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Diversity and Abundance of Benthic Macro Invertebrate at Middle Reaches of Orashi River, Niger Delta

Sabina Alatari Ngodigha[1*], Uyi Hanson[2], Deekae, Nanee Suanu[3]
[1]Department of Agricultural Education, School of Vocational and Technical Education, Isaac Jasper Boro College of Education, Sagbama, Bayelsa State
[2]Institute of Pollution Studies, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State
[3]Department of Fisheries and Aquatic Environment, Faculty of Agriculture, River State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State
Corresponding Author: Sabina Ngodigha alatari3004@gmail.com

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A B S T R A C T

Benthic macro-invertebrates are important in any aquatic ecosystem as they serve as bio-indicator of pollution and provide nutrient through their activities. The study was conducted for a period of 12 months from October 2018 to September 2019 along the middle reaches of the Orashi River to investigate the diversity and abundance of Benthic Macroinvertebrate. Samples were collected from each of the sampling stations using Ekman grab. A total of 40,826 benthic macro invertebrates were recorded of three taxa and fourteen species. Highest total number of individuals of 10,644 was in December while the lowest was in September. Species diversity estimated was higher in July and at station 2

INTRODUCTION

Aquatic organisms residing within benthic environment are known as benthic organisms or benthos consisting of invertebrates and vertebrate animals. These benthos are vital and known to play tremendous role in nutrient recirculation within the water system by providing viable nutrient requirement between sediment and water interface through their various actions. The organisms also serve as useful protein source for various aquatic organisms as food which in-turn, are consumed by man (Idowu &Ugwumba 2005).

Composition, distribution, and abundance of benthic macro invertebrates could be affected by the physical, biological, and chemical variables of the environment such as temperature, salinity, dissolved oxygen and other factors of the sediment including contaminants in the water system (Odiete 1999, Ikomi, Arimoro & Odihirin, 2005). Alteration of a habitat by human activity can lead to ecological succession of species in a community to an extent such that, the community of organisms may be wiped away totally due to human action and be replaced by other foreign species (secondary succession).

Benthic macro-invertebrates also serve as bio-indicators of pollution for environmental studies. They provide more vivid understanding of the changing conditions of the aquatic environment than studying only the chemical and microbial characteristics, which provide short-term fluctuation of data (Ravera 2000). Some aquatic organisms like finfishes can move from one point to another because they are equipped with adaptive mechanisms that enable them swim away from an impending danger within an environment when necessary. However, most benthic organism, are relatively less mobile especially the sedentary species. The inability of most aquatic organisms like the infauna to move effectively away from their habitat pre- supposes that the benthos are deemed to be exposed to ecological danger. These features and other peculiar characteristics of the benthic organisms such as hardiness, longer life span, ability to multiply in population and size, renders them useful as potential environmental indicators (Zabbey &Hart,2006).

This study is therefore aimed at investigating species diversity and abundance of benthic macro-invertebrates of the middle reaches of the Orashi River. The findings will provide information on the composition and diversity of benthic macro-invertebrates along the middle reaches of the River in the Niger Delta.

THEORETICAL REVIEW

Benthic macro-invertebrates are found in brackish water, marine environment and fresh water bodies (Umunnakwe, Uyi, Umunnakwe & Deekae, 2020). They are known to play tremendous role in nutrient recirculation within the water system by providing viable nutrient requirement between sediment and water interface through their activity. These organisms also serve as useful protein source for various aquatic organisms as food which in-turn, are consumed by man (Idowu & Ugwumba 2005). Some benthic organisms move in and out of the sediment to graze on benthic algae which grows on the sediment and particles that settle at the bottom. These movement actions of the benthic macro-invertebrates therefore, accelerate breakdown of organic materials digesting into inorganic forms as nutrients. Sulphate, nitrate, phosphate and a host of others are produced in that process (Idowu &Ugwumba 2005). The nutrients produced during the process, becomes available to be used by all forms of aquatic assemblages, including the aquatic macrophytes that form the first link of the food chain in the water system.

Some studies have been conducted in fresh water streams and rivers in Niger Delta by some authors (Idowu &Ugwumba 2005). Ethiope River was studied by Ikomi, Arimoro & Odihirin (2005) both studies recorded similar trend of composition, abundance and distribution of benthos which was reported to correlate positively with the physical and chemical characteristics of the water. Furthermore, Ogbeibu & Oribhabor (2001), Egborge, Ezemonye & Awoze (2003) also share similar opinion and suggested that a clean water system free of pollutants and having unique features such as good habitat, stable bottom sediment for breeding/relaxation, favourable biotope and good water quality often favour the abundance and survival of aquatic communities. But a deviation from the natural wellbeing of any water system can result to reduction of specie composition and abundance.

METHODOLOGY

The Study Area

The study was conducted along the middle reaches of the Orashi River, at the eastern section of the lower Niger Delta between October 2018 and September 2019. The study area lies between longitude 06⁰ 26′ 32.5″ to 06⁰ 30′ 05.0″ E and latitude 05⁰ 26′32.5″ to 05⁰ 08′ 24.6″ N (figure 1). Orashi River originates after Oguta Lake, and flows south where it joins the Oguta Lake water system. The water from Oguta Lake discharges into Orashi River both in the dry and wet seasons, which serves as the second main source of the Orashi.

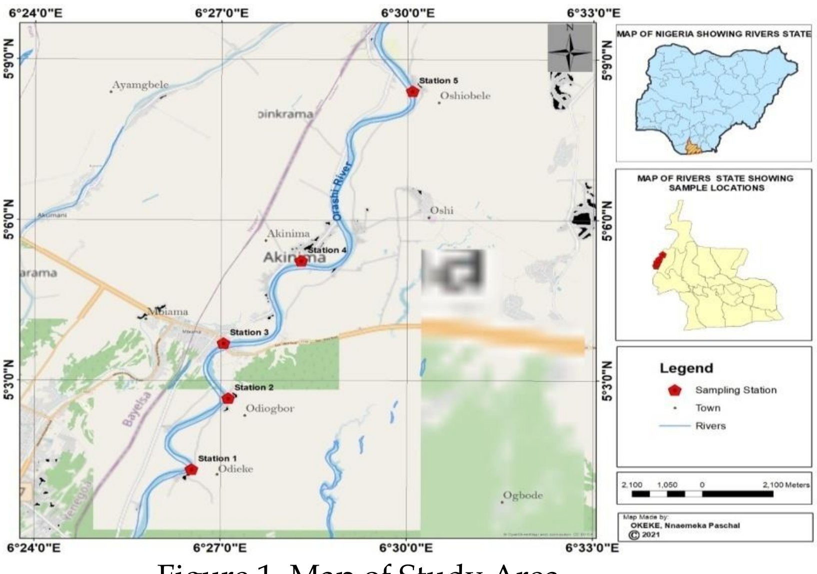

Figure 1. Map of Study Area

Sample Stations

Station 1: Is the waterfront of Odieke-Ugbobi community, before the meander loop. Human activities include washing, fishing, artisanal sand mining and recreation. The aquatic vegetations were more of bank side species, such as trees, shrubs, herbs and grasses. The aquatic macrophytes were restricted to few species as *Eichhornia crassipes* (water hyacinth), *Azola, Salvinia, Nymphaea* and some rooted aquatic macrophytes in form of grass and herbs that forms floating beds of grass mat.

Station 2: Odiobhor waterfront is an area with serious human activities such as sand dredging, bunkering, illegal artisanal crude oil refineries (kpo-fire) and area for waste dump. Plant species observed in this area are similar to those of station one above but dominated mainly by *Nymphaea* and *Euchinochloa* grass mat.

Station 3: This site is downstream and close to Mbiama East/West Road Bridge crossing the Orashi River. Anthropogenic activities were much higher at this site. Lots of dredging activities takes place here. Illegal refined crude oil products are landed and sold to marketers at this site. Aquatic vegetation is mostly floating aquatic macrophytes, a combination of rooted floating leaves, and grass mats.

Station 4: This is located upstream of Akinima, Ahoada West L.G.A headquarters. The area has shallow and strait watercourse. It is one of the major fishing communities in the area, with serious fishing activity and trading. Anthropogenic activity is very active upstream about 2 kilometres away. Illegal bunkering and crude oil theft is common around this site. Aquatic vegetation at this point is homogenous as in other stations mentioned before. The dominant vegetation was floating grass mat and *Nymphaea lotus*.

Station 5: This sample point is located between Oshiobele and Joinkrama community. This section is the shallowest, widest and fast flowing water current amongst all the area. It is quiet with less anthropogenic activity. Much fishing is done in this section than other areas. Various species of floating plants, rooted floating species, forming huge strands of floating grass mats with *Nymphaea lotus*. The station served as control station of others downstream.

Collection and Analyses of Benthic Samples

Benthic macro-invertebrates were obtained from sediment samples using Ekman grab sample for a period of 12 months. Three separate random samples were collected ones a month at each sampling station. Each of the sample collected was sieved in situ of its sediment and coarse materials using fine mesh sieve nets. Benthic organisms and sediment detritus materials were retrieved and preserved in the field with 10 % dilution media of formalin solution previously treated with a red dye. The stain usually colours the organisms in the sediment red, making it easy and visible for the dead living organisms to be carefully and more easily picked out of the sample during laboratory benthos screening. During the benthos screening, the organisms were individually sorted and transferred into labelled specimen vial bottles containing 75% ethanol (3 per station and sampling date) for counting and microscopic/taxonomic studies. Sorted fauna benthos was identified to species level under a compound microscope with the key guide by Clegg (1974), Mellanby (1975), Pennak (1978), Powell (1980).

(a) Shannon-Wiener Diversity Index or Dominance Diversity. Determines the importance of each species in the community. This measures the proportion (p) of individuals in the species Shannon &Weiner (1963) and defined as:

$$\sum_{r=i}^{n} P_i \ln P_i$$

S = Total number of species observed
N = Total number of individuals (sample size)
Pi = Proportion of individuals of each species in the station.

(b) Equitability Index (J) also called Evenness Index Kreb (2009), measures the distribution of the individuals and defined as:

$J =$

$H_{(s)}$ = Shannon-Wiener Diversity Index, $H_{(max)}$=Log_2S, S=Total number of species

$$\frac{H_{(s)}}{H_{(max)}}$$

(c) Species Richness Index of Margalef (1968), defines the ratio of the number of species to the number of individuals. It is the total number of different organisms present. It does not take into account the proportion and distribution of each species within the local aquatic community.

$$M = \frac{S - 1}{Log_e N}$$

S= the number of species in the sample, N = the total number of individuals (sample size), M= species richness index. The diversity, species richness and distribution (evenness) analyses were carried out on the benthos data.

RESULTS

As shown in Table 1, station 3 had the least number of individuals 2,403 while station 5 recorded the highest number of individuals (4,654). Three taxa groups were recorded. Station 3 recording the lowest number of Oligochaeta (2027) and station 4 recording the least value of Insecta (254) while stations 2 recorded the lowest number of crustacea (93). *Chironomous ablabiesmyia* recorded the highest value at station 5 (490) and the lowest number at station 4(234).

Diversity was estimated at 2.37, 2.39, 2.31, 2.22 and 2.26 for stations 1,2,3,4 and 5 respectively (Fig 2).

Species richness estimated were: 0.12 (Station 1), 0.13(Station 2), 0.13(Station 3) 0.13(Station 4) and 0.12(Station 5) was lowest in stations 5 and 1, but highest at

Stations 2, 3 and 4. Evenness that shows the distribution of individuals amongst the different species estimated was lowest at Station 5 and highest at stations 2 and 3 (Fig 3).

Crustaceans were not recorded in December, January and February during the study period.

Chaetogaster diatrophus was not recorded in May and June; *Nepa cinerea* not recorded in January, February and March (Table 2).

Table 1. Distribution and Relative Abundance of Benthic Invertebrates at Different Stations of the Middle Reaches of Orashi River (October, 2018 – September, 2019)

S/N	Species	St 1(%)	Stn 2 (%)	Stn 3(%)	Stn 4(%)	Stn 5(%)	Total Organism
	OLIGOCHAETA						
1	*Lumbricillus sp*	455(2.7)	331(2.0)	259(1.6)	343(2.1)	625(3.7)	2013(12.0)
2	*E tetrahedral*	500(3.0)	324(1.9)	336(2.0)	437(2.6)	563(3.4)	2160(12.9)
3	*O serpentine*	632(3.8)	332(2.0)	247(1.5)	420(2.5)	552(0.3)	2183(13.1)
4	*C diastrophus*	181(1.1)	106(0.6)	118(0.7)	94(0.6)	183(1.1)	682(4.1)
5	*Dero Obtusa*	292(1.7)	264(1.6)	250(1.5)	291(1.7)	389(2.3)	1486(8.9)
6	*Nais sp.*	343(2.1)	236(1.4)	218(1.3)	268(1.6)	434(2.6)	1499(9.0)
7	*Paranais sp*	270(1.6)	229(1.4)	181(1.1)	171(1.0)	310(1.9)	1161(6.9)
8	*Stylaria lacustris*	196(1.2)	210(1.3)	167(1.0)	168(1.0)	347(2.1)	1088(6.5)
9	*Uncinais uncinate*	512(3.1)	294(1.8)	251(1.5)	350(2.1)	547(3.3)	1954(11.7)
	Total	**3381**	**2326**	**2027**	**2542**	**3950**	**14226**
	Percentage	**20.2**	**13.9**	**12.1**	**15.2**	**23.6**	**85.2**
	INSECTA						
10	*Chironomus ablabiesmyi*	453(2.7)	284(1.7)	241(1.4)	234(1.4)	490(2.9)	1702(10.1)
11	*Nepa cinerea*	47(0.3)	21(0.1)	25(0.1)	20(0.1)	59(0.4)	172(1.0)
	Total	**500**	**305**	**266**	**254**	**549**	**1874**
	Percentage	**3.0**	**1.8**	**1.6**	**1.5**	**3.3**	**11.2**
	CRUSTACEA						
12	*Macrobrachium vollenhovenii*	69(0.4)	46(0.3)	44(0.3)	39(0.2)	75(0.4)	273(1.6)
13	*Macrobrachium macrobrachion*	50(0.3)	31(0.2)	44(0.3)	41(0.2)	51(0.3)	217(1.3)

14	*Macrobrachium felicinum*	28(0.2)	16(0.1)	22(0.1)	21(0.1)	29(0.2)	116(0.7)
	Total	**147**	**93**	**110**	**101**	**155**	**606**
	Percentage	**0.9**	**0.6**	**0.7**	**0.6**	**0.9**	
	Total no. of individuals	**4028**	**2724**	**2403**	**2897**	**4654**	**16706**
	Percentage	**24%**	**16%**	**14%**	**17%**	**28%**	**100%**
	Total no. of species	14	14	14	14	14	

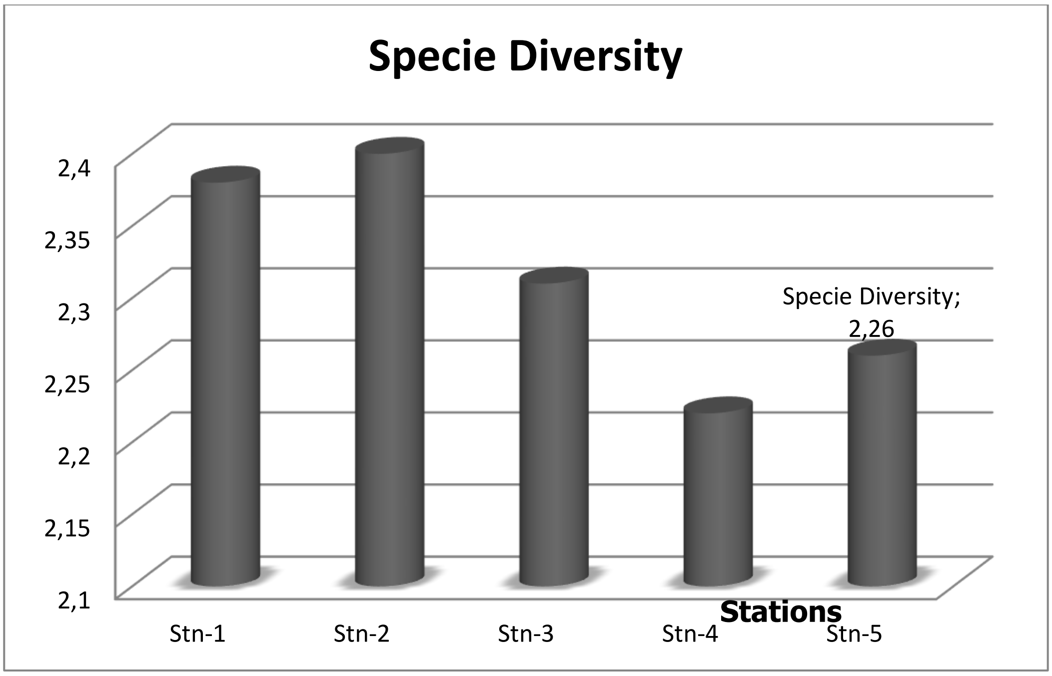

Figure 2. Species Diversity of Benthic Invertebrates Between October 2018 and September 2019 at the Various Stations of the Middle Reaches of Orashi River

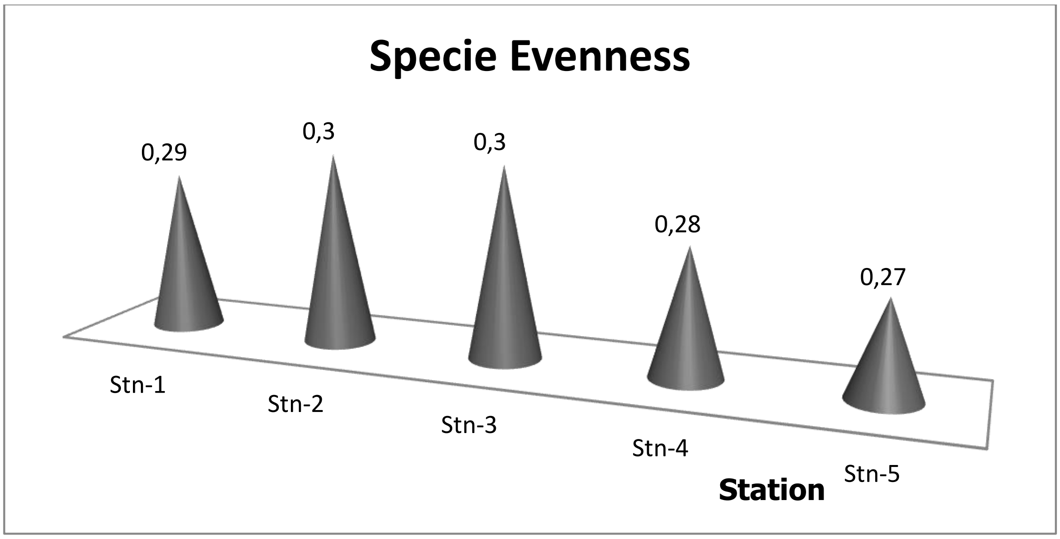

Figure 3. Annual Species Eveness of Benthic Invertebrates at the Various Stations of the Middle Reaches of Orashi River (October, 2018/September, 2019)

The highest total number of individuals 10,644 was recorded in December and the least value of 587 was recorded in September (Table 2). The relative abundance of Crustacea was 1.7%, Insecta was 11.5% and Oligochaeta was 86.8% (Fig 4). Species diversity was highest in July (Fig 5), richness was highest in March and July (Fig 6) while the highest eveness was estimated in July (Fig 7).

Table 2. Annual Monthly Distribution and Relative Abundance of Benthic Invertebrates of the Middle Reaches of Orashi River (October, 2018 –September, 2019)

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
OLIGOCHAETA												
Lumbricillus sp	811	1087	973	166	122	67	104	318	259	114	333	74
E tetrahedral	794	1024	998	140	114	54	221	250	279	99	461	56
O serpentine	767	889	1455	115	379	42	199	354	363	79	373	48
C diastrophus	217	1158	1164	83	78	45	90	0	0	67	283	25
Dero obtuse	634	989	1004	67	91	48	191	171	210	45	204	31
Nais communis	486	1046	1180	108	59	44	201	255	250	73	205	29
Paranais sp	524	1012	759	85	99	45	111	68	55	53	321	29
Stylaria lacustris	560	904	715	80	71	44	98	92	62	53	197	26
Uncinais uncinated	719	993	1209	161	178	56	213	296	303	95	292	36
Total	**5512**	**9102**	**9457**	**1005**	**1191**	**445**	**1428**	**1804**	**1781**	**678**	**2669**	**354**
Percentage	**13.5**	**22.5**	**23.2**	**2.5**	**2.9**	**1.1**	**3.5**	**4.4**	**1.7**	**6.5**	**0.9**	**0.9**
INSECTA												
C. ablabiesmyia	603	1076	1181	132	235	202	208	175	151	73	388	104
Nepa cinerea	23	20	6	0	0	0	11	16	29	36	28	29
Total	**626**	**1096**	**1187**	**132**	**235**	**202**	**219**	**191**	**180**	**109**	**416**	**133**
Percentage	**1.5**	**2.7**	**2.9**	**0.3**	**0.6**	**0.5**	**0.5**	**0.5**	**0.4**	**0.3**	**1.0**	**0.3**
CRUSTACEA												
M.. vollenhovenii	40	21	0	0	0	4	12	15	47	63	53	43

M . macrobrachion	38	34	0	0	0	1	8	13	40	46	38	34
M . felicinum	25	8	0	0	0	0	1	0	18	23	26	23
Total	**103**	**63**	**0**	**0**	**0**	**5**	**21**	**28**	**105**	**132**	**117**	**100**
Percentage	**0.3**	**0.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.1**	**0.3**	**0.3**	**0.3**	**0.2**
Total no: of Ind	6241	10261	10644	1137	1426	652	1668	2023	2066	919	3202	587
Total Abundance	15.3	25.1	26.1	2.8	3.5	1.6	4.1	5.0	5.1	2.3	7.8	1.4
Total no: of sp	14	14	11	10	10	12	14	13	13	14	14	14

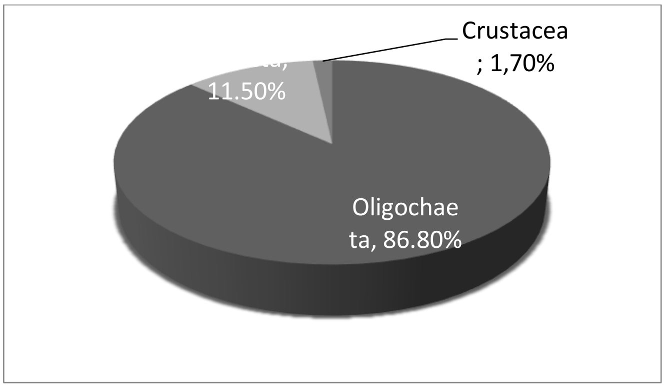

Figure 4. Annual Relative Abundance of Taxonomic Groups of Benthic Invertebrates of the Middle Reaches of Orashi River (October, 2018/September, 2019)

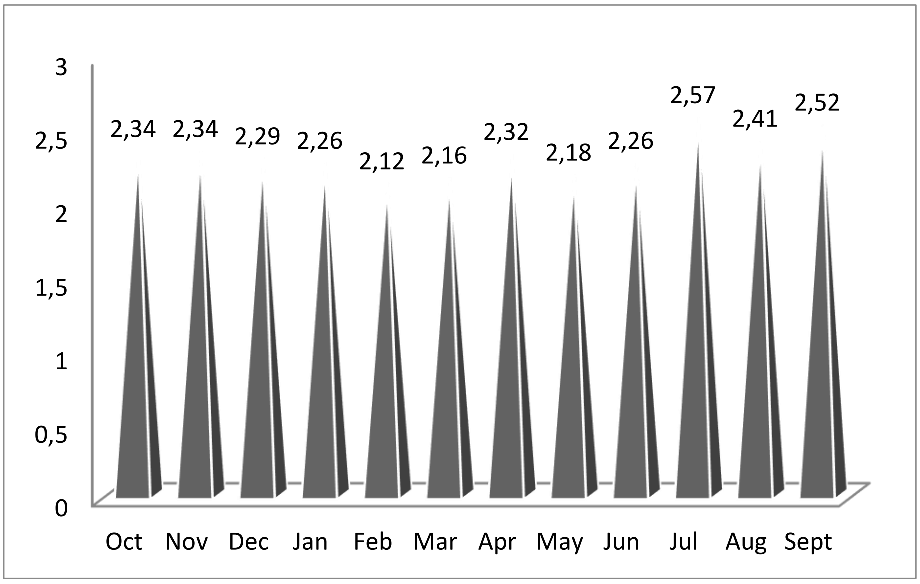

Figure 5. Monthly Diversity of Benthic Invertebrates of the Middle Reaches of Orashi River (October, 2018/September, 2019)

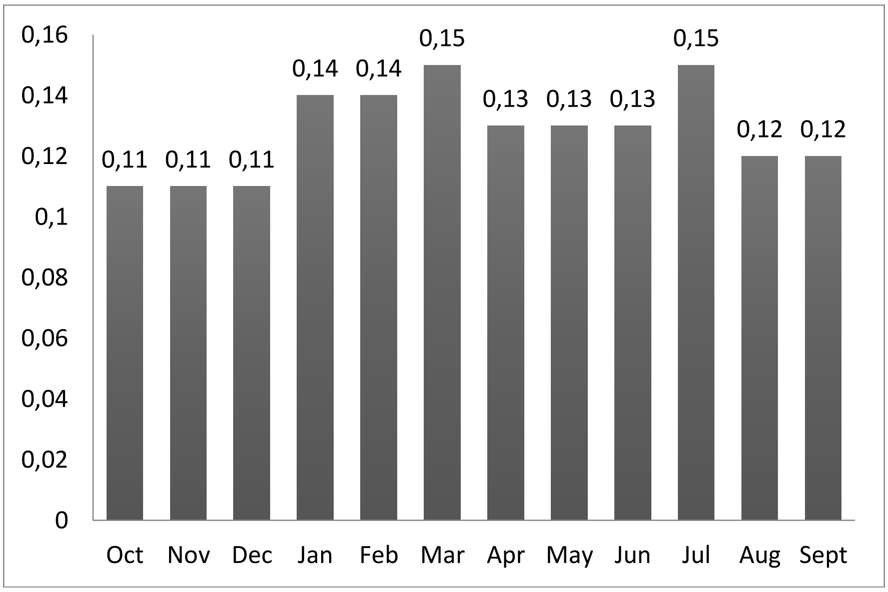

Figure 6. Monthly Species Richness of Benthic Invertebrates of the Middle Reaches of Orashi River (October, 2018/September, 2019)

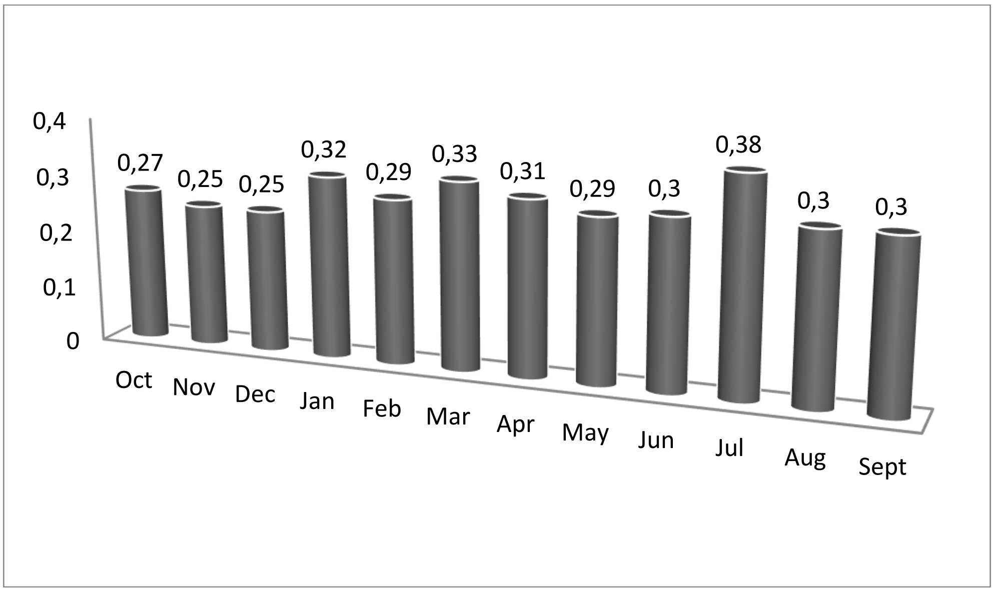

Figure 7. Monthly Species Evnness of Benthic Invertebrates of the Middle Reaches of Orashi River (October, 2018/September, 2019)

DISCUSSION

The least and highest number of individuals recorded in stations 3 and 5 respectively aligns with those of Uyi, Deekae & Ngodigha(2022a) at the same location between October 2017 and September 2018. The results indicates that more macro benthos recorded between Oshiobele and Joinkrama community along the middle reaches of Orashi River could be due to the not serious anthropogenic activity in the area. Three taxa groups recorded also agrees with earlier studies by Uyi, Deekae & Ngodigha(2022b). Least number of Oligochaeta at station 3, lowest number of Insecta and crustacea in stations 4 and 2 respectively could be attributed to the numerous human activities that includes illegal artisanal crude oil refineries (kpo-fire), bunkering, waste dump and sand dredging Uyi, Deekae & Ngodigha(2022a).

Abundance of *Chironomous ablabiesmyia* at station 5 (Oshiobele and Joinkrama) is an indication of an area that is polluted (Uyi, Ngodigha, & Deekae, 2023). The pollutants must have moved down stream since there are no serious activities apart from fishing and washing between Oshiobele and Joinkrama. This findings agrees with the assertion given by Andem, Okoroafor, Udofia, Okete & Ugwumba, 2012).

Lowest estimated value of diversity (Fig 2) at station 4 could be as a result of the down stream movement of pollutants. Though there were numerous human activities at station 2, highest species diversity was estimated there. This could be attributed to continuous movement of pollutant away from the area that are carried downstream to station 4**.** The low values of species richness estimated suggest that the middle reaches of Orashi River is experiencing an unstable ecosystem. The low evenness estimated (0.27-0.30) indicates a stressed ecosystem which could be caused by the dominance of few species. According to Odum (1971) the more evenly distributed the individuals of species are, the more balance is the system.

Crustaceans not recorded in December, January and February could be as a result of the higher temperature. As reported by Uyi, Deekae & Ngodigha (2022a), Crustaceans were also not recorded in February suggesting that the environment is not favourable for them in February. Another study by Ngodigha, Uyi & Deekae (2024) at the middle reaches of Orashi River, reported a negative correlation between Crustaceans with temperature represented by *Macrobrachium felicinum, Macrobrachium macrobrachion*, *Macrobrachium vollenhovenii* and Temperature. *Chaetogaster diatrophus* not reported in May and June and *Nepa cinerea* not recorded in January, February and March (Table 2), could be attributed to unfavourable condition of the system during the dry season for these organisms. The low relative abundance of Crustacea, Insecta as against Oligochaeta suggest the ability of Oligochaeta to survive better in the area irrespective of the season.

The highest value of individuals 10,644 recorded in December and the least 587 recorded in September (Table 2) corroborates with those of Uyi, Deekae & Ngodigha(2022b) who reported highest number of macro benthos in November and lowest in September. This shows that macrobenthos strives better between November and December (excluding Cruataceans) and less able to survive in September at the middle reaches of the Orashi River.

CONCLUSIONS AND RECOMMENDATIONS

The rich presence of Chironomous species and low species diversity of benthic macro invertebrates in the study area was an indication of high level of pollutants in the study area that could stress the aquatic environment. The continuous anthropogenic activities must have contributed to the high level of pollutants resulting in low species richness. It is hence recommended that environmental protective measure be introduced to conserve and protect the area from further degradation that will eventually improve species abundance and diversity.

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