

Studies on the Physicochemical Properties of Ebonyi River in Ebonyi State, Nigeria and on the Abundance of Benthic Fauna during the Rainy Season

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Abstract

The study of physicochemical parameters have been documented, however little may still be known on how those parameters determine the abundance and composition of benthic fauna. We investigated, from May to August, 2018 the relationship between physicochemical parameters and the abundance of some benthic fauna found in Ebonyi River. Using a scoop-net, we collected samples ranging from vertebrates and invertebrates. Four sampling stations were chosen so as to encompass as a wide range of physical conditions. The mean values of dissolved oxygen (10.56 ± 0.6 mg/L), alkalinity (25.5 ± 0.3 mg/L) and hardness (15.3 ± 0.4 mg/L) were determined. We found out that the abundance of benthos was influenced by physicochemical quality of the water, habitat, and immediate substrate of occupation, tropic condition, resource partitioning and predation. Six classes of both vertebrates and invertebrates were recorded of which the class Insecta was dominant. The genera of Coenagrion nymph, Sympetrum, and Chironomus negatively correlated to the depth and velocity of water. However, we found a positive relationship between the water temperature and Belostoma genus. The negative relationships may be as a result of pollutants acquired through anthropogenic activities. However, the positive relationship between temperature and Belostoma genus may be as a result of essential resources e.g. food and mating season.

Keywords: Benthic fauna; physicochemical; Ebonyi river; Nigeria

Introduction

Most benthic organisms feed on debris that settle on the bottom of the water and in turn serve as food for a wide range of fishes [1]. Benthic faunal community studies provide the 'golden standard' in terms of determining whether alterations in benthic communities are occurring and together with sediment, physical and chemistry or if such changes are due to toxic contaminants in the sediments [2]. Many studies using benthic organisms as bio-indicator of anthropogenic impact on aquatic ecosystem have shown general decrease in benthic population and reduction in species diversity and abundance and they possess higher ability to tolerate pollution-induced environmental stress [3]. The Ebonyi River has been subjected to several anthropogenic activities such as domestic, fishing, agricultural and industrial activities. The River is the major source of livelihood to the inhabitants of these communities. According to Okoye [4], basic information on the physico-chemical components of the sources of natural water becomes very crucial in a society where there is limited provision of pipe borne water or bore hole water supply. This study therefore, provides a baseline data on the composition, abundance and diversity of benthic organisms present in Ebonyi River. The study also gives preliminary information on the influence of physicochemical properties on benthic composition and species abundance of the river.

Materials and Methods

The study area was the portion of the Ebonyi River that flows through Ezillo in Ezillo Local Government Area of Ebonyi State. The bottom of the River contained sparsely sand which is densely overlaid by mud at the edges. Four sampling stations were chosen to encompass a wide range of physical conditions and the research area. Each station has an area of 10 m². Samples were randomly collected from each station. Sampling was made for four months which lasted from May to August, 2018. This was done in the morning period of each sampling day between 9.30 am to 11.30 am, and in the first week of each month. Eight samples were taken, i.e. two from each sampling station on each

day. The major sampling equipment used was scoop-net; which is made from a jute bag with a depth of 45 cm. The net was attached by cords to a triangular metal frame (28×27×27) cm with an iron handle of 90 cm long.

The scoop-net is mainly used to collect fauna that live on and below the substratum at the bottom level of water bodies. The benthic animals observed were sorted out by pouring them in a white tray containing water and fauna picked out by means of forceps. A binocular dissecting microscope was used to identify the organisms. Various parameters were taken on each sampling day. Air and water temperatures, pH, turbidity, water depth and currents were measured by using appropriate scientific methods. The dissolved oxygen, alkalinity and hardness were taken to the laboratory for measurement following the methods described by APHA [5]. Descriptive statistics such as mean and standard deviation was used to analyze the physicochemical properties of the river and estimation of species abundance and diversity of benthic organisms in the river were calculated using Renkonen similarity [6].

Results

The values and mean values of the physicochemical parameters of the different stations of the River from May- August, 2018 are presented in the Table 1. The mean values of the physical parameters of the River were presented in Table 2 below. The highest and the lowest average

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monthly air and water temperatures for the four stations were recorded on May and August respectively. The highest and the slowest current velocity of the River were recorded in August and June respectively. The depth of the River varied in different months. There were varieties of fauna found in the benthic community of Ebonyi River of which a total of 255 both vertebrate and invertebrate animals were collected at the various stations throughout the study period.

The vertebrates which were mainly fishes had the least percentage among the entire collection while the aquatic invertebrates were most abundant. Among the aquatic invertebrates, the class Insecta dominated while the other classes made up the remaining percentage of the specimen collected (Table 3). According to Figure 1, species diversity index ranged from 1.701-2.136. From Table 3, the more the data showed significant negative correlation across the depth and velocity of the

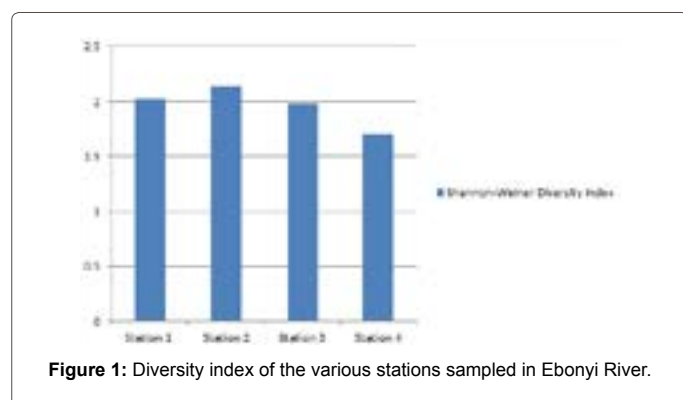
Parameter	Mean value
Dissolved oxygen (mg/L)	10.56 (± 0.6)
Alkalinity (mg/L)	25.5 mg/L (± 0.3)
Hardness (mg/L)	15.3 mg/L ($\text{CaCO}_3 \pm 0.4$)
pH	4.9 (± 0.2)
Turbidity (NTU)	9.75 (± 0.3)

\pm stands for mean and standard deviation.

Table 1: Mean values of the chemical parameters recorded in Ebonyi River.

Month	Physical parameters	Air temp (°C)	Water temp (°C)	Depth (m)	Velocity (m/s)
May	Station 1	29.4	26.2	1.6	0.13
	Station 2	29.6	26.5	1.5	0.13
	Station 3	30	27	1.8	0.14
June	Station 4	29.4	26.6	1.4	0.14
	Station 1	29.4	26	1.6	0.11
	Station 2	29.4	26.1	1.5	0.14
	Station 3	29.8	27.1	1.8	0.17
July	Station 4	28.9	26	1.3	0.12
	Station 1	28.1	25.6	2.1	0.2
	Station 2	28.6	25.7	2	0.2
	Station 3	29	26	2.4	0.28
August	Station 4	28.6	25.4	1.8	0.18
	Station 1	27.6	24.8	2.4	0.25
	Station 2	28	25	2.3	0.23
	Station 3	28.9	26	2.7	0.33
	Station 4	28.3	25.1	2.1	0.23

Table 2: Mean values of the physical parameters from different stations sampled from May to August.



Genus	Total	% of total No collected	Abundance (percentage)
<i>Ephemera</i>	8	3.14	0.20 (3.16)
<i>Paraleptophlebia</i>	7	2.75	0.18 (2.84)
<i>Macrobrachium</i>	51	20	1.28 (20.22)
<i>Sudaonates</i>	4	1.57	0.10 (1.58)
<i>Coenagrion nymph</i>	29	11.37	0.73 (11.53)
<i>Aeschna nymph</i>	8	3.14	0.20 (3.16)
<i>Gyrinus</i>	15	5.88	0.38 (6.00)
<i>Sympetrum</i>	36	14.12	0.90 (14.22)
<i>Lestes</i>	8	3.14	0.20 (3.16)
<i>Dytiscus</i>	5	1.96	0.05 (0.79)
<i>Holobdella</i>	6	2.35	0.15 (2.37)
<i>Belostoma</i>	3	1.18	0.08 (1.26)
<i>Viviparus</i>	18	7.06	0.45 (7.11)
<i>Tilapia</i>	9	3.53	0.23 (3.63)
<i>Gomphoidae</i>	20	7.84	0.50 (7.90)
<i>Chironomus</i>	28	10.98	0.70 (11.06)
Total	225	-	-

Table 3: Total number of individuals of various Genera collected from Ebonyi River.

Genus	Air temp	Water temp	Depth	Velocity
<i>Ephemera</i>	0.212	0.165	-0.209	-0.179
<i>Paraleptophlebia</i>	0.236	0.237	-0.144	-0.123
<i>Macrobrachium</i>	0.24	0.319	-0.037	-0.244
<i>Sudaonates</i>	0.008	0.039	-0.218	-0.244
<i>Coenagrion nymph</i>	0.349	0.363	-0.574	-0.605
<i>Aeschna nymph</i>	0.248	0.263	-0.368	-0.32
<i>Gyrinus</i>	0.201	0.091	-0.246	-0.241
<i>Sympetrum</i>	0.334	0.225	-0.535	-0.517
<i>Lestes</i>	0.011	-0.028	-0.009	-0.047
<i>Dytiscus</i>	-0.058	-0.058	-0.362	-0.352
<i>Holobdella</i>	0.37	0.167	-0.488	-0.452
<i>Belostoma</i>	0.458	0.509	-0.203	-0.324
<i>Viviparus</i>	0.046	0.024	-0.255	-0.168
<i>Tilapia</i>	0.316	0.363	-0.176	-0.18
<i>Gomphoidae</i>	-0.03	-0.06	-0.155	-0.144
<i>Chironomus</i>	0.201	0.113	-0.71	-0.739

Table 4: Test of relationship between the physical parameters and genera of benthic fauna.

river, the less abundant of the benthic fauna for example, *Coenagrion nymph*, *Sympetrum* and *Chironomus*. The more positive the data showed significant positive correlation across water temperature of the River, the more abundant of the benthic fauna e.g. *Belostoma* (Table 4).

Discussion

The surface water temperature, dissolved oxygen and pH were within the permissible limits of United State Environmental Protection Agency [7] for rivers. The air and water temperatures for the four sampling stations of Ebonyi River studied were comparable with previous studies done on some selected water bodies in Nigeria [8]. The abundance of benthic organisms recorded throughout the study was generally low compared to the features of a typical tropical environment. According to Umeozo [9], in his study of the benthic fauna of new Calabar River Nigeria, where he opined that the significantly lower composition of the benthic organisms during the rainy season could be attributed to the indirect effect of the rains on the substrate. During this period, the

substrate is unstable, being washed off or submerged, especially during the flooding season.

According to Hynes [10], insects are the most important group in analyzing diversity and abundance in running water. This is in confirmation with the present observations where class Insecta emerged the most abundant group influencing the biotic diversity in the river. This was also supported by the works of Negi et al. [11] in their study of seasonal variation of benthic macro-invertebrates from Tons River of Garhwal Himalaya Uttarakhand. High abundance of the smaller species was observed in the month of July, when the rain is said to be at its peak. This is attributed to the absence of a good number of vertebrate predators like fish [12]. Monthly variations showed that July and August recorded high abundance of organisms, while May had lower abundance of organisms. Their abundance might be as a result of the fact that there was no human activity recorded in the river during the study period probably due to flooding as a result of high precipitation. Species diversity as a measure of species richness in the study area was generally high in the River with relatively similar values recorded in the four stations.

The low taxa abundance in May can be attributed to the disturbance of the river by human activities as compared to those reported for temperate streams which are not affected by agricultural activities and inert pollution [13]. This is in line with the observations of Mbagwu [14] who stated that during the rainy season especially in the months of July and August, species abundance is usually high due to food availability. However, species diversity index ranged from 1.701-2.136 which revealed that benthic organisms were diverse across the stations of the river. This is in accordance with the postulation of Magurran [15] who opined that Shannon-Weiner diversity index range between 1.5-3.5 and rarely greater than 4 for an ideal ecosystem. The more organisms negatively correlate with the depth and velocity of the River, the less abundant they are and vice versa.

CONCLUSION

In conclusion, factors such as the nature of the water body, physicochemical, immediate substrate of occupation and tropic condition which acted singly or in combination influenced the abundance and distribution of benthic organisms in Ebonyi River. Therefore, continuous assessment of the water quality for a longer period is advised as to checkmate the increasing pollution trend.

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