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Research Article

Preliminary Investigation of the Distribution and Relative Abundance of Plankton and Fish Species in Ivo River Basin Southeastern Nigeria

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Abstract

The abundance and distribution of phytoplankton, zooplankton and fish were investigated across 9 sampling stations in Ivo River Basin southeastern Nigeria. There was a relative low abundance and distribution of phytoplankton with record of fifteen genera from 3 classes: cyanophyceae (57.9%) < chlorophceae (33.3%) < bacciloriophyceae (8.8%). Zooplankton were represented by 2 groups and 8 genera: cladocera (53.9%) < protozoa (46.1%). A total of 5 families with seven genera of fish were recorded. The relative percentage abundance were 2.4%, 4.8%, 12.2%, 39% and 41.5% for claroteidae, schilbeidae, mormyridae, cichlidae and clariidae respectively. Out of the 41 fish sampled 22 were caught in Ivo Dam (Station 4). Diversity was generally low for all the biota. The relative high density of *Microcystis aeruginosa* cells in some sampling stations was indicative that the stations were under pollution stress. Prevailing factors of wet season could also, be responsible for the low abundance and distribution recorded. In order to provide a better explanation for the variations of the biota compositions in the river basin; it is important to identify the properties controlling the water quality and relate them with the biota abundance.

Keywords: Diversity Index; Evenness; *Microcystis aeruginosa*; Pollution; Water Quality

Introduction

The relationship between plankton and fish is vital in understanding the different dynamics of the aquatic ecosystem [1]. The foundations of the food web in an aquatic ecosystem are the phytoplankton which are a nutritional base for zooplankton and subsequently to other invertebrates, shell and finfish [2]. Several authors have reported preliminary investigations of plankton and fish fauna in many Nigerian water bodies including; Mills [3]; Fox [4]; Holden and Green [5]; Imevbore [6]; Egborge [7]; Nwadiaro and Ezefili [8] and Offem., *et al*. [9].

Most freshwater fishes depend on zooplankton as feed in their crucial developmental stages [10]; while plankton communities are influenced by the prevailing physico-chemical properties of the aquatic environment which ultimately determine their composition and variation in time and space [11]. The sensitivity of the plankton community to environmental changes is also reflected in the abundance and distribution of fish fauna. Thus, their respective compositions are more likely to indicate the quality of the water where they are resident [11].

Despite their importance and usage as bio-indicator species, there are no documented reports on the plankton and fish fauna distribution in the Ivo River Basin of Southeastern, Nigeria. However, the water chemistry of the basin had earlier been studied [12,13]. The river basin is characterized by different anthropogenic activities mostly lead-zinc mining, aggregate quarrying and agricultural activities which make heavy use of chemical in puts like pesticides. All these are suspected to affect the population dynamics of the biota in the Ivo River system which serves as sink to these environmentally perturbing anthropogenic activities [14]. The previous studies on Nigerian aquatic ecosystem have established that a knowledge of hydrological conditions will be both useful in assessing its productivity and give a better understanding of the population and life cycle of biota in River ecosystems [15]. Thus, the present study is a preliminary survey that will contribute to our current knowledge of the composition of phytoplankton, zooplankton and fish in the river basin which may serve to understand the relationship between ecosystem and environmental stressors in the basin.

Materials and Methods

Study area

The Ivo River basin is an agrarian river basin made up of surface water bodies such as Ivo River, Ikwo, Iyiodu, Akwukwuo, Nwomaiyi, Obe, Aku, Ngada, Ehuand their tributaries. All these streams are entirely within three (3) Local Government Areas (Isuikwato, Aninri, and Ivo) all in Abia, Ebonyi and Enugu states of South-Eastern Nigeria. It is a sub-basin of the Cross River Basin. The geographical location is within latitudes $5^{0}51'N$ to $5^{0}59'N$ and longitudes $7^{0}24'E$ to $7^{o}40'E$. It covers an area of over 450 square Kilometers and has an estimated population of 200,000 people [14,16].

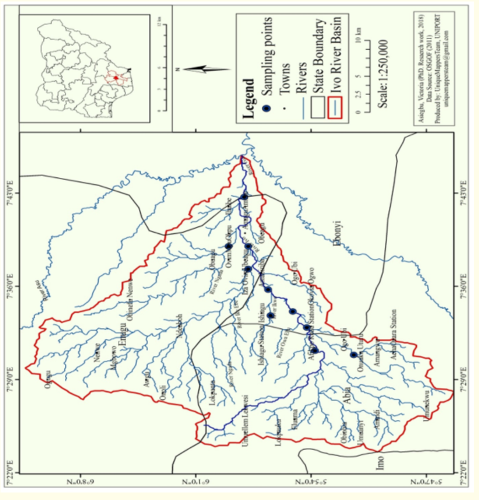

Figure 1: Study Area, showing Stream Tributaries and sampling points.

Plate 1: Pictorial view of a tributary of Ivo River close to Ehu dam revealing features of stream water in the study area.

Description of sampling stations

1. **Bank of Aku stream at overflow (Ebonyi State):** It was a fast moving water which was flooded into yam and rice farms
2. **Okue/Ivo river (Ebonyi State):** It was a fast moving water which was flooded into yam and cassava farms.
3. **Ivo river at Ihube Okpanku (Enugu State):** It was a fast moving water, it was an out flow from Ivo Dam and close to a block molding workshop.
4. **Ivo Dam (Enugu State):** It was the impoundment of Ivo River at Mpu/Okpanku boundary (Ivo Dam)
5. **Ettu River Mpu (Enugu State):** It was a slow moving water body and was surrounded with different macrophytes. It was close to a rice farm and a domestic refuse dump.
6. **Ngada Headstream of Ntapu (Ebonyi State):** It was a fast moving water body. It was close to rice and yam farms.
7. **Ikwo River at Akanu Amagu, Ishiagu (Ebonyi State):** It was a slow moving water body. It was close to a rice farm and domestic refuse dump.
8. **Ivo River at Federal College of Agriculture, Ishiagu (Ebonyi State):** It was a fast moving water body. It was in the Federal College of Agriculture, Ishiagu, the area was littered with human feacal wastes.
9. **Aku River beside Master Energy Ltd (Abia State):** It was a stagnant water which was close to a vegetable farm the station was a drinking point for cattle and with deposits of cow dung.

Plankton sampling and identification

Plankton samples were taken from the selected stations with the aid of plankton net 55μm, for phytoplankton 100mL of the water sample was treated with 1 mL lugol iodine for sample preservation while for zooplankton 100mL of the water sample was treated with 10 mL 4% formalin. These were allowed to settle for 24 hours after which they were decanted and left with 10 mL concentrate. 0.5 mL of the plankton concentrate were pipetted and view under binocular microscope (Olympus microscope) and counted using an improvised counting chamber, both phytoplankton and zooplankton were counted as number per mL and later as number per litre.

Identification of species observed were done using [17-19].

Fish sampling and identification

A fleet of experimental gill net made up of one multifilament net of 2" (5cm) twine was used. The gillnets were placed across the length of the water body according to Mustapha [20] and Komolafe and Arawomo [21]. Each net measured 5m long and 1m deep hanging vertically in the water, with floats attached to the top and sinkers fixed to the bottom to keep the net in its position. The gill nets were left overnight in the sampling stations, the nets were hauled out for fish catch early on the second day. The fish were removed from the net and sorted out. Identification were done to species level using fish identification guides [22].

Data analysis

Descriptive analysis for percentage abundance was done using MS Excel 2013. Plankton and fish diversities were analyzed using PAST 3 software.

Result and Discussion

The phytoplankton community encountered in Ivo River Basin was made up of three classes and fifteen genera. These were majorly cyanophyceae which constituted 57.9% of the total phytoplankton abundance. The most abundant species encountered was *Microcystis aeruginosa*. Baccilorophyceae was the least abundant class (8.8%) with only *Tabellaria fenestrate, Coscinodiscus lacustris, Tabellarta floculosa* and *Nitzschia closterium* identified. Stations 4 and 8 recorded the highest species abundance. There was high Shannon- weiner index in stations 4, 7 and 8. Evenness was high in stations 1, 4, 6 and 7 (Table 2).

There were two groups of zooplankton encountered. The Protozoa accounted for seven species which were more in diversity and distribution while *Cladocera* was only represented by one species which was only recorded in station 9 (Table 3). The diversity of zooplankton was generally low in all of the stations except in Station 1 (Table 4)

IIvo River Basin recorded a relative low abundance, distribution and diversity of phytoplankton which could be attributed to flooding [23,24] since phytoplankton move with water current. The high water velocity observed in the basin were also aided by its hydrology [25] as observed in most sampling stations affected the flora proliferation and residence. Also, pollutant mobilization from mining activities and chemical pesticides from farming could be affecting diversity and abundance of species [14]. The uneven distribution of phytoplankton classes in the river basin was probably due to suspected variations in physico-chemical properties of the different stations [26]. According, to Ezekwe., *et al*. [13] Ivo River Basin was marked with various anthropogenic activities which gave rise to significant variations in water quality properties. In the same vein, the suspected marked differences in water quality across the gradient of the river basin could be attributed to the water characteristics combining both lotic and lentic water systems and the nature of the inflowing stream, topography, and autochthonous production within the water body with different soil types [27]. The stations with increased human interference and high riparian growth which hampered the free flow of water and creating delays in wastes degradation, recorded relative abundance of phytoplankton [28]; thereby encouraging endemism. In contrast, the relative high number of cells of M. aeruginosa in Station 8 despite its water velocity could be related to constant discharge of human feacal wastes into the station.

The dominance of *cyanophyceae* in this study followed earlier trend observed in many tropical water bodies [29-31]. The few stations with high abundance and diversity were the stations with minimal water velocity which paved way for phytoplankton retention and stability for life processes. The high presence of pollution indicator species like *M. aeruginosa, and Chlamydomonas* spp [7,30] signaled pollution stress in the stations where they were encountered.

The period of the collection coincided with the peak of the wet season with low abundance, distribution and diversity of zooplankton as reported in earlier works in some neighboring water bodies in southern Nigeria [9,32]. The other factor that may possibly be implicated is a reduction in the availability of their food which are the phytoplankton with low productivity mostly prompted by high water levels in the rainy season, low temperature and low intense sunlight [33,34].

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Total	%
Chlorophyceae											
Pediastrum biradiatum	-	32	-	15	-	-	-	-	-	47	14.9
Nephrocytium agardhianum	-	1	-	-	-	-	-	-	-	1	0.3
Stephanodiscus astraca	-	-	-	20	-	-	-	-	-	20	6.3
Chlamydomonas ehrenbegiii	-	-	-	13	-	-	-	-	-	13	4.1
Chlamydomonas difanii	-	-	-	-	-	-	7	-	-	7	2.2
Chlamydomonas floscularіae	-	-	-	-	-	-	6	-	-	6	2.0
Closteriopsis longissima	-	-	-	-	3	-	-	-	-	3	1.0
Schroederia setigera	-	-	-	-	8	-	-	-	-	8	2.5
Total	0	33	0	48	11	0	13	0	0	105	33.3
Cyanophyceae											
Anabaena hasscilii	-	-	-	-	-	-	10	-	-	10	3.2

Phabdoderma lineare	18	-	-	-	-	-	-	-	-	18	5.7
Coelosphaerium dubium	12	-	-	-	-	-	-	-	-	12	3.8
Microcystis aeruginosa	-	-	-	-	-	41	-	32	36	109	34.5
Gloeocapsa minima	-	-	-	-	-	-	-	22	-	22	7.0
Alphanothece stagnina	-	-	-	-	-	-	-	-	9	9	2.8
Lyngbya major	-	-	-	-	-	-	-	-	3	3	0.9
Total	30	0	0	0	0	41	10	0	0	183	57.9
Baccilorophyceae											
Tabellaria fenestrata	-	2	-	-	-	-	-	-	-	2	0.6
Coscinodiscus lacustris	-	-	-	17	-	-	-	-	-	17	5.4
Tabellarta floculosa	-	-	-	-	-	-	-	2	-	2	0.6
Nitzschia closterium	-	-	-	-	-	-	-	7	-	7	2.2
Total	0	2	0	17	0	0	0	9	0	28	8.8
Grand Total	30	35	0	65	11	41	23	63	48	316	100

Table 1: Distribution and relative abundance of phytoplankton in Ivo Basin.

Diversity index	**Station 1**	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**	**Station 9**	**combined**
No. of site visits	1	1	1	1	1	1	1	1	1	1
No of spp.	2	3	0	4	2	1	3	4	3	19
No of individuals	20	35	0	65	11	41	23	63	48	316
Shannon-Weiner index (H)	0.67	0.34	0	1.37	0.56	0	1.07	1.06	0.70	2.30
Evenness (E)	0.98	0.47	0	0.98	0.89	1	0.97	0.72	0.67	0.52

Table 2: Diversity Indices of Phytoplankton in Ivo River Basin.

	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**	**Station 9**	**Total**	**%**
Protozoa											
Arculla arenaria	3	-	-	-	-	-	-	-	-	3	11.6
Emiphrys pleurosigma	3	-	-	-	-	-	-	-	-	3	11.6
Dileptus Binucleatatus	-	2	-	-	-	-	-	-	-	2	7.7
Chromogaster Testudolauterborn	-	-	1	-	-	-	-	-	-	1	3.8
Arealla vulgarias	-	-	-	1	-	-	-	-	-	1	3.8
Marituja pelagica	-	-	-	-	1	-	-	-	-	1	3.8
Hemiophrys pleurosigma	-	-	-	-	-	1	-	-	-	1	3.8
Total	6	2	1	1	1	1	0	0	0	12	46.1
Cladocera											
Pleuroxus striatus	-	-	-	-	-	-	-	-	14	-	-
Total	-	-	-	-	-	-	-	-	-	14	53.9
Grand Total	6	4	2	2	2	2	0	0	14	26	100

Table 3: Distribution and relative abundance of Zooplankton in Ivo River Basin.

Diversity index	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	combined
No. of site visits	1	1	1	1	1	1	1	1	1	1
No of spp.	2	1	1	1	1	1	0	0	1	8
No of individuals	6	2	1	1	1	1	0	0	1	26
Shannon-Weiner index (H)	0.69	0	0	0	0	0	0	0	0	1.53
Evenness (E)	1	1	1	1	1	1	0	0	1	0.57

Table 4: Diversity Indices of Zooplankton in Ivo Basin.

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Total	%
Cichlidae											
Oreochromis niloticus	-	-	-	11	-	-	-	-	-	11	26.8
Sarotherodon melanotheron	-	-	-	5	-	-	-	-	-	5	12.2
Total											39
Schilbeidae											
Schilbe mystus	-	-	1	-	-	-	-	-	-	1	2.4
Schilbe intermedius	-	-	-	1	-	-	-	-	-	1	2.4
Total											4.8
Claroteidae											
Chrysicthys nigrodigitatus	1	-	-	-	-	-	-	-	-	1	-
Claridae											
Clarias gariepinus	10	-	-	1	-	4	-	-	-	15	36.6
Heterobrancus bidorsalis	-	-	-	-	-	2	-	-	-	2	4.9
Total											41.5
Mormyridae											
Mormyrus rume	1	-	-	4	-	-	-	-	-	5	12.2
Total											12.2
Grand Total	12	-	1	22	-	6	-	-	-	41	100

Table 5: Fish distribution and relative abundance in Ivo Basin.

Diversity index	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	combined
No. of site visits	1	-	-	1	-	1	-	-	-	1
No of spp.	3	-	-	5	-	2	-	-	-	8
No of individuals	12	-	-	22	-	6	-	-	-	41
Shannon-Weiner index (H)	0.56	-	0	1.27	-	0.63	-	-	-	1.65
Evenness (E)	0.58	-	1	0.71	-	0.94	-	-	-	0.65

Table 6: Diversity Indices of Fish Species in Ivo Basin.

Fish fauna

The eight fish species identified in Ivo River Basin have also been observed by several fisheries authors [9] in inland waters in Nigeria, due to their ability to adapt to the physico-chemical parameters of the water bodies. The relatively low fish species composition in Ivo River Basin (8 species in 5 families) compared with Nun River, in which Sikoki., *et al*. (1998) recorded up to 25 species belonging to 15 families, can be attributed partly to the flood that was experienced during the period of study and mainly from chemical and heavy metal pollution from farming and mining activities. The reduction of food availability may also contribute greatly to the low fish abundance in the river basin. The food base of most fish are plankton, especially micro-crustaceans [35,36], these group of aquatic organisms were reduced in the water body possibly because of the high metal loadings discharge from the mining operations in the area [13] which severed their growth and keeping the fish community in food scarcity. The domination of the basin by cichlidae is usual in most tropical water bodies. The dominance of cichlids by number in this study was similar to the observations of Akinyemi (1987) on Eleiyele River and Olaniran (2003) on IITA water body; they both reported cichlidae as the dominant family and suggested that this could be due to their ability to utilize a wide range of foods at the lower trophic level as herbivores, as well as their high fecundity and prolific nature. However, the high relative abundance of *Clarias gariepinus* in Station 1 could be attributed to gear selectivity and the surrounding rich vegetation that existed in the station.

The relative high diversity of fish in Station 4 was attributed to the impoundment nature of the water body which supported a steady water quality status. Adebisi (1988) noted that during floods in the rainy season most water bodies experience fish migration to a favourable habitat, for food and breeding, causing the increase in population of the hosting water body. Ivo Dam (Station 4) did not encourage constant migration compared to what was observed in the other stations where there was regular fast movement of water caused by the flood. This was contrary to the findings of Williams., *et al*. (1998) who reported that rivers are known to typically support more fish species than their associated reservoirs, often as a result of large scale changes in regimes of temperature, turbidity, flow, allochthonous nutrient inputs and availability of food resources [37-52].

Conclusion

The present condition of the river basin does not support the survival of phytoplankton and zooplankton with consequential low fish catch. However, the stations with a lacustrine environment were suspected to be loaded with organic materials as indicated with the relative high presence of pollution resistant phytoplankton species. Future research will aim at investigating the temporal and spatial impacts of the various anthropogenic activities on the physico-chemical parameters of the river basin and correlating them with the biota abundance.

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