Journal of Aquatic Science and Marine Biology
Volume 2, Issue 3, 2019, PP 1-6
ISSN 2638-5481

Spatial and Temporal Variations in the Benthic Macro-Invertebrates of Douglas Creek, South-Eastern Nigeria

Ofonmbuk Ime Obot, Gift Samuel David* and Uwana Sonny Fombo

Department of Fisheries and Aquatic Environmental Management, University of Uyo, Nigeria

****Corresponding Author:** Gift Samuel David, Department of Fisheries and Aquatic Environmental Management, University of Uyo, Nigeria. giftdavid80@yahoo.com*

ABSTRACT

Environmental concerns of aquatic ecosystems have become emerging issues in Nigeria. Study of the benthic macro-invertebrates of Douglas creek, south-eastern Nigeria was carried out from September 2011 –August 2013. Benthic macro-invertebrates from six classes, nine families and ten species were encountered. Maxillopoda class had the highest abundance of 47.37 %. The others were Bivalvia (18.95 %), Clitellata (15.79 %), Insecta (13.68 %), while the least were Malacostraca and Oligohaeta with 2.11 % each. Again, only Maxillopoda showed a significant seasonal variation ($p<0.05$). Gammarus lacustris was the most frequent and abundant species; occurring in 16 of the 24 months. This was followed by Tubifex tubifex and Anodonta grandis. Iphigenia laevigata, I. rostrata and Pisidium casertanum were the least frequent; each occurring just once throughout the study period. Gammarus lacustris, Tubifex tubifex and Hexacylloepus sp. occurred in all the stations while Iphigenia laevigata, I. rostrata and Pisidium casertanum each occurred in only one station. Margalelf species diversity and Shannon-wiener index were generally low with highest values of 1.924 and 1.591 respectively. The low diversity of benthic macro-invertebrates in Douglas creek is an indication of high anthropogenic perturbation. The presence of T. tubifex in all the stations suggests organic pollution from anthropogenic source. This study thus recommends that private and government agencies operating in this environment implement ecological surveillance and mitigation measures that will prevent further environmental degradation.

Keywords: *Benthos, distribution, abundance, Douglas creek, Maxillopoda, Gammarus lacustris*

INTRODUCTION

Benthic macro-invertebrates are good pollution indicators. They are animals without backbone. They live on or in the sediment of the water body or are attached to rocks or debris at the bottom. Macrobenthos are the organisms maintained in mesh sizes greater than 200µm but less than 50µm (Slack et al., 1973). Macrobenthic invertebrates include crustaceans, molluscs, aquatic worms and larval forms of aquatic insects. They constitute the food chain of the aquatic ecosystem, and are good water quality indicators (Nkwoji et al., 2010). They are utilized as food for economic purpose and as shellfish species in most aquatic environment; they act as secondary producers (Emmanuel and Ogunwenmo, 2010). The dispersion of macro-invertebrate fauna is dictated by a number of factors including the physical nature of the substratum, depth, nutritive content, and degree of stability and oxygen content of the water body (Ogidiaka et al., 2012). Macro-invertebrates' studies offer benefits such as the quick assessment of biological resources for the purpose of conservation and the pollution detection through the differences between anticipated and actual faunal assemblages (Miserendino, 2001). The significant factors that influence the abundance of macrobenthic fauna in a given community are the physico-chemical properties of the water, immediate substrate of occupation and food availability (Dance and Hynes, 1980).

Studies of benthos of Nigeria creeks include; Edokpayi et al. (2010) on Ogbe creek, Emmanuel and Ogunwenmo (2010) on Abule-Agege creek, George et al. (2010) on Okpoka creek, Olomukoro and Azubuike (2009) on Ekpan creek and Woke and Aleleye-Wokoma (2007) on Elechi creek. There is no documented or reported investigation of the macro benthos of Douglas creek before now. Qua Iboe River estuary is located on the south-eastern coast of Nigeria. Its mouth has the coordinate of latitude $4^{0}32'28''$N and longitude $7^{0}59'22''$E. This estuary is close to the sea; with estuarine mouth extension in the order of 100 – 150 m in length and depth variation of 10 – 30 m. Qua Iboe

River estuary channel orientates in N-S direction. The estuary is associated with creeks and channels; notably Douglas creek in Ibeno Local government area, Akwa Ibom State.

Douglas creek is very important and strategically located. At a point, it shares a common boundary with some of Mobil oil processing units in Ibeno and empties at the mouth of Qua Iboe River, where the river drains into the Atlantic Ocean. It creates settlements for waterfront dwellers, timber market and other human activities. This work aims at giving baseline information on the abundance and composition of macro benthic communities in Douglas creek in association with its environmental quality.

Materials and Methods

Study Area

Douglas creek is located along the Qua Iboe River at about 120 m away from its point of discharge into the Atlantic Ocean. It creates settlements for waterfront dwellers, timber market and other human activities. Human activities going on within and around this creek include dredging, fishing, boating, and navigation, and washing, disposal of excreta, bathing and swimming. The mangrove of this creek is characterized by the invasive *Nypa fruticans*. Three sampling stations were chosen (Figure 1).

Station 1. This is at the point where Douglas creek empties into Qua-Iboe River. (4º33'14"N and 7º59'24"E). *Nypa fruticans* is the dominant vegetation with patches of mangroves (*Rhizophora mangle. R. racemosa* and *Laguncularia racemosa*).

Station 2. This is located along Douglas creek (4º33'27"N and 7º59'54"E). This station is characterized by sand dredging with a temporal make-shift depot for petroleum products close to it. Station 3. This is located along Douglas creek (4º33'11"N and 8º0'10"E), close to a bridge. There is a linear human settlement along one side of the creek, close to this station. There is also a timber market close to this station. Not far from this station, you can site gas flaring at one of the operational facilities of Mobil Oil Company, QIT (Qua Iboe Terminal).

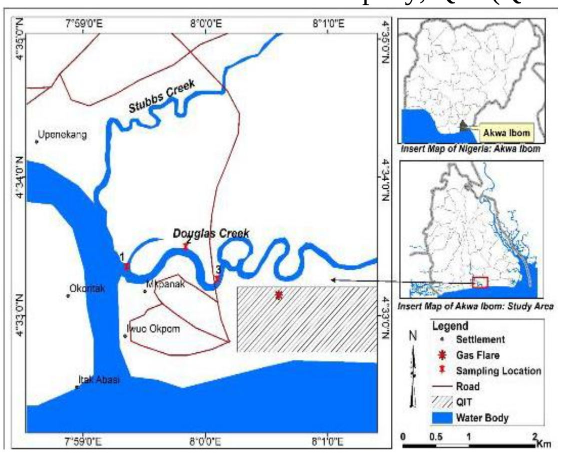

Figure1. *Map showing sampling stations (1-3)*

Sample Collection

Monthly sampling at the stations for 24 months (September 2011 – August 2013) was carried-out. Benthic samples were collected with the aid of a Van-veen grab of 0.5 m^2 surface area. At each station, two grab hauls were collected, sieved with mesh size 0.5 mm (Holme and Melntyre, 1984) and stored in a pre-labelled container. It was then fixed with 10% formalin for further analysis in the laboratory. Identification with microscope, sorting and counting were carried out in the laboratory. Identification keys such as Day (1967), Pennak (1978), WHO (1984) and Brown (1994) were consulted. Rainfall data was collected from the Meteorological unit, Department of Geography, University of Uyo, Nigeria.

Statistical Analyses

The means, ranges, percentages and one-way Analysis of Variance (ANOVA) at probability level of $p<0.05$ of the data generated were determined using SPSS (version 19) package. Microsoft Excel 2013 was used for graphical illustrations. The community structure (Margalef species diversity, Shannon-wiener index and species evenness) was analysed using PAST (version 2.12) software.

Results

The monthly variation of benthic macro-invertebrates in Douglas creek sediments is presented in Table 1. *Gammarus lacustris* was the most frequent and abundant benthos;

occurring in 16 of the 24 months. This was followed by *Tubifex tubifex* and *Anodonta grandis*. *Iphigenia laevigata*, *I. rostrata and Pisidium casertanum* were the least frequent; each occurring just once throughout the study period. Table 2 displays the spatial variation of benthic macro-invertebrates in the study area. *Gammarus lacustris* had its highest and lowest occurrences in stations 3 and 1 respectively while *Tubifex tubifex* had its highest and lowest occurrences in stations 1 and 3 respectively. *Gammarus lacustris*, *Tubifex tubifex* and *Hexacylloepus sp.* occurred in all the stations while *Iphigenia laevigata*, *I. rostrata and Pisidium casertanum* each occurred in only one station. Station 3 had the highest number of taxa (8) compared to station 2 (7) and station 1 (5) Table 3 is the relative class abundance and species composition trend of the benthic macro-invertebrates in Douglas creek. The class Maxillopoda was the most abundant and constituted 47.37 % while Malacostraca was the least abundant and constituted 2.11 %. Bivalvia had the highest species composition of 40 %. Figure 2 is a graphical presentation of rainfall for the period of study. The rainfall data obtained from the Meteorological unit, Department of Geography, University of Uyo, Nigeria, showed a seven months' wet season period, stretching from April to October, and a dry season extending from November to March. Figure 3 is the Class seasonal variation of benthic macro-invertebrates in Douglas creek. Although there were differences in the occurrences of the benthic macro-invertebrates in seasons, only Maxillopoda showed a significant difference ($p<0.05$). While, Bivalvia, Clitellata and Malacostraca were more in the wet season, Insecta, Maxillopoda and Oligochaeta were more in the dry season. Figure 4 is the relationship between total number of individuals per station and total number of species per station. Both followed the same pattern; highest in station 3 and lowest in station 1.Figure 5 is the Shannon-wiener diversity values, Margalef species diversity values and species evenness values for each station. Margalef species diversity and Shannon-wiener index were highest and lowest in stations 3 and 1 respectively while Species evenness was highest in station 2 and lowest in station 1.

Table1. *Monthly Variations of Macro-invertebrates (ind/m^2) in Douglas Creek from September, 2011 to August, 2013*

	Sep-11	Oct	Nov	Dec	Jan-12	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan-13	Feb	Mar	Apr	May	Jun	Jul	Aug-13
Class: Bivalvia																								
Family: Unionidae																								
Anodonta grandis	10	0	6	0	0	2	2	0	0	2	0	0	4	0	0	0	0	0	0	0	0	0	0	0
Family: Donacidae																								
Iphigenia laevigata	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iphigenia rostrata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Family: Spaeriidae																								
Pisidium asertanum	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Class: Clitellata																								
Family: Tubificidae																								
Tubifex tubifex	0	0	0	2	4	0	0	0	0	6	0	0	0	0	0	0	2	0	12	2	2	0	0	6
Class: Insecta																								
Family: Elemidae																								
Hexacylloepus sp	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	16	0	0	0	0	0	2
Family: Hydropsychidae																								
Hydropsyche sp.	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	2	0	0
Class: Malacostraca																								
Family: ecarcinidae																								
Cardisoma armatum	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Class:Maxillopoda																								
Family: Gammaridae																								
Gammarus lacusta	0	4	6	4	8	2	0	4	0	0	6	6	2	0	4	12	16	6	2	6	2	0	0	0
Class: Oligochaeta																								
Family: Naididae																								
Uncinatis uncinais	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table2. *Spatial variation of macro-invertebrates (in d/m^2) in Douglas creek from September 2011 to August 2013*

Class	Family	Species	Station 1	Station 2	Station 3	Total
Bivalvia	Unionidae	*Anodonta grandis*	0	12	14	26
Bivalvia	Donacidae	*Iphigenia laevigata*	2	0	0	2
Bivalvia	Donacidae	*Iphigenia rostrata*	0	0	2	2
Bivalvia	Spaeriidae	*Pisidium casertanum*	0	0	6	6
Clitellata	Tubificidae	*Tubifex tubifex*	14	10	6	30

Insecta	Elemidae	*Hexacylloepus sp*	6	8	8	22
Insecta	Hydropsychidae	*Hydropsyche sp.*	2	2	0	4
Malacostraca	Gecarcinidae	*Cardisoma armatum*	0	2	2	4
Maxillopoda	Gammaridae	*Gammarus lacusta*	24	30	36	90
Oligochaeta	Naididae	*Uncinatis uncinais*	0	2	2	4

Table3. *Number and percentage composition of macro-invertebrates (ind/m^2) in Douglas creek from September 2011 to August 2013*

Taxa	Total Number (No./0.5m^2)	Relative Abundance (%)	Total Number of Species	Species Composition (%)
Bivalvia	36	18.95	4	40
Clitellata	30	15.79	1	10
Insecta	26	13.68	2	20
Malacostraca	4	2.11	1	10
Maxillopoda	90	47.37	1	10
Oligochaeta	4	2.11	1	10

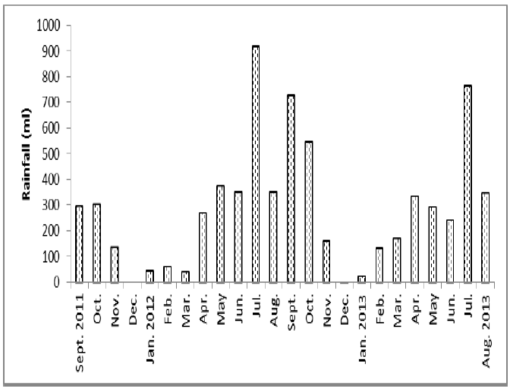

Figure2. *Graph showing rainfall data during the period of study obtained from Meteorological unit, Department of Geography, University of Uyo, Nigeria.*

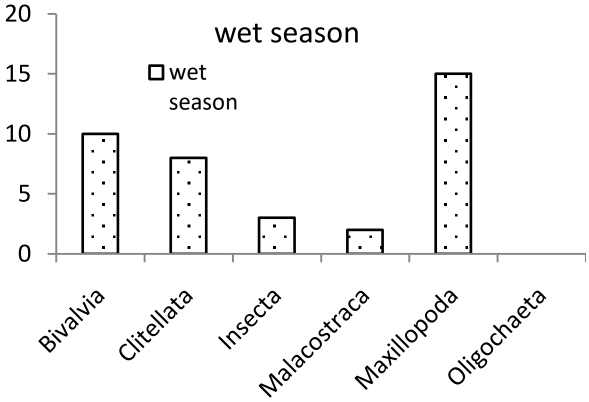

Figure3. *Class seasonal variation of Macro-invertebrates in Douglas creek*

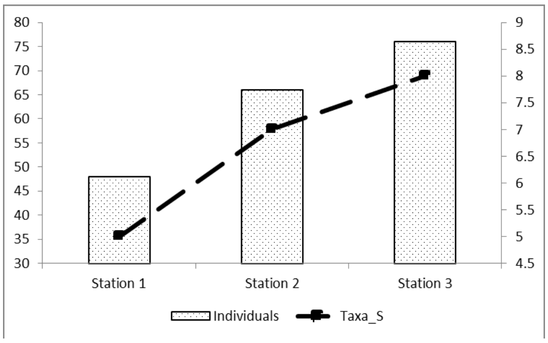

Figure4. *Relationship between number of individuals and number of species of Macro-invertebrates in Douglas creek*

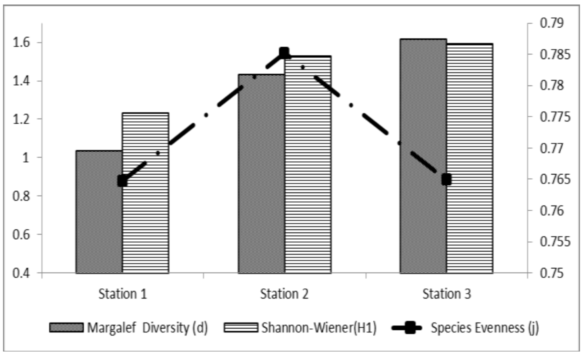

Figure5. *Relationships between the diversity indices of macro-invertebrates in Douglas creek*

DISCUSSION

The ten species belonging to six classes of benthic macro-invertebrates encountered in this study is different from some reports. Sikoki and Zabbey (2006) identified 14 species representing 11 families of macro invertebrates in Imo River, Edokpayi et al. (2010) identified 16 taxa and 4 phyla from Ogbe creek, George et al. (2010) reported 19 species, 6 classes and 4 phyla in Okpoka creek, Ogidiaka et al. (2012) with 6 species from Ogunpa River and Olomukoro and Egborge (2003) reported 138 taxa from Warri river.

However, the recorded 10 species in this syudy is similar to that of Andem et al. (2012) who recorded 10 species from Ona River, Nkwoji et al. (2010) who reported 9 species from Lagos lagoon and Williams (1999) who recorded 9 species at Lighthouse creek. The low number of recorded benthic macro-invertebrates in the present study could have been due to some ecological instabilities originating from modifications of some important factors affecting the abundance and distribution of the benthic communities (Andem et al., 2012). Such factors are water quality, immediate substrate for occupation and food availability (Dance and Hynes, 1980). The distribution pattern of macro invertebrates in all the stations of the creek showed major differences. Highest and lowest number of individuals and species were recorded in stations 3 and 1 respectively.

The lower number of individuals and species of macro invertebrates encountered in station 1 as compared to stations 2 and 3 is a reflection of the slight differences in the physico-chemical and sediment quality of the aquatic habitat (George et al., 2010). Wood (1987) explained that species have to cope with environmental alterations and biological interactions, which brings about significant alterations in community structure generally.

Results from the study showed that *Gammarus lacustris* (47.37 %) was the most abundant benthic macro-invertebrate, followed by *Tubifex tubifex* (15.79 %). The presence of *T. tubifex* in all the stations suggests organic contamination from anthropogenic source (Andem et al., 2012). Margalef species diversity and Shannon-wiener index were generally low with highest values of 1.924 and 1.591 respectively. Low species diversity could partly be due to some physico-chemical statuses including fast flow of water and low dissolved-oxygen (Emere and Nasiru, 2007). The occurrence of relatively higher taxa and individuals' in station 3 could be attributed to the lower degree of anthropogenic activities at this station compared to other stations. Only Maxillopoda showed a significant seasonal variation ($p<0.05$) in abundance among the six classes of benthic macro-invertebrates encountered during the study. Victor and Ogbeibu (1991) suggested overall diversity to be the result of all dynamic spatial and temporal changes impacting the macro invertebrate communities. It could also be a reflection of the extent, to which the ecosystem has been disturbed by human activity (Edokpayi et al., 2010). The low diversity of the present study is an indication of high anthropogenic perturbation.

CONCLUSION

The study encountered six (6) classes in Douglas creek. Bivalvia (18.95%), Clitellata (15.79%), Insecta (13.68%), Malacostraca (2.11%), Maxillopoda (47.37%), and Oligochaeta (2.11%). The presence of *Tubifex tubifex* is an indication of organic contamination from human sources. Similarly, the low Margelef species diversity (1.924) and Shannon-weiner index (1.591) observed in this study across all stations suggests the status of the study area being low in dissolved oxygen and having fast flow of water. All these designating the aquatic ecosystem of Douglas creek being stressed as a result of organic contamination from human activities. The present study thus recommends that agencies, including private and government agencies operating in this environment prevent further perturbation by introducing ecological surveillance and other mitigation measures.

REFERENCES

[1] Slack KV, Nauman JW, Tilley LJ. Benthic inveretebrates in a North flowing stream and a South flowing stream, Brooks Range. Alaska. *Water Resources Bulletin*. 1973; 15: 108-135.

[2] Nkwoji JA, Onyema IC, Igbo JK. Wet season spatial occurrence of phytoplankton and zooplankton in Lagos Lagoon. *Nigeria Science World Journal*, 2010; 5(5): 7-14.

[3] Emmanuel IS, Ogunwenmo CA. The macrobenthos and the fishes of a tropical estuarine creek in Lagos, south-western Nigeria. *Report and Opinion*, 2010; 2(1): 6-13.

[4] Ogidiaka E, Esenowo IK, Ugwumba AAA. Physico-chemical parameters and benthic macroinvertebrate of Ogunpa river at Bodija, Ibadan, Oyo State. *European Journal of Scientific Research*, 2012; 85(1): 89-97.

[5] Miserendino ML. Macro-invertebrates assemblages in Andean Patagonian rivers and stream: Environmental relationship. *Hydro biologia*. 2001;444: 147-158.

[6] Dance KW, Hynes HB. Some effect of agricultural land use on stream insect communities. *Environmental Pollution Service*. 1980;22: 19-28.

[7] Edokpayi CA, Olowoporoku AO, Uwadiae RE. The hydrochemistry and macro benthic fauna characteristics of an urban draining creek. *International Journal of Biodiversity and Conservation.* 2010; 2(8): 196-203.

[8] George ADI, Abowei JFN, Alfred-Ockiya JF. The distribution, abundance and seasonality of benthic macro invertebrate in Okpoka creek sediments, Niger Delta, Nigeria. *Research Journal of Applied Science, Engineering and Technology*. 2010; 2(1): 11-18.

[9] Olomukoro JO, Azubuike CN. Heavy metals and macroinvertebrate communities in bottom sediment of Ekpan Creek, Warri, Nigeria. *Jordan Journal of Biological Sciences*. 2009; 2(1): 1-8.

[10] Woke GN, Aleleye-Wokoma IP. Effect of organic waste pollution on the macrobenthic organisms of Elechi creek Port Harcourt. *African Journal of Applied Zoology and Environmental Biology*. 2007; 9: 26-30.

[11] Holme NA, Melntyre AD. Methods for the study of marine benthos. United Kingdom: Blackwell Scientific Publishers; 1984.

[12] Day JA. A monograph on the polychaeta of southern Africa part 1 Errantia. , London: British Museum of Natural History; 1967.

[13] Pennak RW Freshwater invertebrates of the United States, 2nd Ed. New York: John Wiley and Sons; 1978.

[14] International Standards for drinking water, 4th ed., Geneva: World Health Organization; 1984

[15] Brown DS. Fresh water snails of Africa and their medical importance. London: Taylor and Francis Ltd.; 1994.

[16] Sikoki FD, Zabbey N. Environmental gradients and benthic community of the middle reaches of Imo River, south-eastern Nigeria. *Environm ental Ecology*. 2006; 24(1): 32 36.

[17] Olomukoro JO, Egborge ABM. Hydro biological studies on Warri River, Nigeria: The composition, distribution and diversity of macro benthic fauna. *Journal of Aquatic Pollution*. 2003; 15(4): 15-22.

[18] Andem AB, Okorafor KA, Udofia U, Okete JA, Ugwumba AA. Composition, distribution and diversity of benthic macroinvertebrates of Ona River, south-west, Nigeria. *European Journal of Zoological Research.* 2012;1(2): 47-53.

[19] Williams AB. Ecological studies of macro benthic fauna of the Lighthouse creek and Oworonsoki areas of Lagos Lagoon. M.Sc. Thesis, University of Lagos; 1999.

[20] Wood E. Subtidal ecology. London: Edward Arnlod; 1987.

[21] Emere MC, Nasiru EC. Macroinvertebratess as indicators of the water quality of an urbanized stream Kaduna, Nigeria. *Journal of Fisheries International*. 2007; 2: 152-157.

[22] Victor R. Ogbeibu AE. Macroinvertebrate communicates in the erosional biotope of an urban stream in Nigeria. *Nigerian Journal of Science*. 1991; 4: 1-2.

Citation: *Ofonmbuk Ime Obot, Gift Samuel David, "Spatial and Temporal Variations in the Benthic Macro-Invertebrates of Douglas Creek, South-Eastern Nigeria", Journal of Aquatic Science and Marine Biology, 2019, 2(3), pp.1-6.*