American Journal of Engineering Research (AJER)
e-ISSN : 2320-0847 p-ISSN : 2320-0936
Volume-03, Issue-04, pp-265-270
www.ajer.org

Research Paper Open Access

Effect of Water Quality on the Distribution of Aquatic Entomofauna of Great Kwa River, Southern Nigeria

Oku, E. E[1], Andem, A. B[1], Arong, G. A[1] And Odjadjare, E[1]

[1] *Department of Zoology and Environmental Biology, University of Calabar, Calabar, P.M.B. 115, Cross River State, Nigeria*

Abstract : - Aquatic insects are very significant as indicators of water quality. The study was carried out between January and August, 2013 for both seasons. Sampling of aquatic insects of Great Kwa River was done with sampling nets in three stations: Unical Female Hostel, Unical Staff quarters and Obufa Esuk Beach. A total of 261.0 aquatic insects were collected with Unical Female Hostel accounting for the highest abundance. Unical Staff quarters had the highest Ephemenoptera, Plecoptera, Trichoptera (EPT) richness. The result of the study shows that the aquatic ecosystem health of the Great Kwa River varied significantly ($P<0.05$) along the course of flow with some areas slightly and moderately polluted while others are in useable conditions. The Diptera obtained during the study, are pollution tolerant species. They were more prevalent during the wet season than the dry season suggesting that the level of pollution was higher during the wet season.

Keywords: - *water quality, distribution, aquatic, entomofauna, Nigeria*

I. INTRODUCTION

Aquatic insects are a group of arthropods that live or spend part of their life cycle in water bodies (Popoola and Otalekor, 2011). Most importantly, aquatic insects are a good indicator of water qualities due to their various environmental disturbances tolerant levels (Arimoro and Ikomi, 2008). Anthropogenic activities of humans encourage discharge of untreated animal waste, such as releases from sewage and septic tanks, run-off from agricultural lands, laundering into Streams and Rivers. Most water bodies have been subjected to increasing pollution loads consequently, affecting greatly their quality and health status, this could result in changes of physico-chemical properties of water such as Temperature, Dissolved oxygen, Alkalinity, Biological oxygen demand, Nitrates and metal concentrations. Variations in these water properties greatly influence the distribution patterns of aquatic insects in the water, since some of them are highly sensitive to pollution while others are somewhat tolerant or completely tolerant to pollution and environmental disturbances (Bauernfeind and Moog, 200). This study was carried out to provide information on the effect of water quality on seasonal distribution of aquatic insects of Great Kwa River, Southern Nigeria as regards the state and quality of water bodies (Arimoro and Ikomi, 2008). Published works on the use of Aquatic insects for assessing health and water quality status of streams revealed that studied in tropical Africa is not extensive (Deliz-Quinones, 2005; Arimoro and Ikomi, 2008).

II. MATERIALS AND METHODS

2.1 DESCRIPTION OF STUDY AREA

The Great Kwa river, Cross River State is located between latitude 8^0 15'E and 8^0 30'E and longitude 4^0 45'N and 5^0 15'N. It has an estimated length of 56km and is about 2.8km wide at the mouth where it empties into the Cross River Estuary. Two climatic seasons wet and dry prevail in the study area. The wet season is characterized by high rainfall while the dry experiences occasional downpours. The shorelines are lined with dark mud plates usually exposed during low tides; the water at the shore is brackish and mostly rich in macroinvertebrates and debris. The banks are also surrounded by lush evergreen, forest vegetation with different species of trees, shrubs and grasses (Okorafor *et al*., 2012).

2.1.1 SAMPLING STATIONS
Three sampling stations (1-3) were chosen along the course of the River.

Station 1
The station is the control station; it is assumed to be unpolluted because activities are very minimal around the station. This station is located at Female Hostel within the University of Calabar community.

Station 2
The station is located at Obufa Esuk Beach, along the University of Calabar, Staff Quarters. The Substratum in the station is covered by mud and clay with average depth of 0.2m. It is swift-flowing and has a low transparency. The vegetation includes Fan palm (*Hyphaene petersiana*) and grasses grasses (Okorafor *et al.*, 2012).

Station 3
The station is located at University of Calabar Staff Quarters, beside the Female Hostel along Obufa Esuk Beach. Substratum here is covered with coarse sand and clay with an average depth of 0.2m. It is also swift-flowing and his medium transparency. The vegetation included Elephant grasses, Palm trees and Fan palm (*Hyphaene petersiana*).

2.2 COLLECTION OF WATER SAMPLES AND ANALYSIS
Water samples were collected fortnightly from each sampled stations with 200ml plastic containers washed with nitric acid to remove any form of contaminants. The sampling period spanned from January to August for both wet and dry season. Sampling was usually carried out between the hours of 8:00 am and 12:00 noon. The water samples collected were then taken to the laboratory and analyzed immediately to ensure that the physical and chemical properties of the water were maintained. Surface water temperature was recorded with a Mercury-in-glass thermometer; pH was measured *insitu* with pH meter (Model pH-1), Dissolved oxygen was measured *in situ* with Dissolved oxygen meter (Model DO–5509) and the water sample were taken to the Postgraduate laboratory, Department of Zoology and Environmental Biology and incubated for five days at 20^0C, after five days the reading was taken. The Dissolved oxygen (DO) of day one minus the DO of day five (DO_1- DO_5) gave the Biological Oxygen Demand (BOD) as recommended by APHA, (1995)

2.3 AQUATIC INSECTS SAMPLING AND IDENTIFICATION
At each sampled station, adult insects were collected from water surface using a dip-net with Nytex® netting of 500m mesh. Adult insects and their nymph were also collected from the vegetation's around the river using a sweep net with a mesh size of 250m. The sweep net was passed over the area for at least two minutes. The contents collected were placed in a sorting bucket and the net was properly checked for insects clinging to the mesh. Other several insects were handpicked from specific microhabitats throughout the River. Insects collected were later preserved in 70% Ethanol in jars labelled according to sample station, description, and collection date. All samples collected were taken to the Department of Zoology and Environmental Biology laboratory where they were transferred to a large watch glass for a more detailed examination under the dissecting microscope. Subsequently they were identified to order and family using identification key guide (Bouchard, 2004).

III. RESULTS
4.1 WATER SAMPLE PHYSICO-CHEMICAL PARAMETERS
Result of the physico-chemical parameters of Great Kwa River is presented in Table 1. The spatial trend in the pattern of each physico-chemical characteristic was similar along the River, physico-chemical parameters during the study period between stations shows significant difference for both seasons ($p<0.05$). Correlation coefficient (r) values for Physico-chemical parameters and Aquatic Insects (Orders) abundance for both wet and dry season are presented in Table 2. Plecoptera and Ephemenoptera significantly correlated positively with Biological oxygen demand (r = 0.99; 0.98) respectively. Hemiptera significantly correlated positively with Temperature (r = 0.98) and diptera significantly correlated positively with pH (r =0.99) at $p<0.05$.

COMPOSITION AND DISTRIBUTION OF AQUATIC INSECTS ENCOUNTERED DURING THE STUDY PERIOD
Results of the composition and distribution of aquatic insects in Great Kwa River show a total of 261 aquatic insects belonging to seventeen (17) families, seven (7) Order, and Eighteen (18) genera. The orders, Plecoptera, Ephemenoptera, Trichoptera, Odonata, Hemiptera, Diptera and Coleoptera were collected during the

study (Table 3). *Hemiptera* was more prevalent 95.0, (45.0%) in Female Hostel and (27.0) in Staff quarters. This was followed by *Diptera* 41.0, (20.0%) from Hostel Female and (12.0%) in Obufa Esuk Beach. The least collection was recorded in *Coleoptera* with no collections in Hostel and Staff quarters but (5.0%) in Obufa Esuk. The result shows that the aquatic insects distribution during this study differ significantly between stations ($P<0.05$). The result also shows the seasonal distribution of aquatic insects for both wet and dry seasons in Great Kwa River (Table 4). They the number of aquatic insects recovered in the wet season were higher than that of dry season. Odonata and Hemiptera recorded higher values than Trichoptera and Coleoptera recorded in wet season. In dry season, Hemiptera and Plecoptera recorded higher values while Coleoptera was lower. Distribution of aquatic insect in Great Kwa River differed significantly ($P<0.05$) between seasons.

IV. DISCUSSION

According to Leska, (1998), the variety of aquatic insects likely to be found in an excellent station includes different types of Aquatic Insects such as Stoneflies, Mayflies and Caddisflies. This corresponds to the stations sampled during the dry season with Ephemenoptera, Plecoptera and Trichoptera (EPT) richness being recorded in Unical Female Hostel and Unical Staff Quarters. This indicates that these two Stations were in good (useable) condition during the dry season. This might be as a result of less human activities observed in these areas as compared to Obufa Esuk Beach. However, Obufa Esuk Beach had no species of Plecoptera collection during the wet season. The absence of this order of aquatic insect indicates that the station was in a poor condition (Leska, 1998) especially that the Odonates found in this area were deformed. Ephemenoptera species were more prevalent in Obufa Esuk and Unical staff quarters with no significant difference in female hostel station. Peckarsky (2006) observed that Mayflies are very sensitive to water quality which include both chemical and temperature attributes. This temperature is usual for slightly polluted to polluted rivers. Seasonal variation is directly attributed to the climate of the study area which is usually characterized by a hot dry season and cold wet season (Harper and Peckarsky, 2006). During the wet season, low number of Trichoptera (caddisfly) was recorded (3.7%). According to silsby (2001), the larva of caddisfly does not tolerate polluted water, so finding a large population is a good sign for any aquatic body but the reverse is the case for low number. This indicates that a higher level of pollution occurred during the wet season. The observed variation in location may not be unconnected to water velocity, canopy cover, Nature of bottom sediments and the amount of dissolved oxygen in each station. Temperature values recorded during the sampling period ranged from 23 to 30ºC for both seasons. This value falls within the optimal range for tropical fresh waters. This was also corroborated by Ayodele and Ajani (1999), but that tropical freshwaters had temperature values ranging from 21 to 32ºC. The variation in temperature observed was as a result of low solar heat radiation across the stations. Inundation by run-off water into the River also causes a reduction in temperature (Popoola and Otalekor, 2011). This temperature reading indicates a great impact on the distribution of aquatic insects as more species were collected at relatively high temperature than when there was a drop in temperature. Ajao (1990) cited by Oben (2004), recorded similar observation during their studies. Pearson's correlation coefficient (r) analysis between aquatic insect abundance and water temperature showed that Hemiptera correlated positively with water temperature. Possibly because this aquatic insect is temperature dependent, this favours their rate of feeding and metabolism. Dissolved oxygen (DO), concentration in Great Kwa River was inversely related to changes in temperature. The low values of DO concentration recorded during this study, is an indication of deterioration of the water quality as a result of various anthropogenic activities in the stations as observed. Yakub (2004) also attributed the low level of DO in his study could be as a result of human activities discharged into the River. The plausible reason for low dissolved oxygen could be attributed to the small surface area of the sampling stations and the less impact of organic waste in these stations. Great Kwa River pH during the study ranged from 7.0–8.0. Pearson's correlation coefficient showed that pollution tolerant species such as Diptera had relationship with pH. The pH value obtained from this study ranged from slightly acidic. Most aquatic insects such as Diptera, Hemiptera and Coleoptera are only slightly affected by acidification whereas others like Plecoptera, Ephemenoptera, Trichoptera and Odonata are acid-sensitive and they are mostly found in clean waters that are alkaline in nature. Biological oxygen demand (BOD), concentration in Great Kwa River was related to changes in temperature. Pearson's correlation coefficient (r) analysis confirmed the relationship between BOD and water temperature. This observation agreed with Arimoro and Ikomi (2008) findings, who reported that increase in water temperature brings about a decrease in BOD. This is because as water temperature increases, biological oxygen demand decreases, also it may be due to respiration and other processes such as breakdown of organic matters. Pearson correlation coefficient analysis showed a positive relationship of the aquatic insect such as Plecoptera and Ephemenoptera with biological oxygen demand ad also showed statistical significance at $p<0.05$ value . This observation is in accordance with Emere and Nasiru (2007), from their study carried out in an urbanized stream in Kaduna, Nigeria.

V. CONCLUSION

This study brings forth the evidence on some aquatic insects as indicators of the extent and severity of pollution in the aquatic body. A close study of these aquatic insects could led to the fact that Great Kwa River has some level of pollution., it should be continuously monitored to reduce this pollution level and this was greater during the wet season as against the dry season. Expected future developments will put increasing pressure on the self-purification capacity of the River with negative consequences on most water uses.

REFERENCES

[1] Popoola, K. O. and Otalekor, A. (2011). Analysis of Aquatic Insects' Communities of Awba Reservoir and it's Physico-Chemical Properties. *Reserve Journal Environmental Earth Science*, 3(4), 422-428

[2] Arimoro F.O. and Ikomi, R. B. (2008). Ecological Integrity of upper Warri River, Niger Delta using Aquatic insects as bioindicators. *Ecological Indicators*, 395, 1-7.

[3] Bauernfeind, E. and Moog, O. (2000). Mayflies (Insecta: Ephemenoptera) and the assessment of ecological integrity: A methodological approach. *Hydrobiologia*, 135, 155-165.

[4] Deliz-Quiñones, K.Y. (2005). Water quality assessment of a tropical Freshwater marsh using Aquatic insects. M.Sc. Project Research in the Department of Biology University of Puerto Rico, pp. 148.

[5] Okorafor K. A, Andem, A. B., Okete, J. A., Ettah, S. E. (2012). The Composition, Distribution and Abundance of Macroinvertebrates in the Shores of Great Kwa River, Cross River State, South-east, Nigeria. *European Journal Zoological Research*, 1(2), 31-36.

[6] American Public Health Association (APHA) (1995). Standard Methods for the Examination of Water and Waste Water, 15th Edition, Washington D. C 1995; P. 32-33.

[7] Bouchard R. W. (2004). *Guide to Aquatic Macro Invertebrates of the Upper Midwest*. Water Resources Centre, University of Minnesota, St. Paul, MN, pp. 208.

[8] Leska S. F. (1998). *Field Guide to Fresh water invertebrates*: First Edition, pp. 120.

[9] Peckarsky B. L. (2006). *Predator-prey interactions*: Chapter 24 In: R. Hauer and G. Lamberti (Eds.)Methods in Stream Ecology, Second edition. Academic Press, New York, pp. 89.

[10] Harper M. P and Peckarsky, B. L. (2006). Emergence cues of a mayfly in a high altitude stream ecosystem: Implications for consequences of climate change. *Ecological Application*, 16, 612-621.

[11] Silsby, J. (2001). *Dragonflies of the World*. Natural History museum in Association with CSIRO Publishing,UK and Europe, pp. 122-127.

[12] Ayodele I.A and Ajani, E. K. (1999). *Essentials of fish farming* (Aquaculture). Odufuwa Press, Ibadan, pp. 46.

[13] Ajao E. A.(1990). The influence of domestic and industrial effluents on the population of sessile and benthic organisms in Lagos lagoon. Ph.D. Thesis, University of Ibadan, Ibadan, pp. 411.

[14] Oben, B.O. (2000). Limnological assessment of the impact of agricultural and domestic effluents of threeman-made lakes in Ibadan, Nigeria. Ph.D. Thesis, University of Ibadan, Nigeria, pp. 344.

[15] Yakub A.S. (2004). Assessment of water Quality and Plankton of Effluent receiving lower Awba stream and Reservoir, Ibadan. *African Journal of Applied Zoology and Environmental Biology*, 6, 107-110.

[16] Emere M.C and Nasiru, C. E. (2007). Macroinvertebrates as indicators of the water quality of an urbanized stream in Kaduna *Nigerian Journal of Fisheries*, 2(2), 152-157.

Table (1): Mean Variations and F-values of Physico-chemical Parameters for Wet and Dry Seasons at Sampling Stations along Great Kwa River

Parameters	Station 1	Station 2	Station 3	F–value	*P*-Probability	Inference
Wet Season						
Temperature (^{0}C)	25.7±0.58 (25-26)	25.5±2.18 (23 – 27)	25.7±1.15 (25-27)	1.12	P<0.05	(H_0 rejected)
pH	7.2±0.25 (7-7.5)	7.2±0.31 (6.9 -7.5)	7.3±0.31 (7 -7.6)	1.32	P<0.05	(H_0 rejected)
Dissolved oxygen (mg/L)	4.3±0.31 (4-4.6)	4.3±0.21 4.1 – 4.5)	4.3±0.06 4.3-4.4)	1.11	P<0.05	(H_0 rejected)
Biological oxygen demand (mg/L)	2.5±0.26 (2.3-2.8)	2.6±0.21 (2.4-2.8)	2.6±0.35 (2.3-3.9)	1.36	P<0.05	(H_0 rejected)
Dry season						
Temperature (^{0}C)	28.3±2.08 (26 – 30)	29.7±1.53 (28-31)	28.3±1.15 (27-29)	0.650	P<0.05	(H_0 rejected)
pH	8.4±0.38 (8 – 8.7)	8.8±0.51 (8.2-9.2)	8.6±0.68 (7.8-9.1)	0.320	P<0.05	(H_0 rejected)
Dissolved oxygen (mg/L)	3.7±0.58 (3 – 4.0)	4.7±0.29 (4.5-5.0)	4.6±0.72 (3.8-5.2)	0.530	P<0.05	(H_0 rejected)
Biological oxygen demand (mg/L)	1.8±0.72 (1 – 2.4)	2.5±0.25 (2.0-2.5)	2.7±0.81 (1.8-3.2)	0.340	P<0.05	(H_0 rejected)

Station 1*=Female Hostel,* ***Station 2****= Obufa Esuk Beach,* ***Station 3****=Unical Staff Quarters*

Table (2): Pearson Correlation (r) Values between the Physico-chemical Parameters and Aquatic Insects (Orders) for Wet and Dry Seasons at Great Kwa River.

Parameters / Aquatic Insects	Temperature (^{0}C)	pH	Dissolved Oxygen (mg/L)	Biological oxygen Demand (mg/L)
Plecoptera	-0.98	-0.99	-0.97	0.99*
Ephemenoptera	-0.99	-0.97	-0.98	0.98*
Trichoptera	-0.96	-0.95	-0.96	0.93
Odonata	-0.97	-0.96	-0.98	0.94
Hemiptera	0.98*	0.98	0.99	-0.97
Diptera	0.99	0.99*	0.90	-0.99
Coleoptera	0.98	0.97	0.92	-0.98

*Significant difference at p<0.05

Table (3): Composition and distribution of Aquatic Insects in Great Kwa River during the study period

Order	Family	Species	No. Collected	(%)
Ephemenoptera	*Baetidae*	*Afreobetodes Pusillus*	2	(0.8)
		Baetis sp.	4	(1.5)
	Caenidae	*Caenis* sp	11	(4.2)
	Ephemeridae	*Ephemera* sp.	17	(6.5)
Hemiptera	*Vellidae*	*Velia* sp.	18	(6.9)
	Gerridae	*Geris* sp.	27	(10.3)
	Belostomidae	*Belostoma* sp.	36	(13.8)
	Nepidae	*Nepa sp.*	14	(5.3)
Trichoptera	*Hydropsychidae*	*Hydropsychid* sp.	27	(10.3)
Coleopteran	*Gyrinidae*	*Gyrinus* sp.	5	1.9
Plecoptera	*Perlidae*	*Perlid* sp.	27	(10.3)
	Leuctridae	*Latelmis* sp.	6	2.3
Odonata	*Libellulidae*	*Pantata flarescens*	17	(6.5)
	Aeshnidae	*Aeshna* sp.	6	(2.3)
	Libelluidae	*Hemistigma* sp.	9	(3.5)
Diptera	*Chironomidae*	*Chironomus* sp.	9	(3.5)
	Culicidae	*Culex* sp.	30	(11.5)
	Culicidae	*Aedes* sp.	2	(0.8)

Table (4): Seasonal Distribution of Aquatic Insects (orders) in Great Kwa River.

Aquatic Insect (Order)	Wet Season		Dry Season	
	$\bar{X}$±S.D	%	$\bar{X}$±S.D	%
Plecoptera	7.33±0.33	(5.2)	25±0.58	(20.5)
Ephemenoptera	12.0± 0.58	(9.7)	20± 0.58	(16.5)
Trichoptera	6.0± 0.58	(3.7)	16± 0.58	(12.6)
Odonata	11.7±0.88	(48.5)	17.6± 0.89	(15.0)
Hemiptera	63.3±1.2	(48.5)	30.0± 0.58	(23.6)
Diptera	24.3±0.89	(19.5)	16. 0±0.58	(11.8)
Coleoptera	5.3± 0.33	(3.7)	2.7 ± 2.7	(0.00)

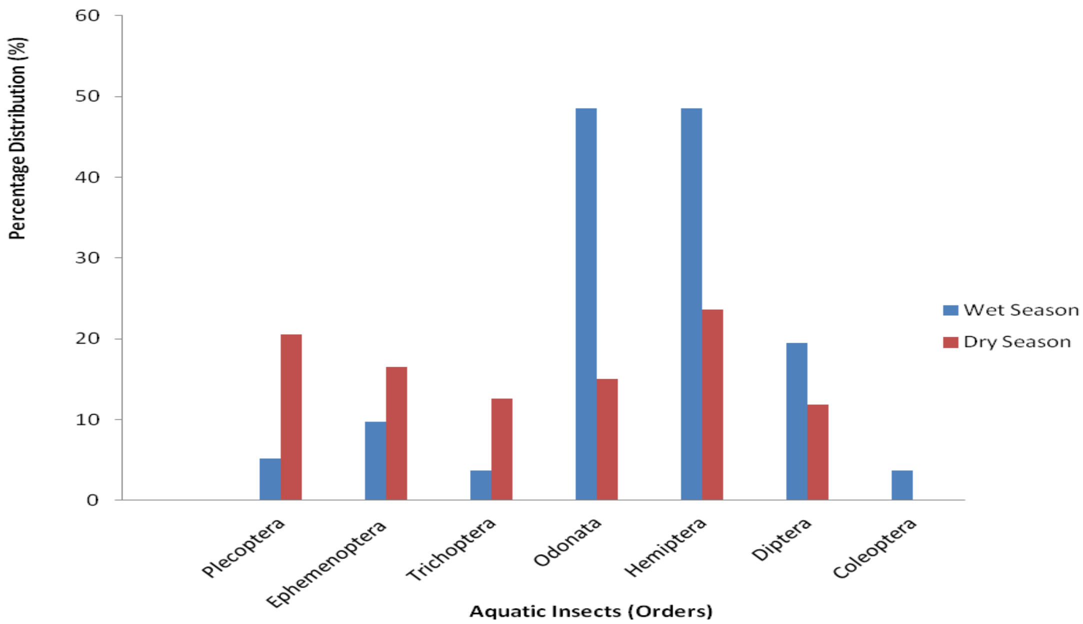

Figure (1): Seasonal distribution of Aquatic insects (orders) in Great Kwa River