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THE PHYSICO-CHEMISTRY AND AQUATIC INSECT'S DIVERSITY OF NWANIBA RIVER, AKWA IBOM STATE, NIGERIA

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ABSTRACT

The physico-chemical parameters and aquatic insect composition, distribution and abundance of Nwaniba River in Akwa Ibom State were investigated from March to September, 2013. Surface water samples were collected for physico-chemical parameters and aquatic insect analysis from four (4) sampling stations according to standard methods. The results of the physico-chemical parameters were within The National Environmental Standards and Regulations Enforcement Agency (NESREA) recommended limits for aquatic life in the tropic. A total of 2130 insect individuals were collected consisting of 7 Orders and 14 families. The Order Odonata was the most abundant with 55.8% followed by Coleoptera (37.75%), Hemiptera (4.5%), Diptera (1.7%), Orthoptera (0.2%), Hymenoptera (0.09%) and Dermaptera with 0.05% percentage abundance. The absence of pollution sensitive taxa such as Ephemeroptera, pecoptera and Tricoptera (EPT) which are only found in clean water bodies indicates that Nwaniba River is relatively polluted.

Contribution/ Originality: The paper contributes the first aquatic insect's diversity from the study area. There is no such study that has been carried out in the past; therefore, it will contribute into future studies.

1. INTRODUCTION

Water is an essential resource in which aquatic organism depends on for survival. When polluted, its value is lost and can become a threat to organisms inhabiting it Esenowo and Ugwunba [1]. Fresh water sources such as lake, river and streams are open to anthropogenic activities [2]. This results in changes in the physico-chemical properties of water, such as Temperature, Dissolved Oxygen, pH, Total dissolved solids (TDS), Salinity, Conductivity, Biological Oxygen Demand (BOD) etc. Variation in these water properties greatly influences the distribution patterns of aquatic insects, since some of them are highly sensitive to pollution while others are somewhat tolerant or completely tolerant to pollution and environmental disturbances [3, 4].

Aquatic insects are groups of arthropods that live or spend part of their life cycle in water bodies [5]. They are of great importance to water bodies were they are found and their presence in water serves various purposes such as food for fishes and other invertebrates, others as vectors through which disease pathogens are transmitted to both humans and animals [6, 7]. Most importantly, aquatic insects are very good indicators of water qualities [8-10].

Studies on aquatic insects of fresh water and stream ecosystem have frequently examined the species–habitat relationship with regard to the water quality of the habitat [10, 11]. Some species are known to have particular requirements with regard to nutrients, water quality, substrate components and the structure of vegetations [12-14]. Since fluctuations in aquatic insect community are commonly used as a tool for marking an integrated assessment of water quality, hence the need to investigate the water quality and aquatic insect of Nwaniba River.

2. MATERIALS AND METHODS

2.1. Study Area

Nwaniba River lies between (5°51′ N, 8° 41′ E; Figure 1) of longitude of south-south Nigeria (Figure. 1). The area has an annual rainfall of about 2500mm with a mean annual temperature of 32 °C and a relative humidity of 75%. The main source of this river is the Calabar- Itu River which runs from the Atlantic Ocean. During high tides it flows to Oron River and returns during low tides. The River has a beach called Nwaniba beach which serves as habour for logging activities, peasant fishing and other domestic activities like bathing and laundry.

The bank of the river is mostly covered with grass such as elephant grass (*Pennisetum purpureum*) and watercress (*Nasturtium officinale).* Mangrove swamp vegetation also included shrubs and trees such as white mangrove (*Laguncularia racemosa*), screw pine (*Pandamus spp*), mangrove palm (*Nypha fruticans*), and other pneumatophorous plant with prop roots. Tropical hydrophytes include Emegent, Free-floating and submerged aquatic plants, such as; Water hyacinth (*Eichhorina crassipes*), Water lilies (*Nymphaea lotus*), hornwort (*Ceratophyllum demersum*,) and Bladderwort (*Utricularia spp*). Located along the river is the Le Meridian Hotel and Tourist Resort (Ibom Five Star Hotel) which attracts foreigners to the locality.

Station 1 is the source flowing from Itam River in Itu LGA through Mbiakong River down to Nwaniba River. The banks of the area are covered by vegetations mostly elephant grass (*Pennisetum purpureum*), watercress (*Nasturtium officinale*). Other aquatic weeds found in this site included: water hyacinth (*Eichhorina crassipes*), water lilies (*Nymphaea lotus, Ceratophyllum demersum)*, Bladderwort (*Utricularia spp*).

Station 2 is 250 meters from Station 1 and 200 meters from the beach entrance. The banks of the area are also covered with vegetation especially with elephant grass (*Pennisetum purpureum*), watercress (*Nasturtium officinale*). Also submerged plants; Bladderworts (*Utricularia spp.*), *Elodea canadensis*, and *Ceratophyllum demersum* are found this station.

Station 3 is 300 meters from the beach entrance and 450 meters from Station 2. The banks of the area are covered with shrubs and trees like the white mangrove (*Laguncularia racemosa*), screw pine (*Pandamus spp*), mangrove palm (*Nypha fruticans*), and other pneumatophorous plant with prop roots. Floating and submerged plants are absent from this site. This site is used for fishing activities with the use of net traps.

Station 4 is 250 meters from Station 3 with the bank of the river made up of mangrove swamp with Elephant grasses (*Pennisetum purpureum*) and is sparsely distributed. Other plants includes mangrove palm (*Nypha fruticans*), screw pines (*Pandamus spp*), floating and submerged plants is absent from this site. Fishing activities also occurred here with the used of net traps, baits, and cast nets.

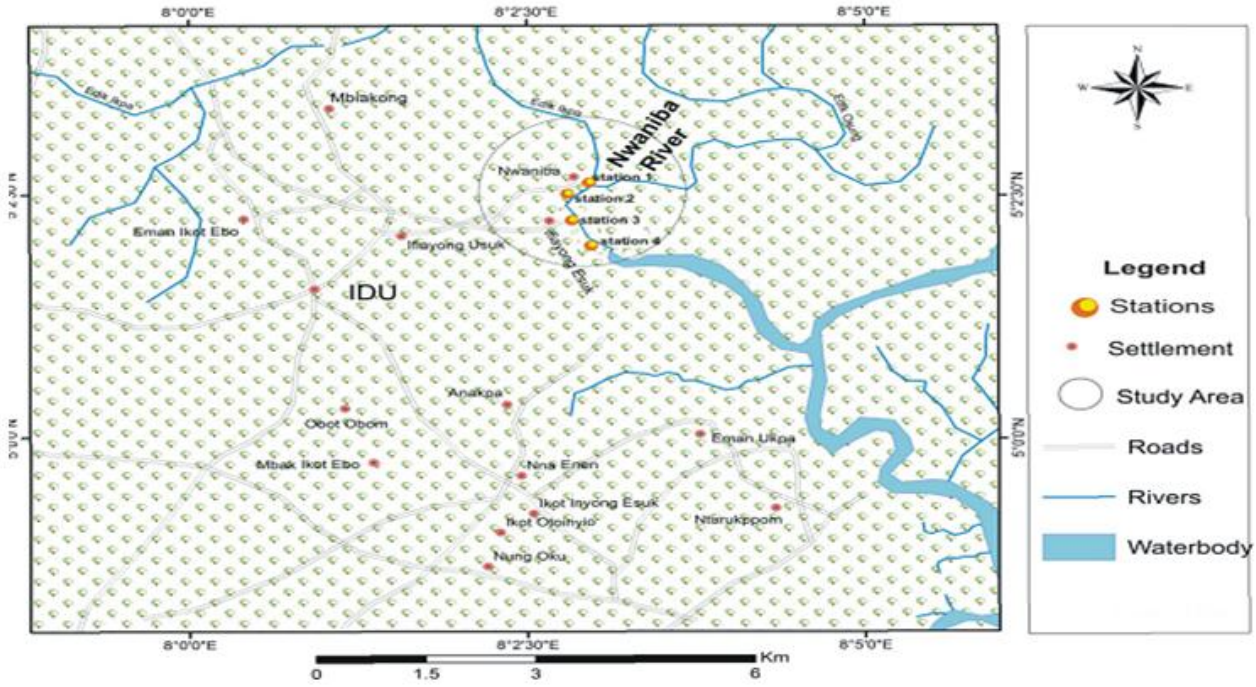

Figure-1. Map of Nwaniba River showing sampling stations

Source: Department of Geography, University of Uyo.

2.2. Sample Collection

Surface water samples were collected in 250 ml glass bottles to determined pH, conductivity, total dissolved solids, Dissolved Oxygen, Biochemical oxygen demand, alkalinity and salinity. Water temperature, transparency and water depth were measured in situ. Surface water temperature was determined using a centigrade mercury-in-glass thermometer and the results were expressed in degrees Celsius (°C). Transparency was measured using a Secchi disc, while water depth was measured with a graduated long pole which was dipped into the river and later measured out with a measuring tape. The results were expressed in meter. The hydrogen ion concentration (pH) was determined in the laboratory using Buffered electronic pH meter. Salinity, TDS and conductivity were measured using an Extech meter Model ExStik EC400. Alkalinity was measured with LaMotte Freshwater Aquaculture Test Kit Model AQ-2. As recommended by American Public Health Association [15] Dissolved oxygen and Biochemical Oxygen Demand concentration was determined using the azide modification of the iodometric method. The results were expressed as mg/L.

Aquatic insects were collected using a sweep net by dragging and sweeping the net along the vegetations and on the surface of the river. After collection, they were placed in a sorting bottle and preserved using 4% formalin. All insects collected were taken to the Entomology Laboratory of Zoology Department, University of Uyo, for identification using the guides of Pennak [5]; Gerber and Gabriel [16] and Danladi, et al. [17]. The numbers were counted.

3. RESULTS

The range, mean and standard error of the physico-chemical parameters of Nwaniba River are shown in Table 1 while Table 2 shows the spatial variation in mean and standard error of the physic-chemical parameters in the four sampling stations.

Table-1. The physico-chemical parameters of Nwaniba River from March to September 2013

Physico-chemical parameters	Range	Mean ±Std Error
Water Temperature (°C	26 - 31	28.02±0.33
Dissolved Oxygen (mg/L)	1.40 – 4.95	4.00±0.22
Biological Oxygen Demand (mg/L)	00 – 0.96	0.66±0.06
pH	5.7 – 8.10	6.61±0.12
Salinity (ppt)	0.01 – 0.04	0.02±0.002
Conductivity (µS/cm)	16.60 – 74.4	25.27±2.28
Total Dissolved Solute (mg/L)	9.10 – 31.0	12.67±0.89
Transparency (m)	0.1 - 0.9	0.63±0.04
Water depth (m)	0.2 - 8.4	3.75±0.57

Source: Current research results

Table-2. Mean and standard error of the physico-chemical parameters measured at the four sampling stations

Physico-chemical Parameters	Station 1	Station 2	Station 3	Station 4
Water Temperature (°C)	27.83±0.70	27.91±0.78	28.16±0.65	28.02±0.70
Dissolved Oxygen (mg/L)	4.0±0.48	4.06±0.41	3.92±0.43	3.93±0.52
Biological Oxygen Demand (mg/L)	0.65±0.13	0.68±0.14	0.60±0.12	0.69±0.14
pH	6.53±0.21	6.60±0.21	6.60±0.24	6.74±0.35
Salinity (ppt)	0.014±0.001	0.013±0.001	0.014±0.001	0.02±0.005
Conductivity (µS/cm)	20.97±1.5	23.52±1.91	23.29±1.31	33.31±8.36
Total Dissolved Solids (mg/L	11.23±0.51	12.62±0.75	12.11±0.84	14.73±3.40
Transparency (m)	0.65±0.07	0.65±0.09	0.62±0.07	0.63±0.11
Water depth (m)	4.70±1.05	6.0±1.45	2.54±0.60	1.8±0.47

Source: Current research results

Aquatic insect encountered consisted of 7 orders and 14 families (Table 3). A total of 2130 insect individuals were collected from three (3) sampling stations. 770 insect individuals were recorded in Station 1, 756 in Station 2 none were encountered in Station 3 and 604 from Station 4. The Order Odonata was the most abundant with a percentage of 55.8% followed by Coleoptera 37.75%, Hemiptera 4.5%, Diptera 1.7%, while Orthoptera, Hymenoptera and Dermaptera were less than 1% respectively.

Table-3. Compositions and Distribution of Aquatic Insects encountered in Nwaniba River from March to September 2013

Insect Diversity		Sampling Stations				Abundance		
Order	Family	1	2	3	4	Total	Percentage (%)	
Coleoptera	Haliplidae	97	92	-	107	296	13.9	37.75
	Hydrophiliidae	167	208	-	131	506	23.8	
		264	300	-	238	802		
Hemiptera	Hydrometridae	6	6	-	2	14	0.7	4.5
	Mesovellidae	12	18	-	3	33	1.5	
	Gerridae	22	22	-	6	50	2.3	
		40	46	-	11	97		
Orthoptera	Tettigoniidae	-	4	-	-	4	0.2	0.2
Dermaptera	Forficulidae	-	1	-	-	1	0.05	0.05
Diptera	Tipulidae	-	-	-	1	1	0.05	1.7
	Muscidae	-	-	-	1	1	0.05	
	Tabanidae	5	2	-	9	16	0.8	
	Calliphoridae	6	7	-	3	16	0.8	
		11	9	-	14	34		
Hymenoptera	Chysididae	-	2	-	-	2	0.09	0.09
Odonata	Aeschinidae	154	203	-	119	476	22.3	55.8
	Gomphidae	301	191	-	222	714	33.5	
		455	394	-	341	1190		
TOTAL		**770**	**756**	**-**	**604**	**2130**		

Source: Current research results

4. DISCUSSION

4.1. Physico-Chemical Parameters

The spatial variation in the physico-chemical parameters of Nwaniba River reveals the influence of anthropogenic activities on the water body. The water temperature recorded ranged from 26-31°C and this falls within the normal temperature range recommended by NESREA for aquatic life in the tropical region. This also corroborated with Ayodele and Ajani [18] that tropical freshwaters had temperature values ranging from 21-32°C. The observed variation in temperature can be attributed to seasonal variation and rainfall pattern [19]. The Dissolved Oxygen recorded a mean value of 4.0±0.22mg/l and this was lower when compared to the NESREA limits for tropical freshwater (5.0mg/l). This could also be attributed to various human and anthropogenic activities such as bathing/laundry into the river, logging and offloading of timber etc. This is corroborated by Yakub [20] and Esenowo and Ugwunba [1] that the presence of submerged aquatic vegetation and anthropogenic activities in the Ogunpa River and Majidun River may have contributed to the decrease in the dissolved oxygen.

Biological oxygen demand (BOD) is important because it provides a measure of the level of organic pollution as a result of consumption of oxygen in the course of biological process of breaking down of organic molecules into inorganic forms [21]. The BOD recorded a mean value of 0.66±0.06mg/l and this was lower than the average value of 4mg/L by NESREA as usable for aquatic life in the tropical region. The water pH ranged from 6.0-8.0 and this falls within the acceptable limit recommended by NESREA for aquatic life in tropical region. Naturally, surface water tends to be alkaline while ground waters are more acidic [22]. The mean values for salinity was 0.02±0.001ppt, indicating that the river is a freshwater habitat.

Conductivity is a measure of water ability to convey an electrical current and is usually related to concentration of total dissolved solids [23]. Conductivity recorded a mean value of 25.27±2.28 µs/m while, TDS was 12.67±0.89ppm. Water transparency ranged from 0.1-0.9m with a mean value of 0.62±0.04m and water depth recorded a mean value of 3.75±0.57m.

4.2. Composition and Distribution of Aquatic Insects

Aquatic insects of Nwaniba River showed spatial variations across the sampling stations. The order Coleoptera, Hemiptera and Odonata were spatially distributed except in Station 3 that recorded no aquatic insect, while Order Orthoptera (Tettigonidae), Demaptera (Forficulidae) and Hymenoptera (Chysididae) were encountered in Station 2 only and Station 4, the Order Demaptera (Tipulidae) and Diptera (Muscidae) were encountered. The variation in the distribution could be as result of nutrient requirements, water quality, substrate components and vegetation structure. Similar report by Popoola and Otalekor [13] showed that water quality plays a vital role in the distribution, abundance and diversity of aquatic insects in Awba Reservoir, Ibadan.

The Order Odonata can survive in low dissolved oxygen because they have a closed tracheal system and could move to the water surface to obtain atmospheric oxygen by trapping air bubbles [12, 24]. No wonder they accounted for up to 55.8% of the total percentage of aquatic insect in Nwaniba River, while the Order Diptera reduce feeding activities and focus more on the respiratory movements when the dissolved oxygen were very low [25-27] hence the low percentage in abundance.

Ward [24]; Rife and Moody [28] reported that the insect group of Ephemeroptera, Plecoptera and Tricoptera (EPT) are sensitive to water quality changes. Their presence in high abundance signifies a relatively clean environment, while their absence is considered to signify environmental stress / pollution. Result from this present study shows that water quality parameter along with vegetation type, plays a role in the distribution of aquatic insects in Nwaniba River; and the absence of pollution sensitive taxa such as Ephmeroptera, Placeoptera and Tricoptera (EPT) which are only found in clean aerated water indicates that Nwaniba River may be under pollution stress, hence there is need for proper management of the river.

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