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ORIGINAL RESEARCH

Physicochemistry and Ichthyofauna of Ikoli Creek, Niger Delta, Nigeria

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ABSTRACT
The Ichthyofauna of Ikoli Creek, Niger Delta of Nigeria was investigated between July and September, 2015. Fish was collect using cast nets, gill nets and traps. Water quality parameters such temperature, pH, salinity, conductivity, turbidity, Total dissolved solids, Total suspended solids, Nitrate, chloride, Sulphate, Total alkalinity, calcium, Magnesium, Sodium, Potassium, Iron, Manganese, Total hardness, Dissolved Oxygen, Biological Oxygen demand and chemical Oxygen demand were determined. Fish species were sorted and identified. Species diversity was determined using Simpson's index while evenness was determined using Shannon weaver index of diversity. The species assemblage comprised 262 individuals, 7 orders, 18 families, 22 genera, and 27 species. The dominant species were *Synodontis clarias, Synodontis membranacea, Clarotes laticeps* with 51, 33 and 22 individuals representing 19.46%, 12.59%, and 8.38% of total fish catch respectively. The diversity indices estimates were simpson's index (D) = 0.074, Simpson's index of diversity (I – D) = 0.926, Simpson's reciprocal index ($^1/_D$) = 13. 51, Shannon – Weaver index (H) = 2.86, Shanon's equitability index (EH) = 0.866, Evenness = 0.262, and Margalef index (DMn) = 4.67. The physicochemical parameters and species diversity. However, there were indications of water pollution with elevated BOD and COD values recorded. This could be attributed to organic loading of Ikoli Creek from Swali market abattoir, Industrial and agricultural discharge and run off from the Swali market and its environs. This study provides information for a more efficient waste management, and conservation of the fisheries resources of Ikoli Creek.

KEY WORDS: *Ichthyofauna, Water Quality, Diversity, Ikoli Creek.*

Introduction

Water is essential for the sustenance of life and the earth ecosystem (Izah *et al*., 2016; Agedah *et al*., 2015; Izah and Srivastav, 2015; Izah and Ineyougha, 2015). It is necessary for human health, agriculture, natural ecosystem and industry. However, rapid population growth, industrialization and unplanned urbanization have continued to put increasing pressure on water resources even to a point of crisis (Mahor, 2010; Rajagopal *et al*, 2010). This has resulted in extensive water pollution in many parts of the world especially in industrial and urban centres.

Nigeria is richly endowed with diverse inland aquatic habitats such as rivers, creeks, brooks, lakes, ponds (Seiyaboh *et al*., 2017; Agedah *et al*., 2015; Izah and Srivastav, 2015) and marshes, which furnish a great variety of fisheries resources. However, these habitats are naturally influenced by environmental factors such as temperature, pH, salinity and dissolved oxygen among others. Also, anthropogenic activities such as organic and industrial waste deposition, mining, petroleum and allied products exploitation and transportation adversely influence the fisheries resources of Nigerian inland waters. These factors in combination with over exploitation and inadequate management of her coastal waters have led to a steady decline of Nigerian fisheries resources (Lawson and Olusanya, 2010; Lawson *et al*., 2013). Several researchers including Chindah and Osuamkpe (1994); Sikoki *et al*. (1998); Lawson and Olusanya (2010); Abowei (2000) and Lawson *et al.* (2003),

have documented the abundance, distribution, composition and diversity of fish fauna of some Nigerian inland waters. However, there is scarcity of information regarding the fish fauna of Ikoli creek in the Niger Delta of Nigeria. The present study aims to provide a detailed description of the Ichthyofauna in relation to the physicochemical characteristics of the water.

The findings will provide useful baseline information for the sustainable management of the fishery resources of Ikoli creek.

Materials and Methods

Description of Study Area

Ikoli Creek is located between longitude $4^{O}55^{1}$N and Latitude $6^{O}16^{1}$E. It is a tributary of River Nun in the Niger Delta region of Nigeria. The creek passes through many communities namely; Yenagoa, Slamegbe, Akaba and Swali. Anthropogenic activities going on around the creek include dredging, fishing, boating, washing, bathing, swimming and pier toilet systems. Also, the aquatic body receives efficient discharge from the Swali abattoir. Typical of the Niger Delta region, the creek experiences seasonal flooding which introduces detritus, domestic and industrial wastes and pollutants from the mainland.

Water Quality Studies

Water samples for physicochemical studies were collected monthly for analysis from three sampling stations; upstream, midstream and downstream. The samples were collected from each station using 1 litre plastic containers, while temperature was measured insitu using a mercury-in-bulb Thermometer. The samples were taken to the central research laboratory of Niger Delta University and were analyzed for PH, salinity, conductivity, turbidity, Total dissolved solids (TDS), Total suspended solids (TSS), Nitrate (NO_3), Chloride (Cl^-), Sulphate (SO_4), Total hardness, Alkalinity, Sodium (Na^+), Potassium (K), Calcium (Ca), Iron (Fe), Manganese (Mn), Magnesium (Mg), Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO) and Chemical Oxygen Demand (COD). Physicochemical analysis of water was based on APHA (1998).

Fish Studies

Field procedures

Fish specimens were collected from Ikoli creek from July to September, 2015. Different types of fishing gears such as cast nets gill nets, siene nets, baited hook and line nets and asserted traps were used. The mesh sizes of the nets ranged from 12mm to 55mm. Services of local fishermen were employed. They set the nets professionally to maximize the number and diversity of species captured. The nets were set between 5pm and 6pm and retrieved between 7:00am and 8:00am the following day. Fish collected were sorted into species and photographs taken prior to preservation in the field. The specimens were fixed with 10% formaldehyde before transportation to the laboratory.

Laboratory Procedures

The specimens were transported to the laboratory of department of biological sciences, Niger Delta University for further investigation. The specimens were removed from formaldehyde, rinsed with tap water and mopped with dried clean cloth. The specimens were sorted into families and identified to species level using identification guides of Reed *et al*. (1967), FAO (1990) and Oguzie (1997).

Data Analysis

The abundance (number of individuals), biomass (wet weight individually recorded) and distribution of species were also established. The total percentage refers to the individuals collected for one species in the creek, considering all replicas.

The occurrence of fish species was described as common, occasional or Rare species common, when a species occurred above 20 individuals; occasional, when often below 20 individuals and rare when often less than 10 individuals or not found at all. The fish diversity was determined using the following indices:

Simpson's index of diversity = (I-D)

Simpson's Reciprocal Index = (I/D

Shannaon – Weaver Diversity index (H) = $\sum$ PilnPi

Shannon's equitability index (EH) = H/InS

Evenness (E) = e^H/S

Margalef index (DMn) = (S-1) / Log (N)

Where, N is total number of organisms of all species found, n is number of individuals of a particular species, D is diversity index, I is an index number for each species present in a sample, Pi = ni/N is the number of individuals within a species i divided by the total number of individuals present in the entire sample. ln is natural log, $\sum$ is sum of the values for each species and S is total number of species.

All the statistical analyses were considered at probability level of 5% (P<0.05). The statistical package for social sciences (SPSS, version 19) and Microsoft Office Excel software were also used.

Results

Water Quality

Data showing the physicochemical properties of Ikoli creek waters are presented in Table 1. The analysis of variance (ANOVA) showed no significant difference (P>0.05) in the values of physicochemical parameters measured across the stations within the period, although there were slight fluctuations in the values. The range for the values of some of the parameters were; Temperature (25.80^0C – 26.60^0C), pH (6.87-6.88), Conductivity (42.33-44.93)uScm^{-1}), Turbidity (18.20-20.33 NTU), Sulphate (2.23-2.31mg/l), Dissolved Oxygen (5.77-6.41mg/l), Biochemical oxygen Demand (13.21-14.67mg/l), chemical oxygen demand (33.27-35.80mg/l), while salinity was 0.01% across the stations.

Table 1: The mean values of the physicochemical parameters of water samples from Ikoli creek.

S/N	Station 1	Station 2	Station 3	Parameters/Units
1	25.80±0.83	26.40±0.67	26.60±0.74	Temperature / °c
2	6.87±0.03	6.87±0.27	6.88±0.02	PH
3	0.01±0.00	0.01±0.00	0.01±0.00	Salinity °/00
4	42.33±2.15	44.93±1.99	43.73±1.46	Conductivity/
5	20.33±1.50	19.50±2.65	18.20±2.95	Turbidity/NTU
6	21.23±1.15	22.75±1.52	22.07±0.90	TDS/mg/l
7	3.03±0.66	3.33±0.56	3.35±0.54	TSS/mg/l
8	0.12±0.00	0.13±0.01	0.13±0.01	Nitrate/mg/l
9	10.17±0.29	10.60±0.54	0.50±0.87	Chloride/mg/l
10	2024±0.29	2.43±0.54	2023±0.44	Sulphate/mg/l
11	0.50±0.00	0.43±0.15	0.47±0.06	Hydrogen Carbonate/mg/l
12	12.33±1.53	11.00±0.00	12.00±2.00	Total Alkalinity/mg/l
13	6.07±0.31	6.17±0.29	6.48±0.33	Calcium/mg/l
14	2.35±0.09	2.37±0.15	2.51±0.11	Magnesium/mg/l
15	3.793±0.40	3.87±0.61	3.64±0.25	Sodium/mg/l
16	1.33±0.58	1.39±0.35	1.39±0.33	Potassium/mg/l
17	0.11±0.06	0.13±0.03	0.09±0.01	Iron/mg/l
18	0.04±0.05	0.02±0.01	0.02±0.00	Manganese/mg/l
19	24.00±2.65	25.33±2.52	24.00±1.00	Total Hardness/mg/l
20	6.41±0.44	6.03±0.35	5.77±0.10	DO/mg/l
21	14.67±1.11	14.23±0.55	13.21±1.94	BOD/mg/l
22	35.80±1.54	34.30±2.17	33.27±3.77	COD/mg/l

Ichthyofauna

A total of 262 individuals comprising 7 orders of 18 families, 22 genera and 27 species were recorded, Table 2. The most dominant order was Siluriformes and was represented by 6 families; Bagidae, Clanoteidae, Claridae, Malapteruridae, Schilbeidae, and Mochokidae. The most dominant families were represented by 2 genera namely; Mormyridae (Mormyrus and Gnathoneus); Claroteidae (Chrysicthys and Clarotes); Schilibeidae (Siluranodon and Schilbe); Cichlidae (Tilapia and Oreochromis).

Table 2: Species composition, abundance and occurrence in Ikoli creek

Order	Family	Genus	Species	Abundance/% Occurrence
Oseoglossiformes	Gymnarchidae	Gymnarchus	*G.rilitices*	4 (1.52)
	Morymyridae	Mormyrus	*M.rume*	13 (4.96)
		Gnathonemus	*G.pictus*	11 (4.19)
Siluriformes	Malapteuridae	Malapterurus	*M.electricuss*	1 (0.38)
	Bagridae	Bagrus	*B.nigerdocmac?*	5 (1.91)
	Claroteidae	Chrysichthys	*C.nigrodigitatus*	2 (0.76)
		Clarotes	*C.laticeps*	22 (8.39)
	Clarridae	Heterobranchus	*H.bidorsalis*	13 (4.96)
	Schilibeidae	Siluranodon	*S.auritus*	13 (4.96)
		Schilbe	*S.niloticus*	6 (2.90)
	Mochokidae	Synodontis	*S.membranacea*	33 (12.59)
			S.clarias	51 (19.49)
			S.gobroni	8 (3.05)
			S.schall	10 (3.81)
Characiformes	Characidae	Alestes	*A.macrolepidotus*	13 (4.96)
			A.nurse	2 (0.76)
			A.brevis	4 (1.53)
	Hepsetidae	Hetsetus	*H.odoe*	5 (1.90)
	Citharcinidae	Citharinus	*C.citharus*	4 (1.53)
	Distichodontidae	Distichodus	*D.atroventralis*	3 (0.76)
Perciformes	Cichlidae	Tilapia	*T.guineensis*	14 (5.34)
		Orochromis	*O.niloticus*	5 (1.91)
	Latidae	Lates	*L. niloticus*	4 (1.52)
	Channidae	Parachanna	*P.obscura*	2 (0.76)
Mugiliformes	Mugilidae	Mugil	*M.cephalus*	11 (4.19)
Decapoda	Palinuridae	Panulirus	*P.regius*	2 (0.76)
Clupeiformes	Clupeidae	Sardinella	*S.maderensis*	2 (0.76)

Table 3: Diversity indices of fish species in Ikoli Creek

S/N	Diversity	Values
1	Simpson's index of diversity (D)=$\sum$(n-1)/N(N-1)	0.074
2	Simpson's index of diversity (1-D)	0.926
3	Simpson's reciprocal index (1/D)	13.51
4	Shannon-Weaver index H=$\sum$ Pi I_n Pi	2.86
5	Shannon Equitability E_H=H/I_nS	0.866
6	Evenness (E) eH/S	0.262
7	Margalef Index (Dm_n) S-1/I_nN	4.67

The most dominant species was *Synodontis clarias* with 51 individuals, representing 19.46% of the total fish caught. This was followed by *S. membranacea* (12.59%), C. laticeps (8.39%) and *T. guinensis* (5.34%), Table 2. In terms of biomass, *S. clarias* and *S. membranacea* of the same family Mochokidae recorded the highest biomass with 3,575.61g (35.30%) and 21,199.45g (21.71%) respectively. On the other hand, *C. citharus* from the family Citharinidae contributed the lowest biomass with 137g representing 1.36% of the total biomass. Of the 262 individuals encountered, 3 species; *S. clarias, S. membranacea* and *C. laticeps* with 106 individuals were categorized as common, 8 species; *m.rume, G. pictus, H. bidorsalis, S. auritus, S. schall*, *A. macrolepidotus, T. guinensis and M. cephalus* with 98 individuals as occasional, while the remaining 16 species with 58 individuals where categorized as rare.

The diversity indices of fish species in Ikoli creek are presented in Table 3. The indices estimates were Simpson's index (D) = 0.074, Simpson's index of diversity (1-D) = 0.926, Simpson's reciprocal index (1/D) = 13.51, Shannon-weaver index (H) = 2.86, Shannon's equitability (EH) = 0.866, Evenness (E) = 0.262 and Margalef index =eH/S – 4.67.

Discussion

The variations in the water quality parameters were minimal and within the reported ranges for tropical and sub-tropical environments, particularly the Niger Delta (Abowei, 2000; Ogamba, 2003; Ogamba *et al*., 2014). The temperature range of 25.80 ± 0.83^0C – 26.60 ± 0.74^0C did not vary significantly (P>0.05) and fell within the optimum range for maximum fish productivity (IPS, 1990; 1991). Furthermore, Pombo *et al.* (2004) reported that temperatures higher than 15^0C led to high fish abundance and biomass in a lagoon on the West coast of Portugal. The PH values of Ikoli creek water samples were found to be within the limit prescribed by World Health Organization (WHO) (Murhekar, 2011). The pH plays a role in most chemical and biochemical reactions thereby determining productivity. The salinity value of 0.10% did not vary in all the stations and is indicative of the fresh water status of Ikoli creek. Salinity is the most important abiotic factor affecting fish biomass and also influences the occurrence and assemblage structure of fish (Marshall and Elliot, 1998; Akin *et al.* 2005; Plaven *et al*, 2010; Neves *et al*., 2011). The occurrence of some salt water and euryhaline species in the fresh water environment such as Ikoli creek should not be a surprise as most marine species migrate to the fresh water swamps for spawning. The conductivity values of Ikoli creek were low and comparable to conductivity values of other creeks in the Niger Delta. Turbidity varied minimally across the three sampling stations, increasing from station 1 (18.20 NTU) to station II (19.50 NTU) to station III (20.33 NTU) respectively. The observed turbidity may be due to the influx of particulate materials into the creek from anthropogenic activities. The nitrate levels of 0.12mg/l-0.13mg/l recorded in Ikoli creek was within the permissible limit of 50mg/l (SON, 2007). Nitrate is the end product of aerobic decomposition of organic nitrogenous matter commonly present in surface and ground water. Elevated levels of nitrate have been reported to induce delayed reactions of light and sound stimuli and can cause methaemoglobinemiae (Robillard *et al*., 2003). The potassium concentrations across the three sampling stations were within the allowable limits of 205mg/l. Higher levels are indication of pollution possibly from agricultural irrigation, fertilizer producing industries and from domestic waste (DWAF, 2001). The mean total hardness across the three sampling stations (0.02mg/l-24.00mg/l) falls within the classification of soft water (Hanna, 2003). This may be due to optimum rainfall as the Ikoli creek is within the tropical rainforest belt of Nigeria. Ekeh and Sikoki (2003) reported total hardness of 1:00mg/l to 1872 mg/l in New Calabar River. The total hardness recorded in Ikoli creek falls within the 20 to 300mg/l reported by Boyd and Lichekoppler (1979) as desirable range for fish production. The dissolved oxygen (DO) range (5.77mg/l-6.41mg/l) indicated the high DO content of Ikoli creek. According to APHA (1995), Oxygen concentration of above 5mg/l is suitable for support of diverse biota. Furthermore, the values were within the optimum range of 3-12mg/l which Boyd and Lichtkoppler (1979) suggested will support growth and survival of fish. The mean Biological Oxygen Demand in the sampled areas of Ikoli creek were higher than some tropical rivers studied. Ekeh and Sikoki (2003) recorded 0.2-6.8mg/l of BOD in New Calabar River, while Alagoa and Aleleye-Wokoma (2012) reported 1.5-2.47mg/l in Taylor creek. The higher range recorded in Ikoli creek (13.21-14.67 mg/l) could be attributed to high decaying organic matter from various human

activities around the creek. Also, the high COD values (33.27mg/l-35.80mg/l) recorded in Ikoli creek indicate a high organic loading of the creek. This may be due to discharge from the Swali abattoir, sewage and agricultural runoff. APHA (1995) recommended COD values of less than 3mg/l for drinking water.

The fish species assemblage comprised of 262 individuals in 7 orders, 18 families, 22 genera and 27 species (Table 2), with the dominant species being *S. clarias, S. membranacea* and *C. laticeps* (Table 3), which contributed 40.44% of total fish catch. The ichthyofaunal assemblage structure of Ikoli creek was similar to those reported for similar water bodies. Oribhabor and Ogbeibu (2010) recorded 20 species in 14 families for Buguma creek, Niger Delta, Nigeria, while Lawson *et al*., (2013) recorded 23 specie in 20 genera and 18 families. Similarly, Sikoki *et al.* (1998) and Abowei (2000) reported 33 species in 15 families and 22 species in 11 families respectively for lower Nun River in the Niger Delta, Nigeria. Also, the distribution and species abundance of fish in Ikoli creek were similar to the observations of Ekpo and Udoh (2013) in the lower Cross River floodplains in Nigeria where the Siluriformes and the Osteoglossiformes were among the dominant orders with the Perciformes being present. Similarly, Araoye (1999) recorded a dominance of Siluriformes with the family Mochokidae being the most abundant in Asa Lake, Ilorin, Nigeria. This was attributed to the diverse feeding habit, low predation, foraging abilities and probably finding a good spawning ground in the creek. Also, the moderately high abundance of the Cichlids particularly Tilapia guinensis, could be attributed to their prolific breeding habit, while the relatively low abundance of *Oreochromis niloticus* may be due to their tendency to go into deeper waters especially when the surface water was agitated.

Diversity indices reflect how rich and productive a water body is in terms of fish species. The results of Simpson's index (D) =0.078, Simpson's index of diversity (1-D) = 0.926, Simpson's reciprocal index (1/D) = 13.51; Shannon-Weaver index (H) = 2.86, Shannon-Weaver equitability index (EH) = 0.87, Evenness = 0.262, Margalef index (DMn) = 4.67 for the fish species of Ikoli Creek were indications of high species diversity and uneven distribution of the fish species. Usually, the value of D for Simpson's index range between O and 1. where 0 represents an infinite diversity and I indicates no diversity. However, Simpson's index of diversity (I-D) represents the probability that two individuals randomly selected from a sample will belong to different species. This index ranges from O to I. The greater the value of Simpson's index of diversity (I-D), the greater the sample diversity. The values of Simpson's reciprocal index (I/D) starts from I to represent a community with one species. The higher the value, the greater the diversity. The value of evenness (E) vary between O and I. The closer the value to I, the more even the population of fish that form the community. Shannon-Weaver index (H) affect both number of species and evenness of their population, diversity increases as both parameters increase. Diversity is maximum when all species that make up a community are equally abundant. The value of E = 0.262, shows that the species were unevenly distributed. The observations were similar to those of Lawson *et al*. (2013) in Majidun creek, Lagos, Nigeria.

Conclusion

In all, the physicochemisty and Ichthyofauna of Ikoli Creek were similar to those reported for equivalent ecosystems. The physicochemical indices show that the creek was being impacted by the various anthropogenic activities within the vicinity of the creek as revealed by the BOD and COD values. However, the creek was observed to have a diversity of fish species which were unevenly distributed. Therefore, this information may be useful to relevant agencies for proper management and conservation, to minimize the organic loading of the creek through a more efficient waste treatment and management. The high organic loading may as well be a factor in the uneven distribution of fish species in Ikoli creek.

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