisanal fisheries assessment and 5 families and 7 species in Kontaroga reservoir, reported by Okereke [18] and Ibrahim et al [19].

The variation in number of fish species and families in the fisher's catch across different water bodies could be attributed to fishing methods and gear selectivity, which could also be as a result of fish size and target species. However, this could not have been a reason in this study as the fishers adopted the same fishing techniques and similar gear usage as in most other water bodies. The distribution of the fish species could also depend upon the biotic and abiotic factors of the ecosystem including rainfall ([20], [21]), volume of river discharge and surface area of river basin ([22], [23]), hydrographic heterogeneity-mean depth, water level fluctuations, morphometric features and nature of the river bottom and pollution status [22].

The distribution and abundance of fish in Ekole river reveal that the wet season (6,740) has a greater species abundance than the dry (5,666) season. Therefore, the amount of fish caught in the river body showed seasonal variations. This trend has also been observed by Abdul [24] who observed a significant increase in the number of fishing effort during the wet season. One reason for this observation may be that fishes are believed to returned from the marginal vegetation where they hide until during the stormy rains in wet season, when water depths are high, attracted more

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fishermen to fish and thus the increased number of fish catch observed in this study.

Also, during the wet season, factors such as flooding, food (detritus) and other conditions including water current, pH and temperature changes essentially affect and improve the survival of fish [25]. Seasonal abundance of fish species has been reported to be influenced by a combination of physico-chemical properties and the presence of food items [26]. However, the findings of this study is in disagreement with the observations of Olufayo and Adebisi [27] in their study of seasonal variations in water quality parameters and fish Catch in Kainji Lake, Nigeria, which found that fish abundance was highest during the dry season, when water quality parameters were more stable, and declined during the rainy season due to increased turbidity and nutrient loading.

In Ekole river, the percentage of species richness show that the family Cichlidae (10.34%), Claridae (10.34%), Cyprinidae (10.34%) > Carangidae (6.89%), Lutjanidae (6.89%), Synodontidae (6.89%) > Mormyridae (3.44%), Citharinidae (3.44%), Monodactylidae (3.44%), Gymnacidae (3.44%), Claroteidae (3.44%), Protopteridae (3.44%), Ariidae (3.44%), Eleotridae (3.44%), Polynemidae (3.44%), Mugilidae (3.44%), Soleidae (3.44%), Tetradontidae (3.44%), Gobiidae (3.44%).

In Ekole river, the percentage abundance of species reveals that Claridae (34.23%) > Cichlidae (33.85%) > Cyprinidae (7.28%) > Carangidae (4.91%) > Synodontidae (3.77%) > Claroteidae (2.77%) > Lutjanidae (2.70%) > Mormyridae (2.61%) > Gymnacidae (2.32%) > Monodactylidae (1.708%) > Mugilidae (0.725%) > Citharinidae (0.717%) > Eleotridae (0.451%) > Protopteridae > (0.45%) > Tetradontidae (0.354%), Anabantidae (0.354%) > Polynemidae (0.346%), Gobiidae (0.346%) > Ariidae (0.274%) > Soleidae (0.0048%).

The dominance of these river bodies by Cichlid fishes as observed in this study is not unusual in the Niger Delta. This kind of dominance by Cichlid fishes have been observed by previous scholars in the past in various water bodies in Nigeria (Tiga Dam [28], Zaria Reservoir [29] and Ero Reservoir [30]. To Elucidate, Cichlids dominated the catch by number and contributed 55.81% to the total number of fish caught in Tiga Dam followed by *Chrysichthys nigrodigitatus* with 13.08% abundance in the catch [28].

Also the dominance of *Tilapia zilli* (22.87%), *Hemichromis fasciatus* (19.83%), *Tilapia guineensis* (13.09%), *Chrysichthys nigrodigitatus* (13.08%), *Hepsetus odoe* (8.90%), *Alestes macrophthalmus* (6.77%), *Parachanna obscura* (6.10%), *Malapterurus electricus* (5.40%) and *Erpethoichthys calabaricus* (3.96%) in the fisher's catch in Imo River at Owerri-Nta as revealed by Okereke [19] further proves the dominance of Cichlid fishes in our local waters.

The variation in number of fish species and families in the fisher's catch across different water bodies could also be attributed to fishing methods and gear selectivity, which could also be as a result of fish size and target species. The distribution of the fish species could also depend upon the biotic and abiotic factors of the ecosystem including rainfall ([20], [21]), volume of river discharge and surface area of river basin [22]; [23], hydrographic heterogeneity-mean depth, water level fluctuations, morphometric features and nature of the river bottom [22].
Ekole river have physiochemical parameters that fall within international permissible limit suggesting an unpolluted water regime.

4.0 CONCLUSION

The broad aim of this research is to gauge the effects of pollution on fish assemblage of Ekole rivers. Pollution was measured by the determination of the physiochemical parameters of the water bodies and its conformity with international permissible standards while fish assemblage was determined by the landing fish catch of the river over a year period. This research therefore navigated the intricacies of monthly fish catch assessment and physicochemical measurements to shedding light on monthly and seasonal variations in fish catch and physiochemical parameters.

The result of the study has shown that seasonal factors have a remarkable effect on fish catch. Wet seasons recorded more fish catch than the dry season while seasonal factors affected physiochemical parameters of water. Ekole river have physiochemical parameters that fall within international permissible limit suggesting an unpolluted water regime. Fish assemblage are similar with that of similar water bodies in Nigeria.

It can be concluded based on the finding of this research, that Ekole river possesses stable and acceptable physicochemical parameters and therefore a healthy status and similar fish assemblage to other water bodies. Ekole river is therefore not under any eminent threat of fish shortages & ecological emergency.

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